NURSES AND MONOPSONY POWER OF HOSPITALS:

THE POSSIBILITY OF STRUCTURAL CHANGE

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PREFACE

This paper sought to analyze and discuss the ability of hospitals to use monopsony status to suppress wages for nursing professionals. Recent market developments, including the impact of government policy changes, were discussed. Monopsony models were examined to demonstrate the relationship between greater employer buying power and lower levels of wages and utilization for labor. Data for registered nurses in Oklahoma were then evaluated in an effort to determine the factors relevant to wage and employment levels. Wage disparities between hospitals were largely explained by factors other than buying power. Estimated supply elasticities suggested that average monopsony power was weak.

I sincerely thank the members of my doctoral committee, Drs. Joseph M. Jadlow (Chair), James R. Fain, Kevin M. Currier, and Timothy L. Krehbiel for their guidance and inspiration. My sincere gratitude is also extended to my parents, Paul and Janet Biller, for their patience and support. Thanks are also in order for my sister, Janice Biller RN, for her unique insight into the nursing field.

And finally, my love and thanks to my sons, Joshua and Christopher, for their timeless faith in their daddy.

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Chapter II

w	wage
N^{hd}	hospital demand for nurses
N^{hs}	hospital supply of nurses
N^{D}	market demand for nurses
N^{S}	market supply of nurses
N^{fd}	fringe demand for nurses
$\bar{w}$ or MFC	marginal factor cost
c	hospital fraction of nursing supply
b	hospital fraction of nursing demand
w_c	competitive wage
N_f	employment by fringe firms in composite model
E^{hs}	wage elasticity of hospital supply
E^{S}	wage elasticity of market supply
E^{fd}	wage elasticity of fringe demand
MRP	marginal revenue product

Chapter IV

α_1	dw/dN^{hs} (slope of hospital inverse supply)
α_2	dw/dN^{hd} (slope of hospital inverse demand)
β_1	parameter vector for supply
X	exogenous variables for supply
β_2	parameter vector for demand
K	exogenous variables for demand
RN^{m}	market total of RNs
RN_i	RNs employed at hospital i
RN^{c}	competitive RNs
RNGRADS	local RN graduates
CWAGE	county wage level
CEMPL	county employment level
MIX	hospital case mix
AGE	percent of county population over age 65
LPN	licensed practical nurses
ADMITS	hospital admissions
CENSUS	hospital average daily census
MDS	hospital staff MDs
λ_r	ratio of LPN to RN wages by region r
γ_c	fraction of hospital expenditures on benefits by size classification c
*	denotes an equilibrium value

I

INTRODUCTION

A. Recent Conditions in the Nursing Market

Do hospitals use their status as the principal purchaser of nursing services to suppress nursing pay? Conventional wisdom suggests that this is quite likely to be the case. However, those espousing conventional wisdom seem to have had some difficulties sorting out some recent trends in the market for nurses.

Reports of nursing shortages were prevalent throughout the 1980s, reaching critical levels in 1979 and 1986. According to American Hospital Association data, roughly 14 percent of all nursing employment positions were vacant at these times.

Popular beliefs surrounding the nursing shortage included the contention that hospital working conditions were becoming overwhelming and stressful. Deplorable conditions were causing a mass exodus of nurses from the profession. After all, only a great flight from nursing could explain the apparent paradox that a nursing shortage should exist at a time when hospital budgets were being curtailed. Hospital utilization fell significantly over the 1983 to 1990 period as medicare's prospective payment system was implemented and the number of inpatients was being reduced.

Also interjected into the analysis was the issue of comparable worth. Nursing, after all, is an occupation comprised almost entirely (97 percent) by females [7]. Thus, discrimination against women was being offered as an explanation for low pay and shortages.

In reality, nurses were not leaving the profession, and hospitals were adding nurses to their staff in large numbers. Labor force participation among registered nurses remained at roughly 80 percent [1]. While total hospital employment was falling, the number of full time equivalent nurses being employed increased by nearly 40 thousand from 1983 to 1986. So, contrary to popular belief, the nursing shortage of recent times appears to have come from the demand side of the market.

Still, the impression remained that something was fundamentally iniquitous in the nursing market. As is evidenced by the following comment from Dollars & Sense.

> "Like other traditionally female occupations, nursing has been undervalued. Moreover, although nurses carry professional status, their wages are more in line with the pay of other wage workers than that of other professionals. .... While the current shortage is forcing employers to bid up nurses' wages and hospitals are even offering bonuses and bounties for finding nursing recruits, nursing is still not a profession known for its financial rewards. When the shortage ends, so will the wage increases."[7]

From the tone of this passage it seems as if the author believes that, somehow, wages were supposed to continue upward after the shortage was alleviated. To the economist, it is exactly the termination of wage increases that signals the end of a shortage. But the competitive model of supply and demand appears to fail to explain the chronic nature of shortages in the nursing market.

The fact that complaints of a shortage of nurses have persisted for more than fifty years has driven economists to look into alternative explanations of the market for nurses. One of the explanations involved the application of a monopsony power model to the nursing market. Hospitals are a primary purchaser of nurse services and therefore might be capable of exerting considerable market buying power in their purchase of nursing services as well as that of other professional labor.

A list of vacancy rates for various hospital professional staff is provided in Table 1.1. The occupations are ranked by their 1991 vacancy rate. A casual glance at these figures seems to point to higher vacancy rates for more specialized positions requiring greater training. One would expect hospitals to have greater buying power for these positions because fewer employment options exist for these individuals. Note, for instance, the vacancy rate for nurse aides/assistants is 3.9 percent. This is a job which requires relatively little training or experience and is usually filled by individuals with many other employment options. Compare this to vacancy rates for licensed practical vocational nurses (LPNs) and staff nurses (RNs and BSNs). The LPN position typically requires one year of vocational school training and staff nurses require two to four years of higher education. Greater investments of human capital for these individuals will tend to narrow their employment opportunities and provide a captive market for their employers. So higher vacancy rates for LPNs (6.4 percent) and RNs (8.1 percent) would be consistent with the monopsony hypothesis.

The monopsony model could explain nursing shortages as well as the observation that nurses have been used more intensively by hospitals in the last decade. If employer power can effectively suppress wages or wage increases then, relative to other professionals, the nurse becomes an increasingly inexpensive resource. Add to this a lack of asset specificity, and nurses can readily be substituted for other professionals. This is precisely the employment pattern exhibited since 1970. Specifically, the nurse to patient ratios increased from 50 per 100 (average adjusted daily census) in 1972 to 91 per 100 in 1986.

A contention of the "captive market" or monopsony hypothesis is that, in markets with more than one hospital, the hospitals act collusively or at the very least, avoid wage competition. This is not a terribly unrealistic assumption. Indeed, in a 1971 survey by Yett, 14 of the 15 hospital associations which responded indicated that they employed a

Table 1.1

HOSPITAL VACANCIES FOR FULL TIME POSITIONS (%)

OCCUPATION	1991 RATE	1989 RATE
Pharmacy technician	3.4	4.1
Nursing aide/assistant	3.9	4.2
Clinical perfusionist	5.1	11.5
Medical technologist	5.2	6.0
Medical laboratory technician	5.3	6.4
Surgical technologist	5.4	4.4
Social worker	5.5	7.0
Medical transcriptionist	5.6	6.2
Pharmacist	5.7	7.1
Histologic technician	5.9	6.3
Licensed practical vocational nurse	6.4	6.5
Medical record coder	6.7	6.6
Radiologic technologist	6.7	7.6
Ultrasound technologist	7.0	8.3
Respiratory therapist	7.4	8.9
Staff nurse	8.1	8.7
Nuclear medicine technologist	8.2	9.1
Physical therapy assistant	8.2	7.8
Certified registered nurse anesthetist	9.4	10.8
Occupational therapy assistant	10.3	8.2
Speech pathologist	11.1	9.9
Cytotechnologist	12.8	12.3
Radiation therapy technologist	12.9	10.3
Physician assistant	12.8	10.1
Occupational therapist	14.2	13.6
Physical therapist	16.6	16.4

Source: AHA Human Resource Survey, 1989 and 1991

"wage-standardization" program for nursing pay.[1] A more tacit type of cooperative behavior was observed by Aiken:

[1] It is a popular anecdote in the nursing market literature that the fifteenth respondent to Yett's survey did not have a wage standardization program, but asked him how they might implement one.

> "Moreover, hospital administrators tend to assume that there is a finite number of nurses in any given community, and that wage competition among hospitals will be costly and will not resolve community shortages."[1]

In a study of the nursing shortage of the mid-1980s, the National Center for Health Services Research found that hospitals did not increase their relative expenditure on nursing salaries in the face of what was considered a severe shortage.

> "A surprising finding...is that high shortage hospitals did not increase nursing salaries as a percent of total hospital expense in the two years following their relatively high shortage in 1982. In fact, high shortage hospitals raised salaries less than low shortage hospitals according to all measures. The classic market solution for eliminating shortages apparently has *not* been tried by the hospital industry."[25]

This finding may be consistent with the presence of monopsony power. If shortages are due to market power, then hospitals with the greatest shortages would also have the most sluggish response to changes in wage levels.

Lower wages are not necessarily the only way in which monopsony power could manifest itself. Market power may lead to complacency or "x-inefficiency". Nurses have traditionally exhibited a preference for daytime work. It has been observed that shift differentials in the hospital industry are relatively small and do not provide sufficient incentive to staff evening and night shifts. Instead, hospitals often make shift rotation a mandatory condition of employment. Data for Oklahoma hospitals indicate that shift differentials are highest for hospitals in the metropolitan areas of Oklahoma City and Tulsa, where a greater degree of competition for nurses would be expected. On average, 1992 RN shift differentials for metropolitan hospitals exceeded those of rural hospitals by a margin of 45 percent for evenings, 40 percent for nights and 24 percent for weekends [21].

Effective wage reductions can be achieved by increasing work requirements and reducing the support staff available to the clinical nurse. Finally, hospitals seem to have performed poorly in employee retention and providing monetary incentives for nurses to continue their education. Even as beginning salaries approach those of other college graduates, the average nurse can expect her/his annual salary to increase by only $7000 over the course of her/his career [7]. Wage premia between nurses with two year associate degrees and those with a bachelors degree are virtually insignificant. All of these factors provide suggestions for additional indicators of hospital monopsony power.

B. The Purpose and Goal of This Project.

The monopsony model seems to explain much of the past. Indeed, one may ask if shortages have more to do with a lack of competition than a lack of supply. But does hospital monopsony power exist now? Overall hospital monopsony power may have faced some erosion in recent years. This hypothesis grows from the observation that the imposition of a prepayment system for hospital services based upon diagnostic related groupings (DRGs) has decreased the typical length of a hospital stay. As a result, more out-of-hospital nursing services are being demanded. Taking Oklahoma as an example, data obtained from the Oklahoma Board of Nursing indicate total nursing employment has increased from 1988 to 1992. These data are summarized in the table below.

Table 1.2

TOTAL RNs RESIDING IN OKLAHOMA BY FIELD OF EMPLOYMENT

	Hospital	Nsg. Home	School Of Nsg.	Pvt. Duty	Cmnty. Health	Sch. Nurse	Ind./ Office Nurse
1988	10733	401	395	246	1180	247	1236
1990	11053	494	436	157	1584	238	1273
1992	11885	654	486	168	2039	257	1332
%CHANGE 88-92	10.7	63.1	23.0	-31.7	72.8	4.0	7.8

PERCENT OF TOTAL RNs RESIDING IN OKLAHOMA BY FIELD OF EMPLOYMENT

	Hospital	Nsg. Home	School Of Nsg.	Pvt. Duty	Cmnty. Health	Sch. Nurse	Ind./ Office Nurse
1988	74.3	2.8	2.7	1.7	8.2	1.7	8.6
1990	72.5	3.2	2.9	1.0	10.4	1.6	8.4
1992	70.6	3.9	2.9	1.0	12.1	1.6	7.9
CHANGE 88-92	-3.7	1.1	0.2	-0.7	3.9	-0.1	-0.7

Source: Oklahoma Board of Nursing

One of the most striking features of these data is the rather dramatic increase in nursing home and community health nurses over the past four years. The data for LPNs in Oklahoma maintain a similar trend.

As will be demonstrated below, an increasing ratio of non-hospital to hospital employment is an indication of declining monopsony power. Data from the table above indicate that this ratio has, in aggregate, increased from a value of .335 in 1988 to .415 just four years later. This points to the possibility of reduced monopsony power to hospitals as a group, and does not take into account the additional possibility of competition between hospitals.

It is believed that the principle reason for this shift in nursing employment is the incentive to reduce hospital utilization which is the result of the DRG payment system. It is a well documented fact that the average length of a hospital stay as well as the number of inpatient days decreased substantially in recent years [24,s151]. It seems plausible that a government action designed to reduce public health care expenditures may have inadvertently stimulated competition in the nursing field. With these trends in mind, it appears worthwhile to take another look at the conventional wisdom which tells us that hospitals are capable of monopsony tactics in the nursing market.

II

MONOPSONY MODELS

A. Monopsony Power as a Consequence of Market Share

A model in which vacancies exist in equilibrium was applied to the nursing market by Donald Yett [26]. In the model's simplest form, a single hospital faces the entire market supply for nurses. This supply represents the average wage paid by the hospital to acquire nursing services. Since the hospital must raise wages for all nurses, including the existing staff, to acquire additional nurses; the marginal factor cost will exceed wages for all levels of nursing input. This situation is illustrated in Figure 2.1(b). The profit maximizing (or cost minimizing) hospital will achieve equilibrium at point A in the figure as opposed to the competitive equilibrium at point B. The hospital's monopsony level of employment and wages will be lower than those that would exist under competitive conditions.

