Estimating a Bargaining Contract Curve: Prior Restriction and Methodology

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Estimating a Bargaining Contract Curve: Prior Restrictions and Methodology

by

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Abstract

This paper derives prior restrictions on the effects of changes in demand and supply variables on the position of a bargaining contract curve. If an estimated contract curve does not conform to these restrictions, it is inconsistent with the underlying model. The paper also suggests a two-stage methodology for estimating a contract curve.
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1. Introduction

In the last several years, McDonald and Solow's (1981) efficient-bargain model has attracted considerable attention in the collective bargaining literature. Under this model, bargaining outcomes lie along a contract curve comprised of tangencies between union and employer indifference curves in wage-employment space. The efficient-bargain model has become the principal alternative to the standard "demand-constrained" model of the bargaining process, under which the union picks its preferred point on the employer's demand curve for labor.

In a recent paper, Macurdy and Pencavel (1986) attempt to discriminate empirically between the efficient-bargain and demand-constrained models. Their empirical results indicate that bargaining outcomes violate the tangency condition associated with the demand-constrained model, implying that the chosen point lies off the labor demand curve. This finding is interpreted as evidence in favor of the efficient-bargain model. Eberts and Stone (1986) attempt to discriminate between the two bargaining models by studying the effect of employment-increasing contract provisions. Such provisions would be expected to reduce the wage in the demand-constrained model but could be consistent with higher wages if bargaining outcomes lie along an upward-sloping contract curve. The empirical results, which show the latter relationship, favor the efficient-bargain model.

By contrast, Brown and Ashenfelter (1986) and Brueckner and O'Brien (1988) attempt to estimate entire contract curves. Brown and Ashenfelter's
goal is to test for "strong efficiency," under which employment depends on the alternative wage but is insensitive to the contract wage. Brueckner and O'Brien (1988), who focus on public sector bargaining, look for evidence of bureaucratic self-interest in their estimated contract curve (self-interest is manifested in the pursuit of excessive employment levels by government bureaucrats).

In view of the growing popularity of the efficient-bargain model, it is likely that some future papers will follow the latter studies by attempting to estimate bargaining contract curves. Before such estimates can be used to address hypotheses of interest (strong efficiency or bureaucratic self-interest, for example), researchers must offer evidence that their estimated curves are consistent with the underlying bargaining model. It is well-known that the efficient-bargain model imposes no restrictions on the slope of the contract curve unless preferences satisfy special assumptions. As a result, both upward- and downward-sloping curves are consistent with the theory. Less is known, however, about the effect on the contract curve of changes in the demand and supply variables that underlie employer and union indifference maps and help determine the curve's position. Examples of such variables are the alternative wage (a supply variable) and community population in a public sector model (a demand variable). To aid researchers in evaluating their results, the present paper analyses the effects of demand and supply variables on the position of the contract curve and states the minimal prior restrictions that can be placed on these effects. While the restrictions are fairly weak, Brueckner and O'Brien (1988) were able to reject the efficient-bargain model for several public employee samples by appealing to them. Checking for violation of these restrictions will allow future researchers to
decide whether their estimated contract curves are similarly inconsistent with the efficient-bargain model.

The paper also suggests a two-stage approach to contract curve estimation. The approach is based on the recognition that the point actually reached on the contract curve depends on the bargaining strengths of the union and employer. It is shown that an estimation method such as two-stage least squares is appropriate, with the full list of exogenous variables consisting of the demand and supply variables along with variables measuring the bargaining strengths of the two parties.

2. Prior Restrictions

To begin the analysis, it is assumed that union preferences over the wage \( w \) and employment \( L \) are represented by the utility function \( V(w, L, \beta) \), where \( \beta \) is a supply variable (a scalar rather than vector variable is assumed for simplicity). This function is assumed to be strictly quasi-concave in its first two arguments, and an increase in \( \beta \) is assumed to flatten indifference curves in \( L-w \) space (\( w \) is on the vertical axis). The marginal rate of substitution \( \frac{V}{V_w} \) is thus assumed to be a decreasing function of \( \beta \). In the analysis, it will be convenient to invert the equation \( V(w, L, \beta) = v \) defining an indifference curve so that it reads \( w = h(L, \beta, v) \) (\( v \) is some constant utility level). The function \( h \) satisfies \( h_L = -\frac{V}{V_w} < 0 \), \( h_{LL} > 0 \) (by quasi-concavity), and \( h_v = 1/V_w > 0 \) (the effect of \( \beta \) is discussed below).

Without specifying the details of the institutional setting, the employer's objective function is written \( U(w, L, a) \), where \( a \) is a (scalar) demand variable. The labor demand curve used in the demand constrained bargaining model is found by choosing \( L \) to maximize \( U \) for fixed \( w \), solving \( U_L(w, L, a) = 0 \). Under the assumption \( U_{LL} < 0 \), the second-order condition for this problem is
satisfied, and it follows that \( U_L \) is positive to the left and negative to the right of the labor demand curve.

The employer's indifference curves are defined by \( U(w, L, a) = u \) for some constant \( u \) and the slope of an indifference curve equals \(-U_L/U_w\). Given the behavior of \( U_L \) and the fact that \( U_w \) is negative, it is easily seen that indifference curves are upward-sloping to the left and downward-sloping to the right of the labor demand curve. An increase in the demand variable is assumed to increase the indifference curve slope (\(-U_L/U_w\) is an increasing function of \( a \)), so that a larger \( a \) makes the indifference curves steeper to the left and flatter to the right of the demand curve. The higher \( a \) also moves the demand curve to the right (note that after an increase in \( a \), \( U_L \) is positive along the old demand curve). These changes are illustrated in Figure 1. As in the case of the union indifference curves, it is convenient to invert the equation \( U(w, L, a) = u \) so that the employer's indifference curves can be written \( w = g(L, a, u) \), where \( g_L = -U_L/U_w \) and \( g_u = 1 \) \( U_w < 0 \) (the effect of \( a \) will be discussed below).

Before presenting and analysing the equations that determine the contract curve, further analysis of the functions \( h \) and \( g \) is needed. First, it is necessary to express the assumption that \( V_L/V_w \) is decreasing in \( \beta \) in terms of the function \( h \). The assumption means that the absolute slope expression \(-h_L\) is decreasing in \( \beta \) provided that the utility level \( v \) adjusts to hold \( w \) constant as \( \beta \) changes. The adjustment in \( v \) restricts the focus to an indifference curve passing through a particular \((L, w)\) point, which by assumption becomes flatter. Thus it must be the case that \(- (h_{L\beta} - h_{Lv}[dv/d\beta]) < 0 \), where \( dv/d\beta \) is the utility change required to keep \( w \) constant as \( \beta \) increases. By differentiation of \( w = h(L, \beta, v) \), \( dv/d\beta \) equals \(-h_{\beta}/h_v \), so that the required condition is

\[
\frac{h_{L\beta}}{h_{Lv}} h_{\beta}/h_v > 0. \tag{1}
\]
By exactly analogous reasoning, the requirement that $U_L/U_w$ is decreasing in $\alpha$ means that the function $g$ must satisfy

$$
\frac{\partial g}{\partial \alpha} - \frac{\partial g}{\partial \alpha} \frac{\partial g}{\partial \alpha} > 0.
$$

Since normality conditions on preferences can be used to sign otherwise ambiguous expressions in the analysis of the contract curve, statement of these conditions in terms of the functions $h$ and $g$ is useful. For the union indifference map, normality of $L$ means that indifference curves become steeper moving vertically in the $L-w$ plane. Since a vertical movement corresponds to an increase in $v$ with $L$ held fixed, the appropriate condition is