Furthermore, it has been suggested that, at least in the short term, the hospital may continue to report or advertize vacancies equal to the excess demand at wage w^* (equal to $N^{hd*} - N^{hs*}$). These vacancies would be advertised even though the

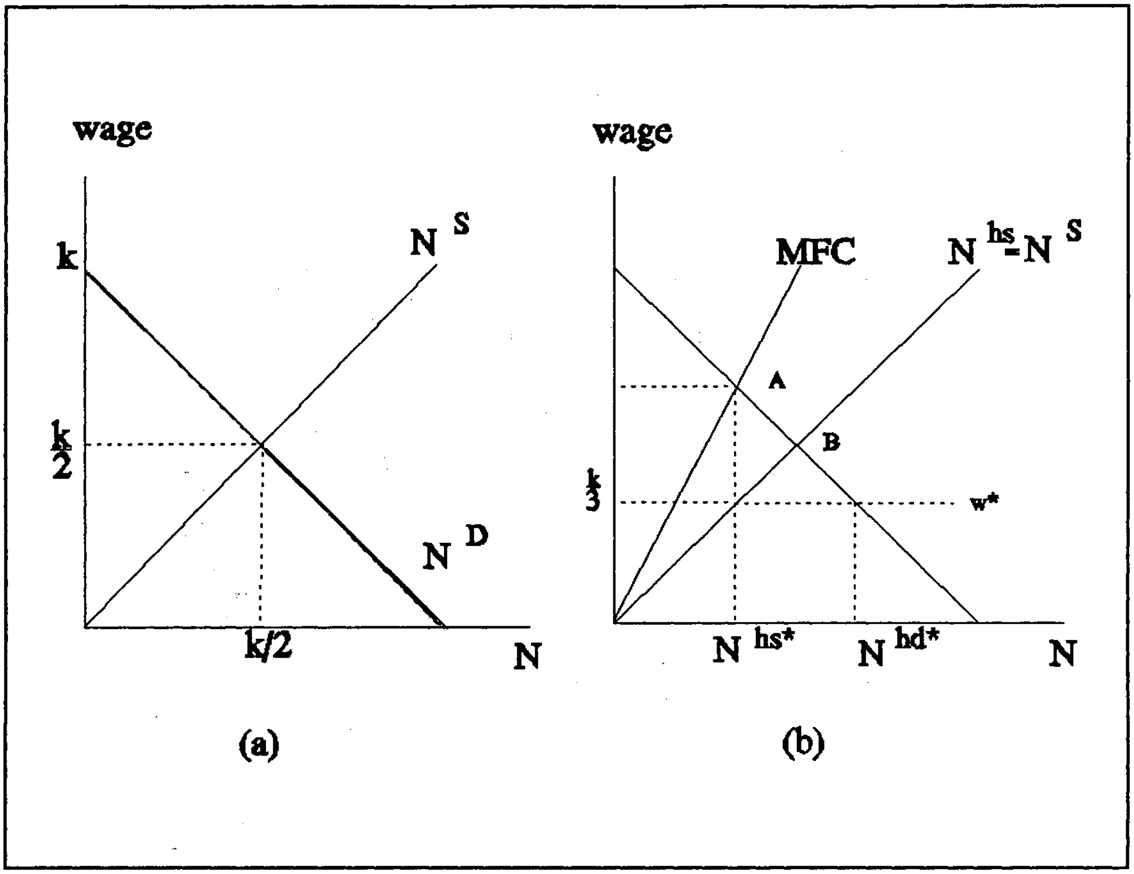

Figure 2.1
Perfect Competition (a) and Pure Monopsony (b)

hospital has no incentive to raise wages in order to eliminate the excess demand or "shortage". At a wage rate of w^*, the hospital would be willing to purchase up to N^{hd*} units of nursing services. This is because the marginal revenue product (A) of the last nurse to be hired (N^{hs*}) is greater than w^*. This is what Yett referred to as an "equilibrium shortage". This type of shortage is to be contrasted to the traditional economic concept of a "dynamic" shortage which would develop as the result of demand increasing faster than supply. Even if one does not accept the view that equilibrium shortages are significant, it can be argued that monopsony wages would continuously dampen incentives for individuals to enter the nursing market. This lack of entry would slow down increases in nursing supply and thus exacerbate the dynamic shortage.

Closer investigation of the market calls for a more sophisticated analysis. First, cities or markets of substantial size will have more than one hospital. Second, hospitals typically face some competition for nurses from other employers. Nursing homes, home health agencies, schools, physicians and private industrial firms represent alternative employment for nurses. Yett made the following observations: 1) Wages for office nurses employed by physicians as well as nurses in long term care facilities and private duty nurses were closely tied to wages for hospital nurses. 2) Wages for nurses employed by educational institutions and manufacturing firms were typically above the hospital wage scale, and nurses in these occupations exhibited relatively low turnover. Finally, 3) nurses tended to view hospital and hospital related occupations as "residual employment". Hospital employment is seen as residual in the sense that nurses have generally shown a preference for the wages and working conditions of non-hospital employment. For example, a home health nurse typically faces a less intense environment, less supervision, and more flexible working hours than a hospital nurse. With the focus on the impact of non-hospital employment of nurses, an appropriate model for most hospital markets is that of firms which dominate employment in the local labor market but face a significant "competitive fringe" in the acquisition of nursing services.

In this model, a hospital or a group of major hospitals acting cooperatively (hereafter referred to as the dominant firm or "the" hospital), will exercise monopsony control over a significant proportion of the local market. The dominant firm sets wages according to its optimal input condition. Remaining nurse employers (hereafter referred to as the fringe or competitive employers), then act as price takers of the hospital wage.

The model is best illustrated with the use of a simple example.[2] Suppose the market for nurses was characterized by the following supply and demand conditions:

(2.1) Market demand:
$$N^D = k - aw \quad \text{or} \quad w = \left(\frac{1}{a}\right)(k - N^D)$$

(2.2) Market supply:
$$N^S = k_o + a_o w \quad \text{or} \quad w = \left(\frac{1}{a_o}\right)(-k_o + N^s)$$

where w represents the wage rate and k, k_o, a, and a_o are constants. To simplify the exposition and focus solely on the

[2] A discussion of the structure and performance of a product market with a dominant firm and competitive fringe can be found in Carlton and Perloff [6, 231-236].

impact of market share, let us assign parameter values of $k_o = 0$, and $a = a_o = 1$.

The extreme cases with respect to market power are illustrated in Figure 2.1. Figure 2.1(a) represents the competitive case where equilibrium wage and output are both equal to (1/2)k. Figure 2.1(b) is the pure monopsony case. The single buyer's marginal factor cost is equal to the demand for nurses at a wage and input level of (1/3)k.

Now suppose the hospital or dominant firm's share of the market was given by the fraction b ($0 < b < 1$). Market demand is now segmented between the hospital and fringe employers. The hospital's demand for nurses is given as

$$(2.3) \quad N^{hd} = bN^D = b(k-w) \quad or \quad (2.3a) \quad w = k - \left(\frac{1}{b}\right) N^{hd}$$

Fringe demand then, is

$$(2.4) \quad N^{fd} = (1-b)N^D = (1-b)(k-w) \quad or \quad (2.4a) \; w = k - \frac{1}{(1-b)} N^{fd}$$

These modifications and the resulting equilibria are represented in Figure 2.2. The diagram on the left represents the demand for nurses of non-hospital or competing nurse employers, denoted N^{fd}. The diagram on the right represents the market supply of nurses and the "residual supply" of nurses faced by the dominant firm, N^S and N^{hs} respectively. The dominant firm's supply is equal to the market supply less the quantities demanded by fringe firms.

Subtracting Equation 2.4 from Equation 2.2 yields the supply of nurses to the hospital.

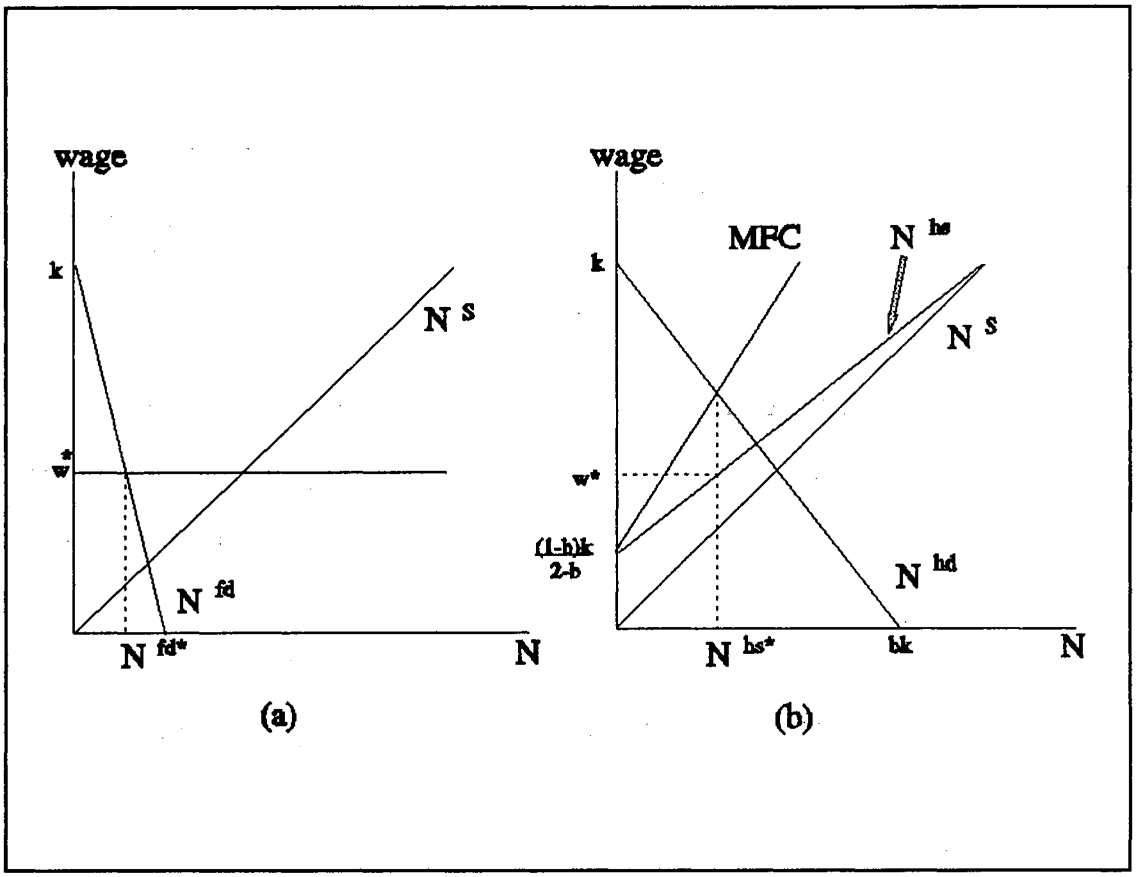

Figure 2.2
Competitive Fringe (a) and Dominant Firm (b)

(2.5) $$N^{hs}=(b-1)k+(2-b)w$$

Solving for wages yields,

(2.5a) $$w=[(1-b)/(2-b)]k+[1/(2-b)]N^{hs}.$$

Multiplying Equation 2.5a by N^{hs}, then taking the derivative with respect to N^{hs} will yield the hospital's marginal factor cost curve.

(2.6) $$\overline{w}=MFC=[(1-b)/(2-b)]k+[2/(2-b)]N^{hs}$$

Equilibrium values can now be derived. The dominant firm will maximize profits at the input level where MFC = N^{hd}.

Setting Equation 2.6 equal to Equation 2.3a provides the optimal level of nurse employment to the hospital.

$$N^{hs*} = \left(\frac{b}{2+b}\right) k \qquad (2.7)$$

The corresponding wage level is then found from the residual supply, Equation 2.5a.[3]

$$w^{*} = \frac{2-b^2}{4-b^2} k \qquad (2.8)$$

Figure 2.3 illustrates the path of hospital wages and employment as market power varies from pure competition (b=0) to pure monopsony (b=1). As expected, $dw/db = -4bk/(16-8b^2+b^4) < 0$, and $dN^{hs}*/db = 2k/(2-b)^2 > 0$.

Fringe employers can now operate under a "wage umbrella" created by the hospital(s). They can hire all the nursing services they desire, paying wages at or above the hospital level. This gives the horizontal nurse supply curve to many non-hospital firms observed by Yett [26]. Substituting the equilibrium wage into the fringe demand function, Equation 2.4, gives the number of nurses employed by competitive firms.

Equilibrium provides some interesting results. The level

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[3] Wages and employment would be further depressed in the case that the hospital operates with monopoly power in its product market. Setting marginal revenue to marginal factor cost yields a hospital employment level of

$$N^{hs*} = (b/4)k$$

and a wage of

$$w^{*} = [((1-b+(b/4))/(2-b)]k.$$

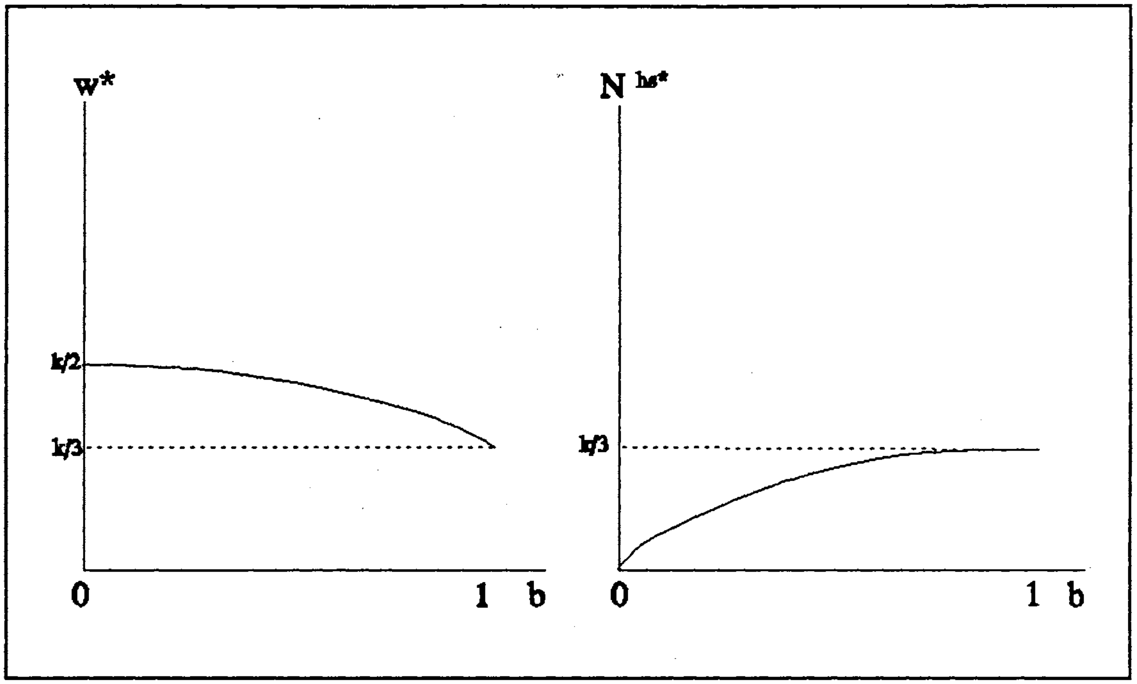

Figure 2.3
Wage and Employment Levels for the Dominant Firm as Concentration Varies

(2.9) $$N^{fd*}=\frac{2-2b}{4-b^2}k.$$

of hospital employment is determined by the hospital's residual supply function at the equilibrium wage. So total employment of nurses is found by adding the quantities of Equations 2.9 and 2.7.

(2.10) $$N^{hs*}+N^{fd*}=\frac{2-b^2}{4-b^2}k$$

This is identical to the hospital's equilibrium wage given in Equation 2.8 and, by Equation 2.2, is also the quantity of nurse services supplied to the market. Thus, the employers desired level of input is equal to the quantity of nurse services provided. No tendency for change exists.

However, the quantity of nurse services provided falls short of the total market demand for nurses at the equilibrium wage. Substituting the equilibrium wage into the market demand function, Equation 2.1, gives us the quantity of nurses demanded.

(2.11)
$$N^{D*}=\frac{2}{4-b^2}k$$

Subtracting the equilibrium quantity supplied in Equation 2.10 from the quantity demanded in (2.11) yields the following monopsony induced shortage.[4]

(2.12)
$$Shortage = N^{D*}-N^{S*}=\frac{b^2}{4-b^2}k$$

The magnitude of the shortage varies from zero to (1/3)k as b approaches unity.

To this point, no mention has been made of the determinants of the parameter b. In a given market, the separation of nursing demand would depend upon the existing technology of producing nursing services that exists among alternative types of nurse employers. Consideration would be given then to the amount of capital available to various nursing employers as well as the productivity levels (i.e. nurse to patient ratios) in each of the employment options. Also of major importance would be barriers to entry in both

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[4] The shortage is presented here as total nursing demand less total nursing supplied. Note that hospital demand less hospital supply is,

$$N^{hd} - N^{hs} = N^{hd} - (N^S - N^{fd}) = N^{hd} + N^{fd} - N^S = N^D - N^S .$$

Thus, the entirety of the shortage is in hospital employment.

product and factor markets.

Note that b is not the proportion of hospital employment. The employment concentration of the hospital can be determined from Equations 2.7 and 2.9.

$$c=\frac{N^{hs*}}{N^{hs*}+N^{fd*}}=\frac{2b-b^2}{2-b^2} \tag{2.13}$$

Solving for b in terms of the concentration level yields,

$$b=\frac{1-(1-2c+2c^2)^{\frac{1}{2}}}{1-c} \tag{2.14}$$

Figure 2.4(a) demonstrates the relationship of b to c.

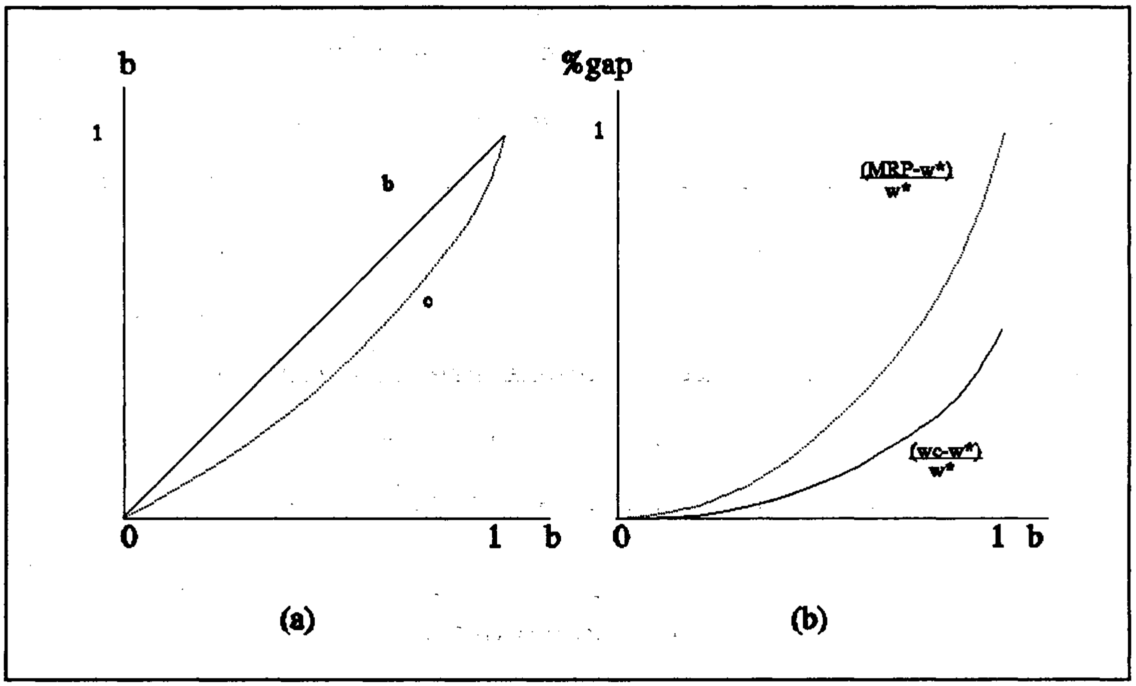

Figure 2.4
Wage Gaps, Employment Concentration and the Market Power Parameter

Other interesting results are found concerning the percentage gaps between equilibrium wage and marginal factor cost and that of the wage to competitive wage. In this example, both are strictly functions of the market power parameter b.

(2.15)
$$\frac{MFC-w^*}{w^*}=\frac{b}{2-b^2}$$

(2.16)
$$\frac{w_c-w^*}{w^*}=\frac{b^2}{4-2b^2}$$

For Figure 2.4(b), c is substituted into Equations 2.15 and 2.16. These gaps are plotted on the actual employment concentration level of the dominant firm.

One outcome worth noting from Equations 2.13 - 2.16 is that, in this example, market power is non-linear. Observe that the gap between competitive and monopsony wage remains low until relatively high levels of concentration. The market concentration of the noncompetitive sector must approach 55 percent before the competitive to monopsony wage gap exceeds 10 percent. If the cost of developing and maintaining a monopsony was equal to 10 percent of the competitive wage, then monopsonization would not be profitable until at least 55 percent of the market were under dominant firm control. This result would lend support to the notion that a "concentration threshold" must be obtained before significant market power becomes evident or is profitable.

B. An Extension of the Model to Non-Cooperative Oligopsony

To this point, the model examines the outcomes of a market with a single large firm and many smaller firms of insignificant market power. Lower wages are associated with a larger dominant firm. There is a single wage in the market established by the dominant firm.

Actual markets are not so neatly defined. One can usually observe markets with more than one hospital of various sizes, as well as smaller nurse employers. The model can be altered to accommodate a small number of firms with substantial market share existing with a competitive group of employers.

The most logical next step is a model of a duopsony. To illustrate, retain the supply and demand Equations 2.1 and 2.2. However, now assume the competitive sector is replaced by a single firm. Now the entire market demand is met by two firms whose share of demand are b_1 and b_2.

Another modification concerns each firm's residual supply curves. To this point, the "other" or non-hospital sector has been a group of competitive wage takers. Thus, there is no difference between the quantity of nurses demanded and the number of nurses employed by fringe employers. Now only two firms exist in the market, each with some degree of monopsony power. Actual employment for each firm will differ from the quantity demanded. So the residual supply facing each firm must be defined more specifically as the market supply less the employment of the other firm.

Now, both firms face an upward sloping residual supply and must raise wages for all employees to attract additional labor. This situation is illustrated in Figure 2.5. However, the condition depicted in Figure 2.5 does not represent market equilibrium. Initially, the smaller firm (firm 2) must pay a higher wage than the first to reach its profit maximizing level of input. This wage disparity will not be maintained. As factors flow from low wage to high wage employment the residual supply facing the first firm (the low wage employer) decreases and wages rise. The residual supply facing firm 2 (the high wage employer) increases and wages fall. Over time, wages converge to a single level and the residual supplies become stable. Figure 2.6 demonstrates this final equilibrium.

To reveal this process algebraically, use will be made of the equations employed earlier with some modifications in notation. The duopsonists' demand functions for nurses are,

(2.17)
$$N_1^{hd}=b_1N^D=b_1(k-w)$$
$$N_2^{hd}=b_2N^D=b_2(k-w)$$

The residual supply functions become,

(2.18)
$$N_1^{hs}=N^S-N_2^{hs}$$
$$N_2^{hs}=N^S-N_1^{hs}$$

For the model being considered, $b_1 = (1-b_2)$. By substituting

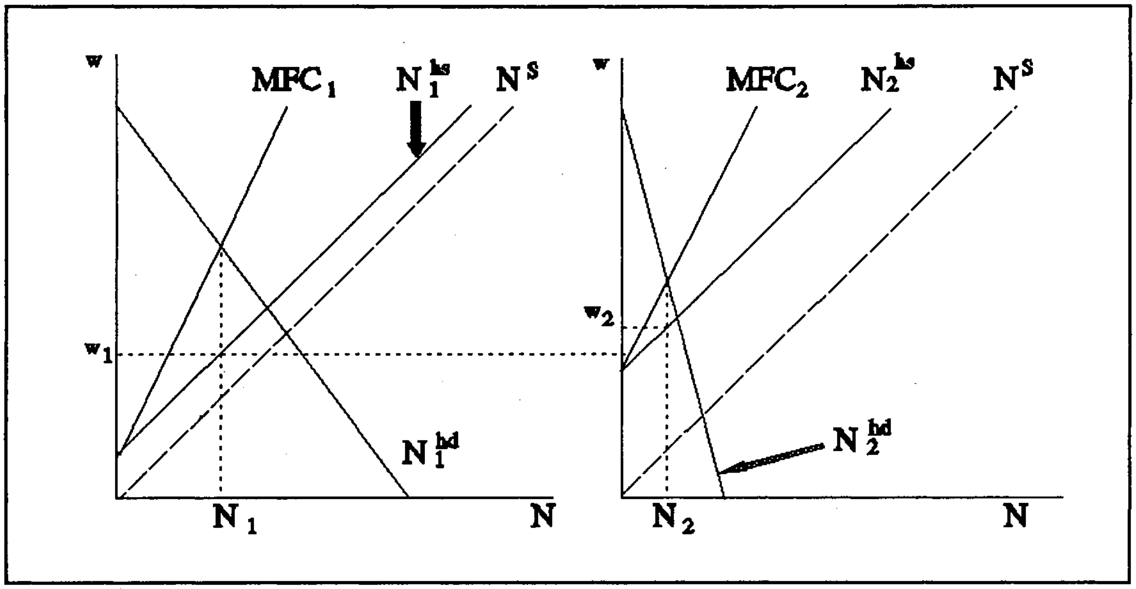

Figure 2.5
Incomplete Adjustment

the market supply function, $N^S = w$, into the residual supplies and solving for w, marginal factor cost curves can be derived for each firm. Setting the MFCs equal to respective demands will yield a pair of equations which express each firm's optimal employment as a function of the other firm's input level. By substitution, the final equilibrium values of employment and wages can be found for each firm.

$$N_1^* = \frac{1+(1/b_2)}{(2+\frac{1}{b_1})(2+\frac{1}{b_2})-1}k \qquad \text{(2.19)}$$

$$N_2^* = \frac{1+(1/b_1)}{(2+\frac{1}{b_1})(2+\frac{1}{b_2})-1}k$$

$$w^* = \frac{2+(1/b_1)+(1/b_2)}{(2+\frac{1}{b_1})(2+\frac{1}{b_2})-1}k \qquad \text{(2.20)}$$

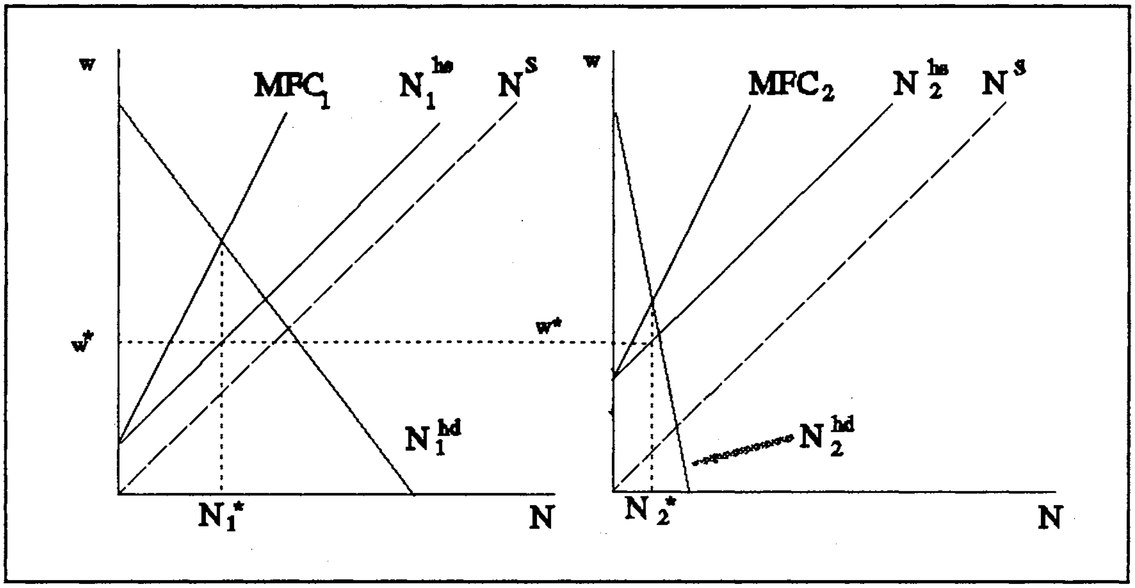

Figure 2.6
Equilibrium in the Duopsony Model

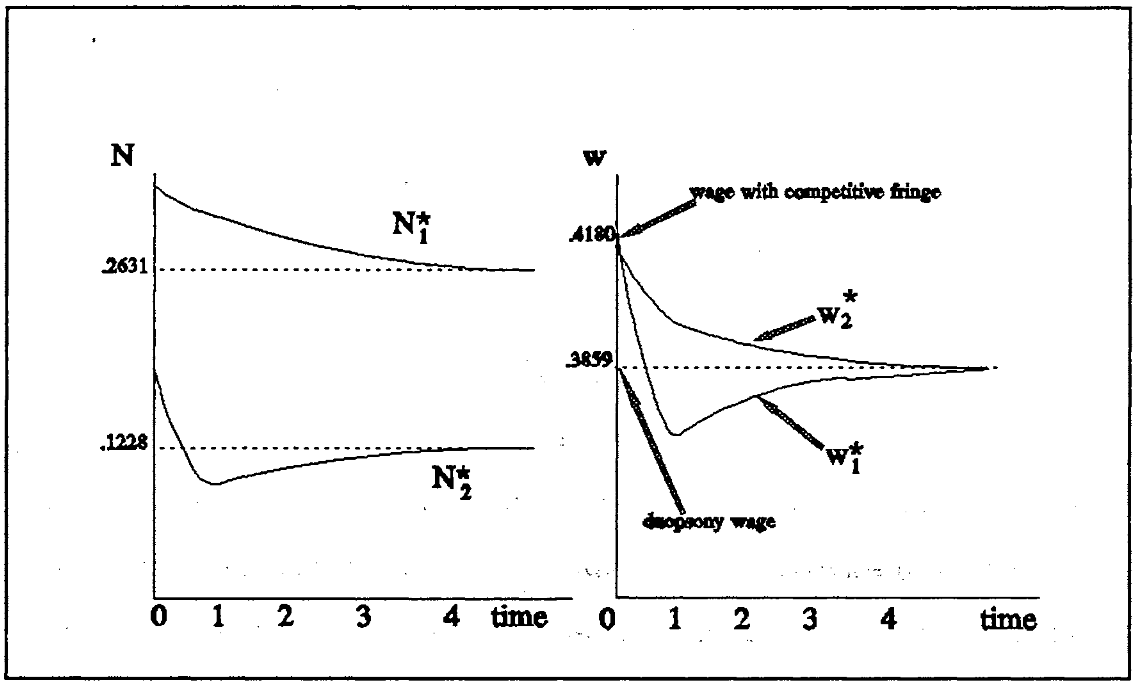

Figure 2.7
Convergence to Equilibrium in the Duopsony Model

Figure 2.7 demonstrates the convergence process for wages and employment resulting from the transformation of a market initially characterized by a single dominant firm facing a competitive fringe to a duopsonistic market. The market power parameter value chosen for this example was $b_1 = 0.75$.

Two results are worth noting at this point. First, both wages and employment fall to levels below those attained when the market had a single dominant firm facing some small competitors. Wages and employment continue to be above pure monopsony levels. This brings about the second point. A wage standardization agreement would conceivably allow the two firms to act as a pure monopsonist. However, such a formal collusive agreement would not be necessary to keep wages below competitive levels. Sub-competitive wages and the convergence toward a standard wage are natural outcomes of the market, even under noncooperative conditions.

The analysis can be extended to more than two firms. The procedure and adjustment toward equilibrium are the same. Residual supplies to high wage employers expand and supplies to low wage employers contract until wages converge. Equilibrium levels of employment for each firm of a triopsony are derived in Appendix A. Results for employment are provided in Equations 2.21. The term "e" in Equations 2.21 is defined as $e_i = 2 + (1/b_i)$.

Table 2.1 lists wage and employment factors for selected triopsony values of b. (Actual wage and employment levels would be found by multiplying these factors by the constant k). These various triopsony market structures are ranked by

$$N_1^* = \frac{1-e_2-e_3+e_2e_3}{2-e_1-e_2-e_3+e_1e_2e_3}k$$

(2.21)
$$N_2^* = \frac{1-e_1-e_3+e_1e_3}{2-e_1-e_2-e_3+e_1e_2e_3}k$$

$$N_3^* = \frac{1-e_1-e_2+e_1e_2}{2-e_1-e_2-e_3+e_1e_2e_3}k$$

a Herfindahl index found in column seven constructed from the values of b. Remember, as a benchmark, the purely competitive level of wages and employment is 0.50 k, and the pure monopsony level of wages and employment is 0.33 k.

As expected, higher concentration levels are associated with lower employment and wages. It is interesting to note that a Herfindahl index constructed from employment levels does not exhibit perfect rank correlation with wages. At one point, this index increases from 3910 to 3988 as the wage factor rises from .4146 to .4152.

Another common observation is that high market power tends to result in slower wage or price adjustment. Note that the factors in Table 2.1 represent responses to changes in the demand parameter, k. Greater concentration is associated with more sluggish wage adjustment in the event of a change in demand (lower dw/dk).

C. A Composite Mixed Model of Dominant Firms with a Competitive Fringe

The final step in this progression of models is to

Table 2.1

Triopsony Results

b_1	b_2	b_3	N_1	N_2	N_3	wage	HHI_b	HHI_N
.90	.05	.05	.3019	.0304	.0304	.3626	8150	7072
.80	.10	.10	.2733	.0559	.0559	.3851	6600	5458
.70	.20	.10	.2467	.0998	.0545	.4010	5400	4589
.60	.30	.10	.2210	.1360	.0536	.4106	4600	4165
.60	.20	.20	.2195	.0976	.0976	.4146	4400	3910
.50	.40	.10	.1949	.1671	.0532	.4152	4200	3988
.50	.30	.20	.1926	.1333	.0963	.4222	3800	3598
.40	.40	.20	.1644	.1644	.0959	.4247	3600	3507
.40	.30	.30	.1635	.1321	.1321	.4277	3400	3369
.33	.33	.33	.1429	.1429	.1429	.4286	3333	3333

Table 2.2

Composite Model Results

b_1	b_2	N_1	N_2	N_f	wage
.90	.05	.3063	.0302	.0316	.3680
.80	.10	.2799	.0554	.0604	.3957
.70	.20	.2521	.0997	.0589	.4107
.60	.30	.2252	.1367	.0580	.4199
.60	.20	.2258	.0968	.1129	.4355
.50	.40	.1979	.1689	.0576	.4243
.50	.30	.1969	.1339	.1115	.4423
.40	.40	.1667	.1667	.1111	.4444
.40	.30	.1654	.1318	.1622	.4594
.33	.33	.1416	.1416	.1819	.4651

incorporate aspects of market power and competition into a single model. The model developed now can accommodate more than one large firm existing with a competitive fringe.

The most simple market structure of this form would be the case of two large firms facing a competitive fringe. The derivation of equilibrium values is still somewhat cumbersome and has once again been relegated to an appendix. The primary difference between this model and the triopsony model is that the fringe demand function (as opposed to the employment level of a third triopsony firm) is substituted into the residual supplies of the two large firms. The final equilibrium solutions for employment levels are,

$$N_1^* = \frac{\epsilon_1 - \epsilon_1\epsilon_2}{1 - \epsilon_1\epsilon_2} k$$

(2.22)
$$N_2^* = \frac{\epsilon_1 - \epsilon_1\epsilon_2}{1 - \epsilon_1\epsilon_2} k$$

$$w^* = \frac{1}{2 - b_1 - b_2} \left[\left(\frac{\epsilon_1 + \epsilon_2 - 2\epsilon_1\epsilon_2}{1 - \epsilon_1\epsilon_2} \right) + 2 - b_1 - b_2 \right] k$$

$$\textit{where} \qquad \epsilon_1 = \frac{b_1}{2 + b_1 - b_2} \quad \textit{and} \quad \epsilon_2 = \frac{b_2}{2 + b_2 - b_1}.$$

Again, from the market supply function used in this illustration, the equilibrium wage is the sum of employment. Thus, fringe employment is $N^{f*} = w^* - N_1^* - N_2^*$.

Table 2.2 presents the results of this model for the same selected values of b_1 and b_2 that are used in Table 2.1 - the triopsony case. Direct comparison of Tables 2.1 and 2.2 demonstrate, as expected, that wages and employment are higher in the case of two dominant firms facing a competitive fringe as opposed to a triopsony.

The composite model allows for a boundless variety of market structures. The presence of any sized competitive element will bring the market closer to the competitive result. Conversely, the presence of any firm or firms of significant size will bring the market closer to the monopsonistic result.

D. Monopsony Power as a Consequence of Occupational Heterogeneity

The model above demonstrates how monopsony power can be maintained even if a significant proportion of the market is competitive. There is an implicit assumption of the model that all nursing occupations are homogeneous - that nurses are indifferent as to where or to what employer they will sell their services. Nurses, especially those in larger cities, do perceive differences among alternative employers. This type of "job differentiation" offered by the nurse employer should be accounted for in a study of wage determination.

Nurses will develop preferences or loyalties to specific employers based upon employment conditions or characteristics. As mentioned before, nurses may show a preference for daytime work. In addition to this, many nurses develop specialized skills available from only a narrow range of employers. Areas of specialization within hospitals would include intensive care, emergency, labor and delivery, etc.

Even with an assumption that jobs and working conditions among various employers are reasonably close to each other in characteristic space, the level of attachment to their current position may be the primary differentiating feature perceived by nurses. That is, all employment opportunities are viewed equally, except for the loyalties and separation cost associated with the current position.

This modification implies that employers face the possibility of enhanced or diminished market power based upon their conditions of employment. The primary impact that perceived job differences and employee loyalty would have on the composite model is that it would cause the wage convergence process to stop before a unified wage has been determined.

For example, suppose a market is duopsonistic. Hospital A and Hospital B are the only employers and are currently paying an identical wage. Suppose further that nurses develop a distinct preference for the working conditions at Hospital A. The monetary value of that preference is discovered by market forces as nurses exhibit this preference over time by shifting from Hospital B to Hospital A. The residual supply increases to Hospital A and wages fall. Residual supply decreases to Hospital B and wages rise. The process continues until the wage differential is equal to the premium imposed by nurses on Hospital B for its poorer working conditions (or the discount to Hospital A for its better working conditions). As a consequence, wages among hospitals will vary in equilibrium. Many non-hospital employers could pay slightly below hospital wages if some nurses exhibited a preference for the conditions of non-hospital employment.

Among non-hospital employers, two major distinctions have been observed. Wages for school nurses, industrial nurses and nurse educators are usually influenced by forces exogenous to the local market and are generally above hospital wages. The wages of nurses employed in nursing homes, clinics, and physicians' offices tend to be closely tied to local hospital wages and embody characteristics which allow the employer to pay at or below the hospital level.

It is worth reiteration at this point, that job differentiation is not a necessary condition for monopsony power. In fact, it is not necessary to explain wage differentials. If the adjustment process of labor moving from low wage to high wage employment is slow or inhibited by a lack of information, persistent differences in wages could be observed.

E. An Elasticities Approach

The influence of fringe employment on the hospital's monopsony power can also be demonstrated in a more general approach by analyzing elasticity relationships. The restrictive assumptions about supply and demand parameters made in Section IIA no longer need to be maintained. Starting with a general form residual supply equation:

$$N^{hs}(w) = N^{S}(w) - N^{fd}(w) \qquad (2.23)$$

where N^{hs} represents the supply of nurses to hospitals, N^{S} is the market supply, and N^{fd} is the demand for nurses by the competitive fringe. (The "fringe" demand can be generalized to include all firms competing for nurses, including other hospitals). Differentiation and further manipulation of Equation 2.23 yields.

$$(2.24) \qquad \frac{dN^{hs}}{dw}\frac{w}{N^{hs}} = \frac{dN^{S}}{dw}\frac{w}{N^{S}}\frac{N^{S}}{N^{hs}} - \frac{dN^{fd}}{dw}\frac{w}{N^{fd}}\frac{N^{fd}}{N^{hs}}$$

where w represents the wage rate. Equation 2.24 can be written as

$$(2.25) \qquad E^{hs} = E^{S}*(N^{S}/N^{hs}) - E^{fd}*(N^{fd}/N^{hs}).$$

In Equation 2.25, E^{hs} is an individual hospital's elasticity of supply for nurses, E^{S} is the market supply elasticity and E^{fd} is the elasticity of demand of other nurse employers. Since $N^{S} = N^{hs}+N^{fd}$, Equation 2.25 can be stated as

$$(2.25a) \qquad E^{hs}=E^{S}+(N^{fd}/N^{hs})*(E^{S}-E^{fd})$$

or,

$$(2.25b) \qquad E^{hs} = E^{S} + (N^{fd}/N^{H})*(E^{S}+|E^{fd}|).$$

Considering that, at equilibrium, marginal revenue product is equal to the marginal factor cost of the input. The marginal factor cost can be expressed as,

$$\overline{w}=MFC=\frac{d(total\,factor\,cost)}{dN^{hs}}=\frac{d(wN^{hs})}{dN^{hs}}=\frac{(N^{hs}dw+wdN^{hs})}{dN^{hs}}=\frac{N^{hs}dw}{dN^{hs}}+w.$$

Thus, the wage gap is,

$$\frac{\left(\frac{N^{hs}dw}{dN^{hs}}+w-w\right)}{w} = \frac{dw}{dN^{hs}}\frac{N^{hs}}{w} = \frac{1}{E^{hs}}.$$

So the gap between the nurses marginal revenue product and wage, evaluated at the monopsony's optimal level of labor input, is equal to the reciprocal of the elasticity of supply.[5]

$$\frac{MRP-w}{w}=\frac{1}{E^{hs}} \qquad (2.26)$$

An individual hospital's monopsony power will decline as its labor supply elasticity increases.

Equation 2.26 demonstrates the direct relationship of a hospital's ability to depress wages to its relative level of employment in the local nursing market. If no fringe employers exist ($N^{fd}=0$), the second term of the right hand side of Equation 2.25b becomes zero and the hospital faces the market supply ($E^{hs}=E^{s}$). With the presence of other nurse employing firms, the firm's labor supply becomes more elastic than the market labor supply. An individual hospital will face a more elastic labor supply as 1) the wage elasticity of demand of other firms, E^{fd}, increases in absolute value or 2) the ratio of total fringe employment to the hospital's employment, (N^{fd}/N^{hs}), increases.

[5] This result is the counterpart of the Lerner index.

III

LITERATURE

A number of cross-sectional studies of nursing markets have been conducted concerning the proposition that hospital market power may suppress nursing wages. Each of these investigations controlled for differences in the cost of living and evaluated the impact of a number of explanatory variables on the level of nursing wages.

Richard Hurd [9] found evidence of monopsony power using 1959-1960 hospital data. The dependent variable in Hurd's intercity regression was median earnings of nurses. The independent variables used to measure market power were the percent of nurses working for hospitals and an eight-firm concentration ratio of hospital employment. Negative and significant coefficients were found for both explanatory variables.

Charles Link and John Landon [13] gathered data from a survey of over 300 hospitals and used beginning nurse salaries as their dependent variable. A Herfindahl index constructed from the market share of beds was used as the measure of market concentration. Higher index values were significantly associated with lower beginning salaries. Similar results were found using a four hospital concentration ratio and an entropy index. All of these are measures of product market concentration. The authors indicate that they experimented with measures of labor market concentration but the use of these measures did not alter the results.

Roger Feldman and Richard Scheffler [8] examined data gathered from a national sample of 1200 hospitals for the years 1976-77. Again, a product market concentration measure, was used as a proxy for monopsony power in the labor market. Both RN and LPN wages were found to be inversely related to a four firm concentration ratio of county hospital beds.

A study by Thomas Bruggink, Keith Finan, Eugene Gendel and Jeffrey Todd [5] also examined wage determination for nurses. Like Feldman and Scheffler, their primary focus was on the impact of unionization. The monopsony variable used was simply the reciprocal of the number of hospitals in the local labor market as defined by the federal government. Higher wage rates for RNs and LPNs were found in markets containing a greater number of hospitals.

Daniel Sullivan [24] used American Hospital Association (AHA) annual survey data in an attempt to directly estimate nursing inverse supply elasticities or the wage gap for individual hospitals (Equation 2.26 above). Unlike the single-equation, cross-sectional approaches discussed above, Sullivan analyzed time series data and used differencing to eliminate hospital specific fixed effects. Sullivan found relatively high estimates of inverse elasticity indicating the presence of significant monopsony power, even over a period of three years.

It was also found that inverse elasticity estimates were not significantly lower in major metropolitan areas, indicating that monopsony power did not decline with an increase in market size. However, the groups being compared in this study were communities with populations of less than 500,000 versus those with populations over 500,000. It is a significant finding that the potential for buying power exists even in large cities. But the notion that market power may vary with market size is only partially correct. Monopsony power is a function of the size of the firm relative to the market.

In an extensive study using 1982 AHA data, James Robinson [22] studied the possible influences of the hospital product market on hospital employment. Dependent variables in this study included total employment values for RNs and LPNs, and employment mix measures (Nurses to total employment, RNs to total nurse employment). Wages were not a dependent variable. Among Robinson's conclusions were the relationship of higher product market competition to i) greater total employment, ii) less LPN employment and iii) greater substitution of RNs for LPNs. In addition, a positive correlation was found between nurse supply and non-nurse employment.

IV

EMPIRICAL ANALYSIS

A. Problems in Estimation

There are two fundamental problems that must be overcome in the estimation of nursing market parameters. First, the observed wage and input data are determined simultaneously by placement of supply and demand conditions. The second problem is a consequence of possible monopsony power.

In competitive markets, estimation of an individual firm's supply and demand is a relatively straightforward process. As pictured in Figure 4.1(a), observed values of N and w are the result of interaction between the firm's marginal revenue product curve and its horizontal supply curve. There will be no deviation of wage and marginal factor cost. However, if firms possess monopsony power, there will be a divergence between supply and marginal factor cost. Observed values of wages and input are the result of equating marginal factor cost to demand and paying the wage necessary to attract the profit maximizing level of input. These observations would look something like the scattered dots in

Figure 4.1(b). These observed values are not the result of an equilibrium intersection of the two structural equations being estimated. Direct estimation of demand parameters using these data would yield biased or incorrect estimates due to simultaneity, the presence of an unobserved wage gap and an equilibrium quantity of vacancies. An estimated demand curve would look more like the dashed line in Figure 4.1(b). The estimate for $|dw/dN|$ in the demand curve would be too high (demand too steep). This will be demonstrated below.

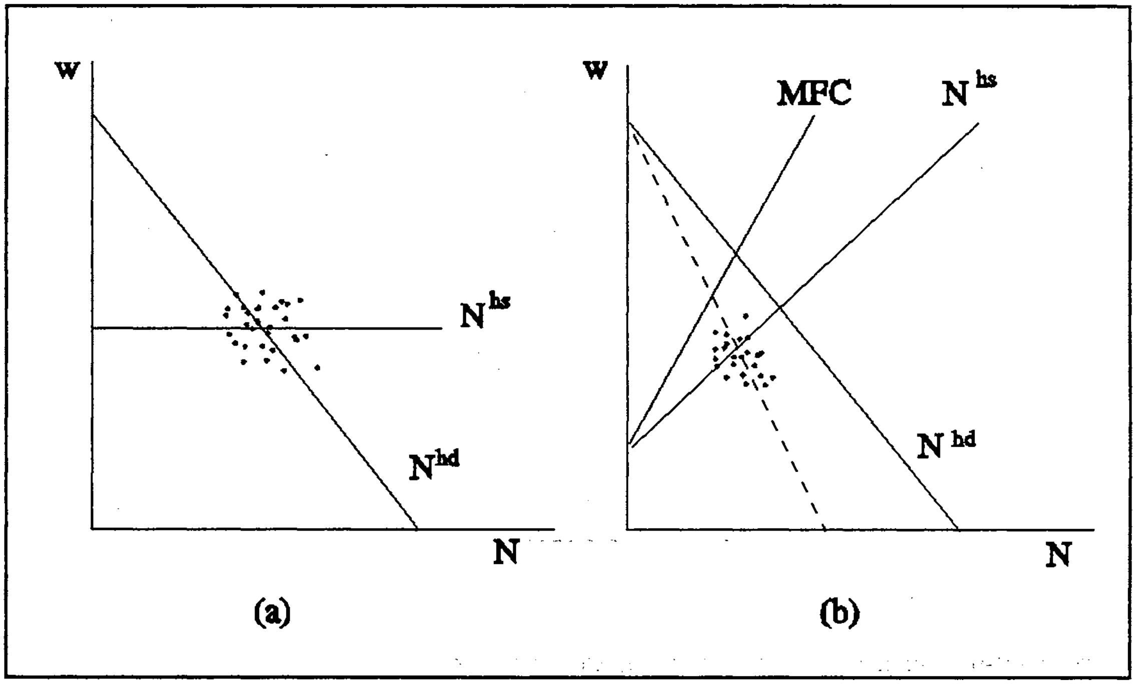

Figure 4.1
Clusters of Observed Values for a Competitive Firm (a) and a Monopsonistic Firm (b)

The first problem of simultaneity will be dealt with by employing a two stage least squares method to estimate structural equations. If the market is competitive, the 2SLS

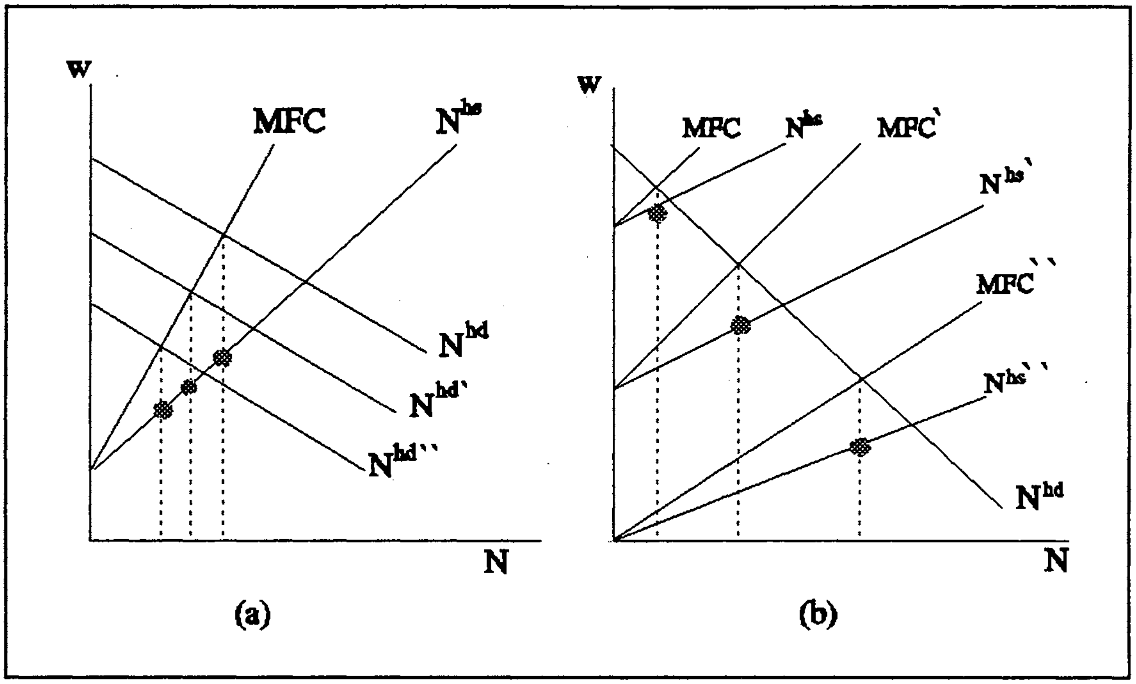

Figure 4.2
The Identification Pattern for a Firm with Monopsony Power

procedure could be directly applied to the data, provided equations are fully identified.

Figures 4.2(a) and 4.2(b) depict the identification process for a firm with buying power. In Figure 4.2(a), it can be seen that exogenous shocks to the demand curve will identify equilibrium points along the supply function. But, as can be seen in Figure 4.2(b), exogenous shifts in supply will not map out the demand curve. Instead, the function that is being identified is demand less the unobserved monopsony wage gap.

The problem is pictured in a different way in Figure 4.3. For a monopsonistic employer, the optimization process generates four equilibrium values; wages, marginal factor cost, the quantity of nurses supplied to or employed by the hospital, and the quantity of nurses demanded by the hospital. But, values for marginal factor cost and the quantity of nurses demanded are not observed. Fortunately, theory will furnish a relationship between observed wage and supply data, and the unobserved MFC and demand values.

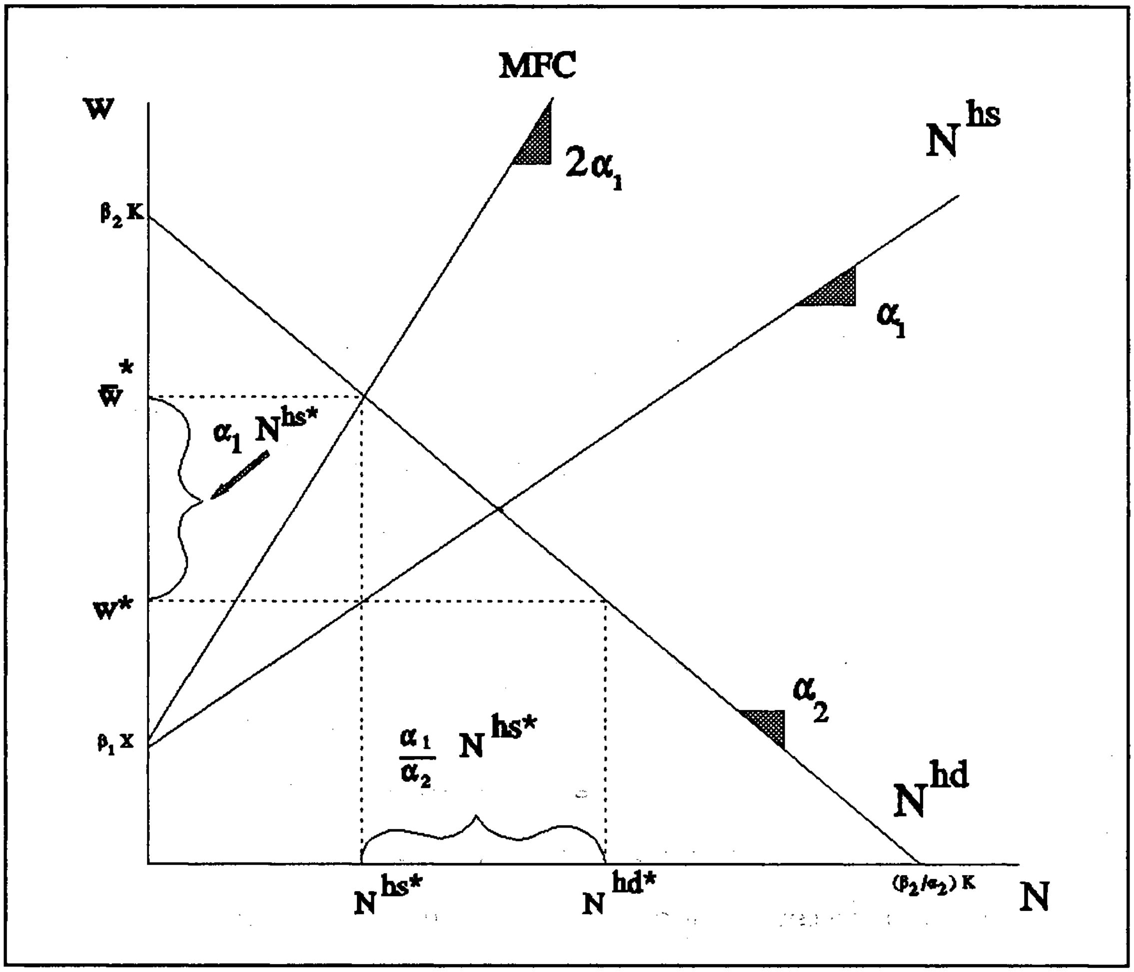

Figure 4.3
Relationships of Observed to Unobserved Equilibrium Values

To explain, suppose a firm's observed wage values are generated from the following supply and demand relationships:

(4.1a) $$\textit{Inverse Supply}:\ w=\alpha_1 N^{hs}+\beta_1 X$$

(4.1b) $$\textit{Supply}:\ N^{hs}=\frac{1}{\alpha_1}w-\frac{1}{\alpha_1}\beta_1 X$$

(4.2a) $$\textit{Inverse Demand}:\ w=\beta_2 K-\alpha_2 N^{hd}$$

(4.2b) $$\textit{Demand}:\ N^{hd}=\frac{1}{\alpha_2}\beta_2 K-\frac{1}{\alpha_2}w$$

where X represents a vector of exogenous variables for supply, K is a vector of exogenous variables for demand, β_1 and β_2 are vectors of corresponding parameters. The total cost of the input N and the marginal factor cost are derived.

(4.3) $$\textit{TFC}:\ wN^{hs}=\alpha_1 (N^{hs})^2+\beta_1 XN^{hs}$$

(4.4a) $$\textit{MFC}:\ \overline{w}=\alpha_1 2N^{hs}+\beta_1 X$$

It will be useful to solve the MFC equation for N^{hs}.

(4.4b) $$N^{hs}=\frac{1}{2\alpha_1}\overline{w}-\frac{1}{2\alpha_1}\beta_1 X$$

Note that the exogenous factors shifting the inverse supply curve are identical in their impact on the MFC curve. Now recall that the MFC is the sum of the observed wage and the monopsony wage gap. That wage gap, as a percentage of wages, was expressed in terms of elasticity in Equation 2.26.

(2.26) $$\frac{(MRP-w)}{w}=\frac{1}{E^{hs}}=\left(\frac{dw}{dN^{hs}}\right)\left(\frac{N^{hs}}{w}\right)=\alpha_1\frac{N^{hs}}{w}$$

The dollar value of the gap and marginal factor cost then, is;

(4.5) $$MRP-w = w(\alpha_1 \frac{N^{hs}}{w}) = \alpha_1 N^{hs}$$

and marginal factor cost can be restated as the sum of the observed wage and the dollar value of the wage gap.

(4.6) $$MFC\colon\ \overline{w}=w+\alpha_1 N^{hs}$$

The equilibrium marginal factor cost can be found by equating the inverted MFC function (4.4b) to demand (4.2b).

(4.7) $$\overline{w}^* = \frac{\beta_2 K 2\alpha_1 + \beta_1 X \alpha_2}{2\alpha_1+\alpha_2}$$

Equilibrium hospital employment is found by setting marginal factor cost (4.4a) to inverse demand (4.2a).

(4.8) $$N^{hs*} = \frac{\beta_2 K - \beta_1 X}{2\alpha_1+\alpha_2}$$

Substituting the values in Equation 4.8 into Equation 4.1a provides the equilibrium wage.

(4.9) $$w^* = \frac{\beta_2 K\alpha_1 + \beta_1 X(\alpha_1+\alpha_2)}{2\alpha_1+\alpha_2}$$

To find the equilibrium quantity of nurses demanded, substitute w^* (4.9) into the demand function (4.2b).

(4.10) $$N^{hd*} = \frac{(\beta_2 K - \beta_1 X)(\alpha_1+\alpha_2)}{\alpha_2(2\alpha_1+\alpha_2)}$$

From Equations 4.8 and 4.10, the equilibrium quantity of vacancies can be determined.

(4.11)
$$N^{hd*}-N^{hs*} = \frac{\alpha_1(\beta_2 K-\beta_1 X)}{\alpha_2(2\alpha_1+\alpha_2)}$$

Note, that in the absence of monopsony power, $\alpha_1 = 0$ and equilibrium vacancies no longer exist.

Finally, from the results above, we can establish the relationship between the quantity of nurses demanded to the quantity supplied.

(4.12)
$$\frac{N^{hd*}}{N^{hs*}} = \frac{\alpha_1+\alpha_2}{\alpha_2} \Rightarrow N^{hd*} = N^{hs*}+\frac{\alpha_1}{\alpha_2}N^{hs*}$$

Figure 4.3 summarizes the relationships derived above. It is also worth noting that the inverse supply and inverse demand parameters, α_1 and α_2, are the only values needed to determine vacancy rates. The equilibrium vacancy rate, as a percentage of employment (N^{hs}) is equal to α_1/α_2; and as a percentage of the quantity of nurses demanded (N^{hd}) is equal to $\alpha_1/(\alpha_1 + \alpha_2)$. The latter measure would be similar to the often reported statistic of vacancies as a percentage of budgeted positions.

As was mentioned above, the supply curve is identified. Since the observed data represent equilibrium points on the supply function, the 2SLS method can be used to estimate supply without any manipulation of data or conditions on the parameter values.

To correctly estimate the inverse demand curve using observed employment data, the dependent variable should be marginal factor cost. From Equation 4.6,

$$(4.13) \qquad \overline{w} = w+\alpha_1 N^{hs} = \beta_2 K-\alpha_2 N^{hd}$$

Equation 4.13 shows us that using wages as the dependent variable will bias the estimation of α_2 upward (in absolute value). Using observed wages will estimate the inverse demand function less the wage gap. Solving (4.13) for w provides the inverse demand function estimated from <u>observed</u> data.

$$(4.14) \qquad w = \beta_2 K-\alpha_2 N^{hs}-\alpha_1 N^{hs} = \beta_2 K-(\alpha_2+\alpha_1)N^{hs}$$

This result is obtained because, at the equilibrium intersection of marginal factor cost and inverse demand, $N^{hs} = N^{hd}$. So the parameter estimate generated is an estimate of $(\alpha_2 + \alpha_1)$, not α_2 alone. If monopsony power exists, $\alpha_1 > 0$. Thus, the value, $-(\alpha_2 + \alpha_1)$ is a negative number larger in absolute value than α_2. In other words, the inverse demand curve estimated by 2SLS using wage data would be "too steep". The only adjustment necessary is to subtract the estimate of α_1 from the inverse supply relationship from the estimated coefficient for N^{hs} in the inverse demand relationship.

If the ordinary demand curve is to be estimated using observed wages, the dependent variable should be N^{hd}. Once again, in the presence of monopsony power, N^{hd} will not be observed and will differ from the observed N^{hs}. Substituting the results of Equation 4.12, into the demand function (4.2b) yields, (4.2a) $$N^{hd} = N^{hs}(1+\frac{\alpha_1}{\alpha_2}) = \frac{1}{\alpha_2}\beta_2 K - \frac{1}{\alpha_2}w$$

Thus, the behavioral equation being estimated using observed data would be,

(4.15) $$N^{hs} = \frac{1}{\alpha_1+\alpha_2}\beta_2 K - \frac{1}{\alpha_1+\alpha_2}w$$

The necessary adjustment then, is to multiply every parameter estimate of the demand equation by a factor of 1 +($\hat{\alpha}_1$ / $\hat{\alpha}_2$).

B. Explanatory Variables.

Sets of equations of the form specified in Equations 4.1 and 4.2 will be estimated. What needs to be cataloged are the explanatory variables in the K (demand) and X (supply) vectors. Generally, the studies mentioned in Section III concentrate on characteristics of the hospitals within a market and not on non-hospital employment of nurses. They do however, suggest a number of variables other than employer buying power, that are responsible for some of the variation in hospital wages. These variables include; hospital type, differences in cost of living, geographic region, product market characteristics, the stock of nurses, the degree of unionization, hospital size, hospital case mix and degree of specialization. The model developed in Section II provides some theoretic reasons that these variables would be important in a cross-sectional examination of nursing wages.

Analysts have noted that wages in federal facilities are not determined in the local market. Specifically, federal hospitals generally pay above the local market wage. This suggests that federal employment should be considered part of the competitive, non-hospital sector of the market. The presence of a federal facility results in a stronger fringe demand and thus higher wages.

This is only part of a more general discussion on exactly which employers should be considered as components of the potentially non-competitive sector of the market. The criteria to be used for inclusion would be firms with 1) significant market share and 2) wages determined within the local market. Employers most akin to these characteristics would be hospitals classified as private, short-term facilities. Difficulties would be encountered by this categorization because of the fact that a growing number of these institutions have become more involved in the provision of out-patient and long term nursing services, making them an active participant in fringe employment.

Fortunately, data exists that allows an accurate decomposition of nursing supply by employer and type of employment. The variable "Competitive RNs" (or RN^c) in the equations below will include all nurses within the relevant market who are employed in other hospitals (if any), nursing homes, nursing schools, industrial firms, physicians offices, home health agencies, and schools as well as private duty employment. Also included in these values, for reasons mentioned above, will be nurses employed at federal hospitals as well as nurses employed by home health agencies run by hospitals.

In any explanation of supply and demand, the economist must point out that the values on the vertical axis represent relative, not nominal prices. The wage variable discussed in this context is that of nursing wages relative to other wages in the local market. Thus, geographic region and the related local wage level become important factors. If wages are to be used as a dependent variable in an econometric evaluation, the wage measure being used should be scaled to local wages. Including the county wage level, CWAGE, as an explanatory variable will be done to determine its significance in the variation of nominal wages. It must also be kept in mind that the local wage level is a measure of income and the ability to pay for medical services. Thus, in addition to representing a relative wage scale, CWAGE may have a separate influence as a factor in the demand for nurses.

As mentioned previously, nurses may not view alternative employers as a homogeneous group. They may show strong preferences for non-hospital work, daytime employment, or the working conditions of one hospital over another. Experienced nurses may have developed highly specialized skills for which only a narrow range of employment opportunities exist. Each of these conditions result in the development of an attachment to specific employers. As a consequence, wage elasticity of supply to individual employers would be reduced and monopsony power enhanced.

A variable such as hospital case mix would be useful in an attempt to isolate these effects. The variable labeled MIX, included in the supply and demand equations, is the number of admissions from outside the state of Oklahoma and the neighboring states of Texas, Arkansas and Kansas. The logic here is that patients would only travel such long distances for highly specialized medical services. High values for MIX would imply that the hospital is involved in providing uncommon services, requiring specialized nursing skills and greater compensation.

Nursing continues to be a predominantly female occupation. Traditionally, nurses have not generated their family's primary income. This implies low factor mobility and would result in reduced wage sensitivity. It also implies that the overall placement of the market supply curve may change due to factors exogenous to the nursing market. That is to say, that the presence of an individual nurse in a given market may have less to do with the wages and working conditions in that market and more to do with the fact that her husband is employed at a local manufacturing firm. Thus, the stock of nurses has often been included as an explanatory variable in cross-sectional studies.

In the present analysis, the entire market stock of nurses is incorporated into the equation system for the theoretical reasons developed in Section II. The stock of registered nurses, RN^m, is the sum of RN_i plus Competitive RNs (RN^c_i), where RN_i is the number of RNs employed at the individual hospital, and Competitive RNs is competitive employment as described above. This type of specification should enable an examination of interaction between hospitals as well as that between hospital and non-hospital employers.

However, as was mentioned above, the total number of RNs and LPNs available within a given market may be a function of employment factors exogenous to that market. To account for this, the variable CEMPL (county employment) has been included in the supply functions. CEMPL is the working population of the county in which the hospital is located.

One of the hospital characteristics often factored into previous studies is the affiliation with a medical school or nurse training facility. Bruggink, Finan, Gendel and Todd found that a dummy variable for teaching hospitals was not a significant determinant of nursing wages. They suggested that greater compensation for higher work loads at teaching hospitals is offset by wage concessions made for greater professional development opportunities. It is suggested here that the presence of a nurse training facility may have a deflating impact on wages because the school provides a continuous influx of rookie nurses to the local market.

Instead of using a binary variable to signal the presence of a teaching facility, the actual number of RN and LPN graduates (RNGRAD and LPNGRAD) from local schools is incorporated into the nursing supply functions.

Assimilated in the demand functions are variables traditionally included with labor in a production function. CENSUS, the average daily number of occupied beds in the hospital, is a measure of the hospital's utilized capital stock. MDS is the number of physicians working for or admitting to the local hospital. These variables should exhibit a complementary relationship to nursing input. The number of "other" nursing personnel employed at each hospital has also been included. For instance, the RN demand function includes the number of LPNs employed by the same hospital. Including this variable will account for the degree of RN/LPN substitution. These variables are intended to capture technological capital-labor and labor-labor relationships.

But input demand is also determined by the demand for the services produced by that input. To encompass the "derived" nature of input demand, utilization and need variables have been integrated into the analysis. Total admissions (ADMITS) are included as a measure of consumer demand for all hospital services. AGE is the percent of local population over the age of 65. Each of these "need" variables should be positively related to nursing demand. It is also believed the variables MD and CWAGE will sufficiently capture the local community's ability to pay for nursing services.

A hospital may have greater capacity to reduce wages if it faces an upward sloping supply curve for nurses and, additionally, has monopoly power in the market for its product (see footnote 3). One would expect to see greater product market power associated with lower wages, provided that the nurse employer does not face a highly elastic labor supply curve. However, including a product market concentration measure as an explanatory variable may present some econometric problems. Product and factor market concentration would tend to be highly correlated, especially if market definition is the same for both [13].

In our present analysis, hospital product and factor markets will be defined differently. It makes intuitive sense to do so. Hospital employees must travel to work roughly 250 times per year (5 days per week x 50 weeks). Patients, however will utilize hospital services far less often and will be less sensitive to distances traveled. So the hospital's service area will be more broadly defined than its labor market. The variable MON is a single firm concentration ratio using the percent of occupied beds as the measure of product market power.

Unions, if effective, would provide market power to nurses. If hospital monopsony power is present, a nursing union could act as a countervailing force through collective bargaining. So one would expect higher wages to accompany a greater degree of unionization. However, there are very few nursing unions (if any) in the population of nurses being examined in this study. For this reason unionization will not be a factor.

C. Model Specification and Procedures

Theoretical groundwork has been laid out as to how individual hospital supply and demand will interact to determine wages. An effort is now put forth to estimate representative supply and demand functions for hospitals in the state of Oklahoma. Estimation procedures are conducted using statewide data for RNs.

There are two essential axioms of the model developed in Section II. First, the supply function facing the individual firm is the residual of the market supply less employment of other firms. Second, the firm's demand function is viewed as its fraction of, or contribution to, total demand. To follow these precepts, estimated equations are constructed as follows, starting with the supply relationships for RNs.

RN Market Supply:

$$RN^{m}=S_{0}(w, RNGRADS, CWAGE, CEMPL, MIX^{m}) \quad (4.16)$$

The m superscript denotes the marketwide summation of the variable. The residual supply facing the i^{th} firm within market m is given as,

$$(4.17) \quad RN_i = RN_i^m - RN_i^c = S_1(w, RNGRADS, CWAGE, CEMPL, MIX^m, RN_i^c)$$

The wage variable represents weekly compensation to RNs, including benefits. The variable RN_i is each hospital's full time equivalent employment of registered nurses. The RN^c label represents competitive RNs or the total employment level of all other nurse employers in the market.

RN Market Demand:

$$(4.18) \quad RN^m = D_0(w, CWAGE, AGE, LPN^m, ADMITS^m, CENSUS^m, MDS^m, MIX^m)$$

That portion of market demand to the i^{th} firm is:

$$(4.19) \quad RN_i = D_1(w, CWAGE, AGE, LPN_i, ADMITS_i, CENSUS_i, MDS_i, MIX_i)$$

To estimate inverse supply and demand, wages are made the dependent variable.

D. Anticipated Findings

One measure of the extent of monopsony power is indicated by the size of the coefficient for RNs (α_1) in the inverse supply functions. Parameter estimates for α_1 not significantly different from zero would suggest that dw/dRN is zero and the nursing markets under examination are, on the average, competitive. An upward sloping labor supply curve by itself may not be conclusive proof of monopsony power.

Estimates of α_1 (or $1/\alpha_1$ from the supply function) will be used to generate estimates of average labor supply elasticities.

The coefficient for RN^c (Competitive RNs) in the supply function will suggest the conjectural responses of individual hospitals to actions of other nurse employers. The model developed in Section II would indicate that this parameter value should be negative.

Theory also provides another way to check for the possibility of market power. If the markets being examined are relatively monopsonistic, then exogenous shifts in the supply and demand functions should have a significant impact on both wages and nursing input. As the markets become more competitive (and nursing supply becomes more wage elastic), variables which may be quite successful explaining variation in the number of nurses employed will have increasing difficulty explaining variation in compensation levels.

E. Data

Data for hospital census, payroll and expenses are found in the 1992 AHA Guide to the Health Care Field. The relative wage variable (CWAGE) is constructed from data available in the 1992 Statistical Abstract of Oklahoma published by the Center for Economic and Management Research at the University of Oklahoma. Average hourly wage rates are calculated for each county.

Individual hospital employment of RNs, LPNs, MDs, as well as the number of total and out of state admissions (MIX) are available in the 1991 Hospital Utilization and Plan Survey. This survey is compiled annually by Health Planning and Policy Analysis Division of the Oklahoma State Department of Health. Data on nursing graduates and non-hospital nursing employment (by county) is available in the Oklahoma State Bureau of Nursing 1992 Annual Report.

The RN compensation variable will be constructed in a manner similar to that used by Sullivan in the article discussed previously. Sullivan had hospital data for total nursing payroll (RNs and LPNs together) as well as the number of full time equivalent RNs and LPNs. Assuming LPN wages to be a constant proportion of RN wages (.765) he computed full time nursing employment as RNs + .765*LPNs. Adding a proportionate share of the hospital's reported expenses for benefits to the payroll figure, the RN wage was calculated as,

(payroll + benefits)/(RNs + .765*LPNs).

The present study uses data from various sources to construct a variable for nursing compensation. In addition to the sources listed above, values for the ratio of LPN to RN wages for six separate regions of the state were derived from the Oklahoma Hospital Association's Wage and Salary Survey. Ratios of fringe benefits to total expenditures for Oklahoma hospitals (classified by size) are found in the AHA's Hospital Statistics.

The annual compensation for RNs in the i^{th} hospital is calculated as

$$Annual\ RNCOMP_i = \frac{[(RN_i + LPN_i)/FTE_i] * TP_i}{RN_i + \lambda_r LPN_i} + \frac{TE_i \gamma_c}{FTE_i}$$

where

RN and LPN = the hospital's FTE staff nurses;

FTE = total full time equivalent personnel;

TP and TE = total payroll and total expenses respectively[6];

λ_r = the ratio of LPN to RN wages for the region of the state, r, in which the hospital is located;

γ_c = the fraction of total expenditures on benefits for Oklahoma hospitals of the size classification, c, of the i^{th} hospital.

The two terms on the right hand side of the formula represent wages and benefits respectively. These figures are divided by 50 to arrive at the weekly "wages" in the equations to be estimated.[7]

Wage information is compiled annually by the Oklahoma Hospital Association in the <u>Oklahoma Wage and Salary Survey</u>,

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[6] The variables TP and FTE came from two separate sources. To correct for possible differences in reported staffing levels, the payroll figure taken from the AHA <u>Guide</u> was adjusted by the ratio FTEo/FTEa. In this ratio, FTEo is the full time employment level reported by the Oklahoma Health Planning Commission survey--the source of the RN and LPN employment figures, and FTEa is the full time employment level reported by the AHA survey--the source of the payroll figure.

[7] Using weekly wages counters the possible problems from discrepancies between, and even within, hospitals in the determination of the hours per week needed to be considered for full time status. Often, nurses working 8-hour shifts are required to work 5 shifts per week (40 hours) and nurses working 12-hour shifts need only work 3 shifts per week (36 hours) to be eligible for full time status.

Winter 1992. However, this data is gathered under a condition of confidentiality and was available only in a grouped format. The state was divided into six geographic regions; northeast, northwest, southeast, southwest, Oklahoma City metro, and Tulsa metro. The reported starting wages are ranked from high to low for each region.

So measurement error is not a concern for the data collected by the OHA--these values are known to be the starting wages for the hospitals surveyed. The problem is that there is no way of knowing which wage belongs to which hospital. However, it is useful to compare these figures with a similar arrangement of our constructed compensation variable.

After subtracting benefits and converting to hourly data, the wage estimates could be compared to the grouped and ranked OHA data. Table 4.1 presents a summary of this analysis.

Before this comparison is made, one should make note of the anticipated differences between estimated wages and the survey data. Estimates derived from the formula above would be expected to have larger means and variances than the survey data. The primary reason is that full wages are being estimated and compared to known base wages reported in the survey. The constructed estimate would include overtime pay, shift differentials and additional compensation for levels of experience and expertise. Other reasons for greater variation in wage estimates could involve rounding (payroll expenses are reported by the AHA in thousands of dollars), a slightly different sample group and of course, measurement error. These caveats must be accounted for.

Table 4.1

RN Wages

Region	Number of Hospitals	Mean	Regional Rank	Std. Dev.	InQtl Range
Northwest					
Survey	10	11.13	6	0.55	0.87
Estimate	11	11.91	5	2.54	2.04
Northeast					
Survey	22	11.43	5	0.96	1.51
Estimate	21	12.48	4	2.39	3.45
Southwest					
Survey	8	11.87	2	0.87	1.09
Estimate	13	12.62	3	1.43	2.64
Southeast					
Survey	21	11.74	4	1.53	1.25
Estimate	22	11.48	6	1.68	2.82
Oklahoma City					
Survey	20	11.82	3	1.12	0.55
Estimate	17	13.59	1	1.67	2.74
Tulsa					
Survey	12	12.16	1	1.11	0.86
Estimate	8	13.17	2	2.68	2.59

Table 4.1 indicates, as expected, that means and variances are consistently higher for the estimated wages. The full wage estimate is higher than base wages by an average of $.85 per hour for RNs. The regional ranking (by means) demonstrates how closely the two measures correspond in regional variation. Both measures rank the Oklahoma City and Tulsa metro regions among the highest for RN pay. The lowest wages are generally found in the southeast region. It should

also be noted that wage estimates indicated, as expected, that federal hospitals would generally have greater wages. Some variation in the estimated wages will be reduced when these federal facilities are classified as non-hospital employers as explained previously.

In all, the estimation process appears to generate believable and reasonably well behaved wage estimates that conform closely with known geographic variations. These are combined with fringe benefits to yield the wage variables used in the estimated equations, (4.16) to (4.19).

F. Market Definition and Description

The basic unit for labor market definition is the county in which the hospital is located. Link and Landon postulate that a labor market for nurses is seldom larger than a county [2,650]. Robinson defines a market as the area within a 15 mile radius of the hospital. This is equal to an area of 707 square miles, which is about 80 percent of the average size of a county in Oklahoma (approximately 908 square miles). Data were available for 92 hospitals from 59 of Oklahoma's 77 counties.

Twenty-four of the hospitals are located in the three most populated counties. Figures 4.4 and 4.5 show patterns of residence and employment for nurses in Oklahoma. The number of FTE nurses for all hospitals in a particular county were totaled and compared to the number of nurses living in that county. The number of hospital FTE positions within the county was subtracted from the nurses residing in the county to produce the amount entered. Negative numbers indicate an "excess demand" and positive numbers, an "excess supply."

For both RNs and LPNs, the vast majority of excess demand is in three counties. These are Oklahoma, Tulsa and Comanche county, the locations of the state's three largest metropolitan areas-- Oklahoma City, Tulsa and Lawton respectively. Counties for which positive figures are posted are counties with the largest excess supply and a combined excess supply sufficient to offset the negative figures in the metropolitan areas. Note that these counties are generally clustered around the metro areas. This pattern suggests that the market conditions of urban areas, which are more apt to be competitive, may have effects beyond the county line.

Counties without numbers did not exhibit a significant exportation or importation of nurses. These counties seem to be concentrated in the western part of the state, and are usually characterized by a single hospital, centrally located at the county seat.

Boundaries for hospital product markets are drawn using hospital trade areas defined by the Oklahoma Health Planning Commission. These trade areas are based on movement of patients to hospitals within the trade area. There are a total of 22 trade areas, which include from one to ten

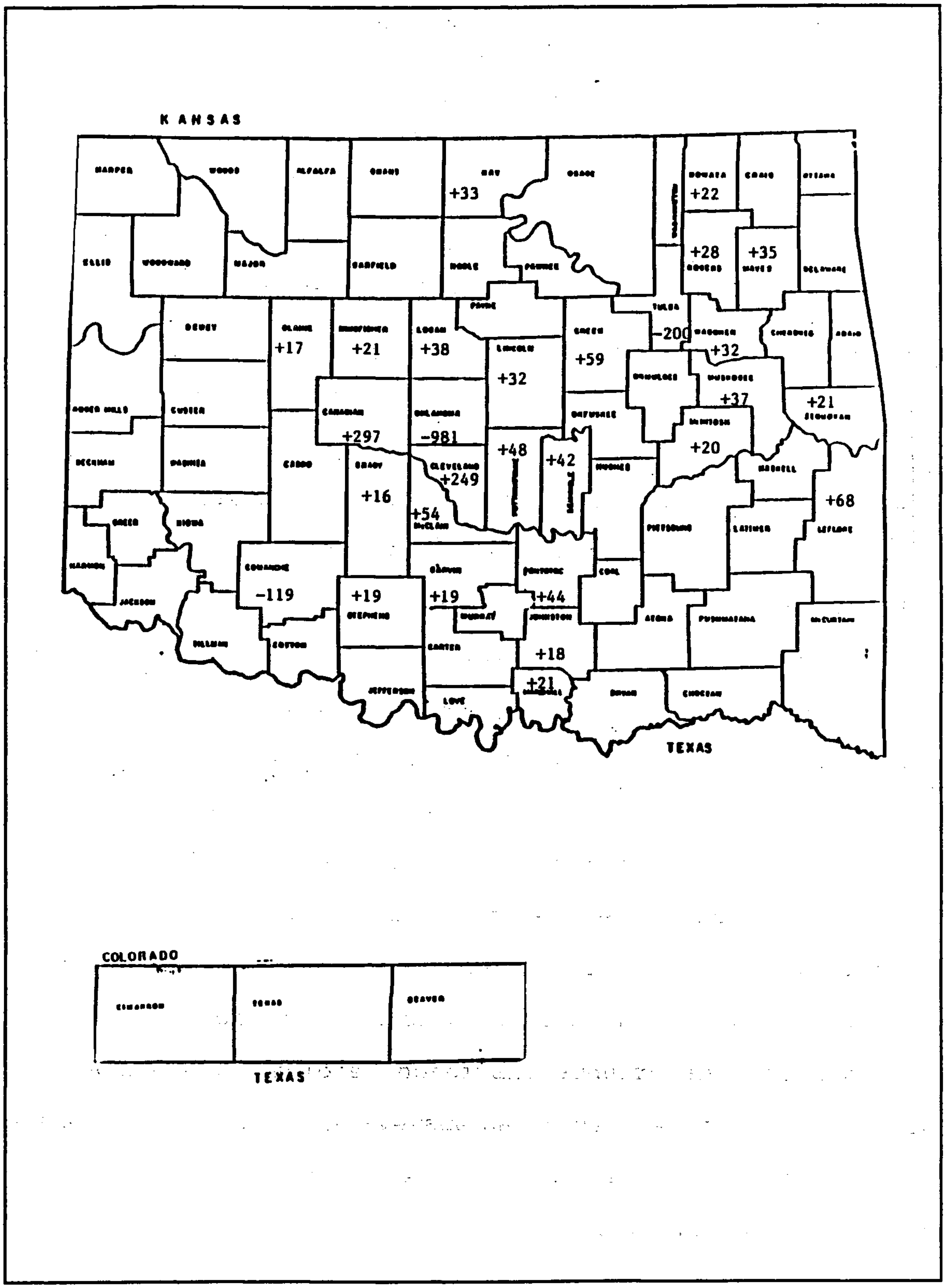

Figure 4.4
Patterns of Residence and Employment of RNs
(+) = Excess Supply, (-) = Excess Demand

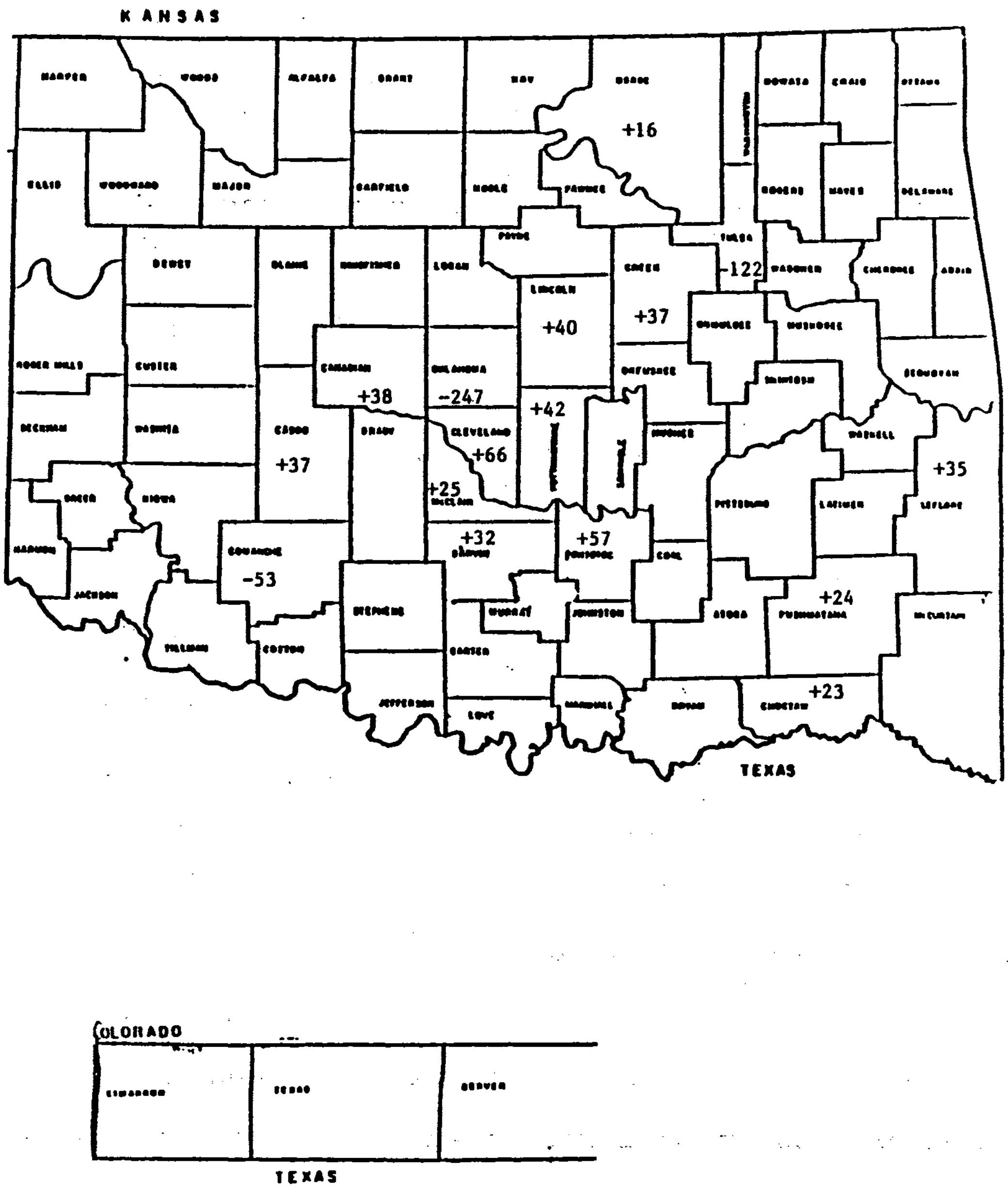

Figure 4.5
Patterns of Residence and Employment of LPNs
(+) = Excess Supply, (-) = Excess Demand

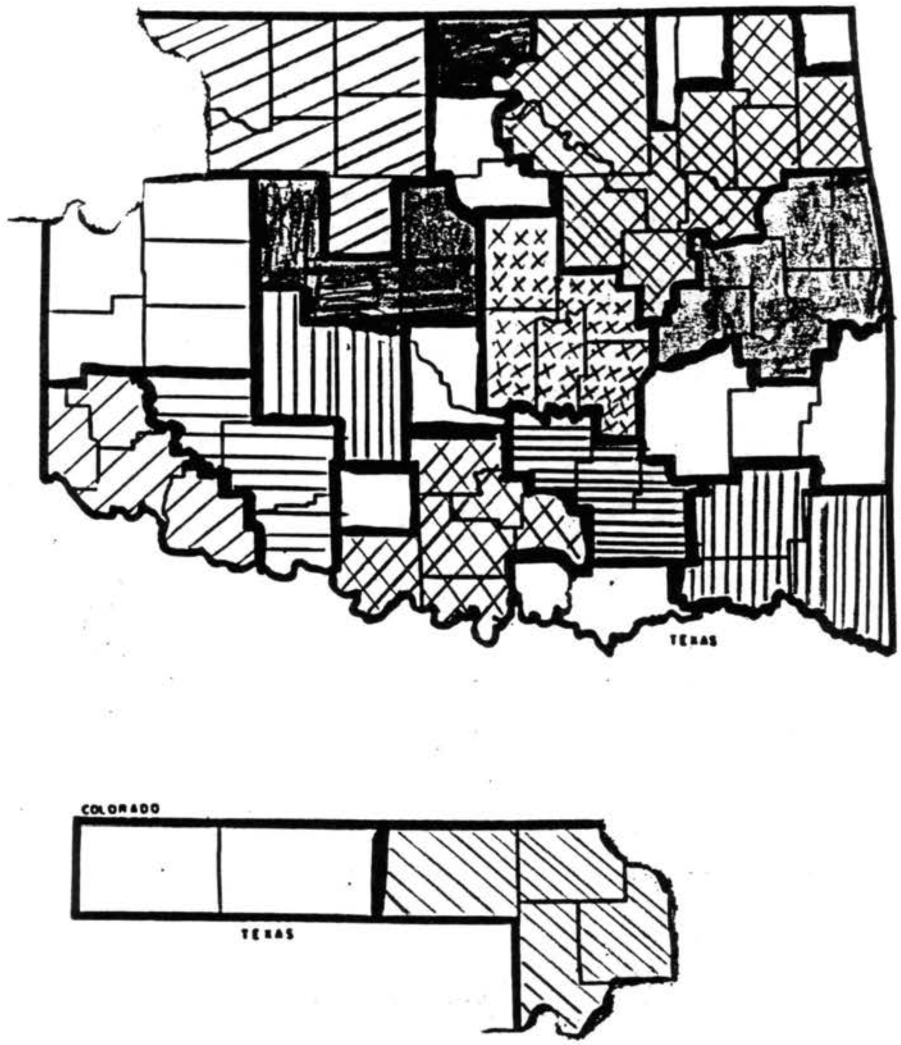

Figure 4.6
Hospital Trade Areas

counties. A map of these product markets is furnished in Figure 4.6.

G. Results

Results of regression for statewide RN data have been recorded on Tables 4.2 through 4.7. Estimates listed reflect the adjustments discussed previously.

One immediately apparent result is that the data are much more successful at explaining employment levels than wages. For the ordinary demand and supply functions, with the number of RNs as the dependent variable, adjusted R-square figures are .9687 and .8999 respectively. For inverse demand and supply functions, with weekly RN compensation (wages) as the dependent variable, adjusted R-square values are .1820 and .2360 respectively.

Estimates of hospital demand parameters are listed in Table 4.2. Each estimate exhibits the expected sign. The negative and significant value for LPNs would suggest an almost one to one substitute relationship with RNs. For each one thousand admissions, hospitals acquire an additional 33 registered nurses. The average daily census, which would also account for the length of stay, indicates that about 2.6 more RNs are acquired for each ten occupied hospital beds. The other significant factor is the hospital's mix. The estimate for mix indicates that about 3.4 more nurses are acquired for every ten specialty patients. Note that monopoly power is inversely related to nurses demanded, but not significantly.

Table 4.3 surveys hospital supply factors for the state. All parameter estimates are significant and have the expected sign. The wage variable, RN compensation, is positively associated with the quantity of nurses supplied. This figure is an estimate of $1/\alpha_1$ and will be discussed in greater detail below.

Each RN graduating from a local nursing school is associated with an additional 1.75 staff RNs at local hospitals. This can be interpreted in two ways. First, it may be an indication of the relative immobility of nurses. On the other hand, it may show the tendency of nursing programs to locate in areas where nurse utilization is high.

In the context of the supply curve, the local county wage represents the opportunity cost of being an RN relative to other types of employment. The estimated coefficient for county wage suggests that, for every one dollar increase in the local hourly wage rate, the hospital supply curve is reduced by approximately sixteen RNs.

There is a strong correlation between county employment and RN supply. Every one thousand additional employees within a county will increase hospital RN supply by roughly eleven nurses. It would be apparent that other types of employment will bring more nurses into the local market.

From the positive parameter value associated with market mix, one could infer that registered nurses are drawn to hospitals located in markets where higher numbers of specialty patients are present.

Finally, the coefficient for competitive RNs is negative and not significantly different from unity. This figure may suggest some interdependence among nurse employers that would not be evident in perfectly competitive markets.

Results of the market demand and supply estimations, listed in Tables 4.4 and 4.5, are generally consistent with hospital level results with two notable exceptions in the demand relationship. First, although RNs and LPNs appear to be substitutes at the hospital level, they exhibit a complementary correlation in the market. Second, the market value of mix patients is negatively related to overall RN demand.

Inverse demand and supply results are provided in Tables 4.6 and 4.7 respectively. The most striking feature of these results is the inability of most of the demand factors to explain changes in the compensation level. Simultaneously, all estimated supply parameters are statistically significant. This result, taken by itself, would point to a competitive market structure.

For the inverse demand function, only the constant term and the county wage level demonstrate a significant impact on RN compensation. Specifically, each one dollar increase in the average hourly wage of county employees is associated with a $19.10 increase in the weekly wages of local RNs. With the exception of MDs, all other estimates exhibit the expected sign.

Attention is now turned to the inverse supply function found in Table 4.7. The signs of estimates are consistent with results of the hospital supply function in Table 4.3. That is, a variable that is positively associated with the quantity of RNs supplied is inversely related to the RN compensation level.

First of all, nursing graduates have the expected downward impact on wages. Each RN graduate within the county is linked to a $1.75 reduction in the weekly compensation for RNs at local hospitals.

As was observed previously, the hourly county wage is negatively related to RN employment. Results in Table 4.7 indicate that each $1 increase in the county wage elevates the inverse supply curve by about $30.

Two factors that draw more nurses into the local market exhibit the expected negative impact on RN compensation. Every one thousand county employees would be associated with a reduction in weekly RN compensation of roughly $12. Each mix or specialty patient within the market moves the inverse supply downward (vertically) by about $0.50.

Competition from other hospitals or nurse employers does display a significant, positive impact on wages. Each competitive RN tends to increase weekly RN compensation by approximately \$1.06.

Finally, the estimate of α_1 is positive and significant. The estimated value of 1.080 suggests that each additional RN employed by the hospital increases weekly compensation for all RNs employed by the hospital by \$1.08. This means that hourly compensation (including benefits) for all RNs within a hospital increases by about \$0.03 with each additional RN employed.

This implies that the typical hospital in Oklahoma faces an upward sloping supply curve, but monopsony power will also depend upon where hospitals are located on that curve. Using average employment and compensation levels, elasticity estimates are generated with information from the supply and inverse supply functions by the following formula, in which $\hat{w}$ represents the average weekly wage or RN compensation.

$$\hat{E}^{hs} = \left(\frac{d\hat{R}N_i}{dw}\right)\frac{\hat{w}}{\overline{\overline{RN}}} = \left(\frac{\hat{1}}{\alpha_1}\right)\frac{\hat{w}}{\overline{\overline{RN}}}$$

From the supply function in Table 4.3, the direct estimate of $1/\alpha_1$ is 0.4477. Using this value, the average wage elasticity of supply to hospital is estimated to be 2.7177. From the inverse supply function in Table 4.7, the estimate of α_1 is 1.0800. Using the reciprocal of this value in the elasticity formula, the estimated average wage elasticity would be 5.620. It should be noted that these figures would be estimates of short term elasticities. Actual employment patterns of hospitals would probably be based on long term elasticities, which one would expect to be larger.

As a comparison, Sullivan [24] found a short term elasticity estimate of 1.266.[8] However, the methodology used by Sullivan was different than that of this paper. Thus, comparisons should be made with caution.

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8 Specifically, Sullivan directly estimated inverse elasticity to be 0.79 for one year changes in wages. The value quoted above is the reciprocal of this estimate.

Table 4.2

Hospital Demand
Registered Nurses
Statewide

Dependent Variable: RN_i

Variable	Parameter Estimate	Standard Error	T-value
Intercept	27.2255	46.1130	0.590
RN Compensation	-0.1046	0.1143	-0.939
Age	0.2431	0.8812	0.276
LPN_i	-0.7194	0.2355	-4.077
Cty. Wage	1.2775	3.2320	0.395
$Admits_i$	0.3338	0.0015	21.677
$Census_i$	0.2635	0.0675	3.906
MDS_i	0.0870	0.0627	1.386
Mix_i	0.3406	0.0758	4.491
Mon_i	-0.1126	0.1638	-0.687

R^2: .9714 adjusted R^2: .9687 F value: 309.767

Table 4.3

Hospital Supply
Registered Nurses
Statewide

Dependent Variable: RN_i

Variable	Parameter Estimate	Standard Error	T-value
Intercept	-124.4346	57.6051	-2.160
RN Compensation	0.4799	0.1486	3.230
RN Graduates	1.7596	0.2084	8.441
Cty. Wage	-16.0899	6.1500	-2.616
Cty. Employment	0.0109	0.0005	22.730
Mix^m	0.4780	0.0475	10.056
Competitive RNs	-0.9830	0.0445	-22.100

R^2: .9065 adjusted R^2: .8999 F value: 137.63

Table 4.4

Market Demand
Registered Nurses
Statewide

Dependent Variable: RN^m

Variable	Parameter Estimate	Standard Error	T-value
Intercept	315.2199	140.6107	2.242
RN Compensation	-1.0446	0.3880	-2.692
Age	1.0089	3.9878	0.253
LPN^m	0.8815	0.3628	2.429
Cty. Wage	17.0183	12.3138	1.382
$Admits^m$	0.0415	0.0099	4.187
$Census^m$	0.1844	0.1689	1.092
MDS^m	-0.0489	0.4944	-0.099
Mix^m	-0.9559	0.2832	-3.375
Mon^m	-0.6254	0.4630	-1.351

R^2: .9976 adjusted R^2: .9973 F value: 3741.313

Table 4.5

Market Supply
Registered Nurses
Statewide

Dependent Variable: RN^m

Variable	Parameter Estimate	Standard Error	T-value
Intercept	-106.8148	53.0039	-2.015
RN Compensation	0.4262	0.1354	3.147
RN Graduates	1.8005	0.1857	9.694
Cty. Wage	-14.9207	5.6920	-2.621
Cty. Employment	0.0111	0.0002	64.651
Mix^m	0.4884	0.0371	13.157

R^2: .9993 adjusted R^2: .9992 F value: 22954.7

Table 4.6

Hospital Inverse Demand
Registered Nurses
Statewide

Dependent Variable: RN Compensation

Variable	Parameter Estimate	Standard Error	T-value
Intercept	314.8755	102.2721	3.079
RN_i	-1.7015	2.3048	-0.738
Age	0.1316	3.2245	0.041
LPN_i	-0.9065	1.9993	-0.453
Cty. Wage	18.9235	8.3745	2.260
$Admits_i$	0.0617	0.0584	1.057
$Census_i$	0.5556	0.5058	1.098
MDS_i	-0.0627	0.2813	-0.223
Mix_i	0.8661	0.5961	1.453
Mon_i	-0.1292	0.6289	-0.205

R^2: .2499 adjusted R^2: .1676 F value: 3.036

Table 4.7

Hospital Inverse Supply
Registered Nurses
Statewide

Dependent Variable: RN Compensation

Variable	Parameter Estimate	Standard Error	T-value
Intercept	281.8767	61.6031	4.576
RN_i	1.0800	0.3849	2.806
RN Graduates	-1.7503	0.8142	-2.150
Cty. Wage	29.8872	8.3840	3.565
Cty. Employment	-0.0119	0.0043	-2.183
Mix^m	-0.5111	0.2032	-2.515
Competitive RNs	1.0587	0.3872	2.734

R^2: .2864 adjusted R^2: .2360 F value: 5.685

V

CONCLUSION

A. Summary

An attempt was made to explain patterns of wages and employment for registered nurses in the state of Oklahoma. Specifically, the effort was to determine to what extent hospital monopsony power could be used to depress compensation and employment. A market model was demonstrated to explain how lower degrees of competition would lead to lower and more sluggish wage levels as well as increased reporting of shortages.

The evidence concerning monopsony is summarized as follows: 1) Using statewide regressions, it appears that the typical hospital does face an upward-sloping, short run supply curve for RNs. 2) Short term elasticity estimates generated from the supply curve and inverse supply curve are 2.72 and 5.62 respectively. 3) Nursing demand factors which explain employment patterns very well have great difficulty explaining wage differences. 4) Some competitive employment exists in all markets and has a significant positive impact on hospital wages.

These results are somewhat mixed. The elasticity estimate above would correspond to potential wage gaps as large as 36.8 percent (=1/2.72) or as small as 17.8 percent (=1/5.62). But long term employment decisions would be based on longer term elasticities, which would be higher. It seems that much of the wage disparity between hospitals can be explained by reasons unrelated to monopsony control.

It is possible that the use of a prospective payment system (PPS) may bring increased competition in the market for nurses. To date, little information has been found concerning this proposition. In 1988, Robinson [22,324] speculated that prepayment reimbursement by medicare would reduce total employment in the industry.

As a possibility for further investigation, the potential erosion of monopsony power due to the PPS could be evaluated by comparing regression results using the most recent data to results using data from 1982 or before. In particular, one would evaluate the employment concentration parameter, α_1, to see if it had declined in magnitude in the most recent time period.

Another possibility of further research would involve running separate regressions for subsamples of hospitals to determine if there are distinctive hospital or market characteristics that may influence buying power.

Specifically, one would expect empirical analysis to indicate that hospitals with a low elasticity ratio (RN^c/RN_i from Equation 2.19a) are capable of exercising more monopsony power than hospitals with a high elasticity ratio. The relevant comparison then, is to see if the estimate of α_1 for low ratio hospitals is significantly greater than the estimate of α_1 for high ratio hospitals.

B. Implications for Health Care Policy

According to Robinson, federal policy toward funding of nursing education was discouraged in 1978, largely due to the acknowledgement of monopsony power of hospitals. This policy could be reevaluated. If markets have become competitive, shortages would be of a dynamic nature and governments could consider support of nursing education on the merits of the profession without being concerned about subsidizing hospitals. On the other hand, if there is a trend toward competition, market forces alone would be more capable of adjusting wages and eliminating shortages of nurses.

Many of the health reform packages currently being proposed by policy makers incorporate prospective payment characteristics. The trend toward capping, emphasis on home health care and preventative medicine all point to declining hospital utilization. This could further stimulate competitive pressures in nursing markets as long as it is not associated with a concurrent and equal reduction in overall nursing employment.

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Appendix A
Derivation of Triopsony Equilibrium

Beginning with simplified market supply and demand equations:

(A.1)
$$N^D=k-w, \quad N^S=w$$

Individual demands are given as,

(A.2)
$$\begin{aligned} N_1^{hd}&=b_1N^D=b_1(k-w) \\ N_2^{hd}&=b_2N^D=b_2(k-w) \\ N_3^{hd}&=b_3N^D=b_3(k-w) \end{aligned}$$

Residual supplies to each firm are,

(A.3)
$$\begin{aligned} N_1^{hs}&=N^S-N_2^{hs}-N_3^{hs} \\ N_2^{hs}&=N^S-N_1^{hs}-N_3^{hs} \\ N_3^{hs}&=N^S-N_1^{hs}-N_2^{hs} \end{aligned}$$

Substitute the supply function $N^S = w$ into the equations above. Then solve for w to obtain inverse supply functions. Total factor costs are obtained by multiplying each equation by their respective quantities supplied. Take the derivative of total factor cost with respect to N_i^{hs} to obtain marginal factor cost equations.

(A.4)
$$\begin{aligned} \overline{w}_1&=2N_1^{hs}+N_2^{hs}+N_3^{hs} \\ \overline{w}_2&=N_1^{hs}+2N_2^{hs}+N_3^{hs} \\ \overline{w}_3&=N_1^{hs}+N_2^{hs}+2N_3^{hs} \end{aligned}$$

Setting inverse demands equal to MFC yields the following. Define e_i as,

$$e_i=2+\frac{1}{b_i}$$

$$N_1=\frac{1}{2+(1/b_1)}(k-N_2-N_3)$$

(A.5)
$$N_2=\frac{1}{2+(1/b_2)}(k-N_1-N_3)$$

$$N_3=\frac{1}{2+(1/b_3)}(k-N_1-N_2)$$

and rewrite equations A.5 as,

(A.6)
$$\begin{aligned} N_1+\frac{1}{e_1}N_2+\frac{1}{e_1}N_3&=\frac{1}{e_1}k \\ N_1+e_2N_2+N_3&=k \\ N_1+N_2+e_3N_3&=k \end{aligned}$$

Equation A.6 in matrix form.

(A.7)
$$\begin{bmatrix} 1 & 1/e_1 & 1/e_1 \\ 1 & e_2 & 1 \\ 1 & 1 & e_3 \end{bmatrix} \begin{bmatrix} N_1 \\ N_2 \\ N_3 \end{bmatrix} = \begin{bmatrix} k/e_1 \\ k \\ k \end{bmatrix}$$

Using Cramer's rule, solutions are found for equilibrium employment levels.

$$N_1=\frac{1-e_2-e_3+e_2e_3}{2-e_1-e_2-e_3+e_1e_2e_3}k$$

(A.8)
$$N_2=\frac{1-e_1-e_3+e_1e_3}{2-e_1-e_2-e_3+e_1e_2e_3}k$$

$$N_3=\frac{1-e_1-e_2+e_1e_2}{2-e_1-e_2-e_3+e_1e_2e_3}k$$

From the market supply equation, the equilibrium wage is the sum of N_1, N_2 and N_3.

Appendix 2
Equilibrium in Composite Mixed Model with Two Major Firms

Begin, as in all previous cases, with market supply and demand Equations 2.1 and 2.2. To facilitate the derivation procedure, denote the fraction of nursing demand of the competitive fringe as $b_f = 1 - b_1 - b_2$. The demand functions for the two major firms and the competitive fringe respectively are as follows.

(B.1)
$$N_1^{hd}=b_1(k-w)$$
$$N_2^{hd}=b_2(k-w)$$
$$N^{fd}=b_f(k-w)$$

Solving for wages yields inverse demands.

(B.2)
$$w=k-\frac{1}{b_1}N_1^{hd}$$
$$w=k-\frac{1}{b_2}N_2^{hd}$$
$$w=k-\frac{1}{b_f}N^{fd}$$

The residual supplies for the two major firms are:

(B.3)
$$N_1^{hs} = N^S-N_2^{hs}-N^{fd} = w(1+b_f)-N_2^{hs}-b_fk$$
$$N_2^{hs} = N^S-N_1^{hs}-N^{fd} = w(1+b_f)-N_1^{hs}-b_fk$$

Solving the residual supplies for wages yields an inverse supply function which is identical for both firms.

(B.4)
$$w = \frac{1}{1+b_f}(N_1^{hs}+N_2^{hs}+b_fk)$$

Thus, the major firm's marginal factor cost functions are:

(B.5)

$$\overline{w}_1=\frac{2}{1+b_f}N_1^{hs}+\frac{1}{1+b_f}(N_2^{hs}+b_f k)$$

$$\overline{w}_2=\frac{2}{1+b_f}N_2^{hs}+\frac{1}{1+b_f}(N_1^{hs}+b_f k)$$

Setting marginal factor costs equal to respective inverse demands will yield each firm's optimal employment level as a function of the other firms employment.

(B.6)

$$N_1=\frac{b_1}{1+b_f+2b_1}(k-N_2)$$

$$N_2=\frac{b_2}{1+b_f+2b_2}(k-N_1)$$

Now define the following terms.

$$\epsilon_1=\frac{b_1}{1+b_f+2b_1} \quad \textit{and} \quad \epsilon_2=\frac{b_2}{1+b_f+2b_2}$$

Then equilibrium employment levels for the two firms can be derived.

(B.7)

$$N_1=\frac{\epsilon_1-\epsilon_1\epsilon_2}{1-\epsilon_1\epsilon_2}k$$

$$N_2=\frac{\epsilon_2-\epsilon_1\epsilon_2}{1-\epsilon_1\epsilon_2}k$$

Equilibrium wages are found by plugging employment levels of (B.7) into the inverse residual supply function (B.4). Equilibrium fringe employment is found by either i) substituting the equilibrium wage into the fringe demand function (B.1), or ii) subtracting equilibrium employment levels of the two dominant firms from the equilibrium wage.

v

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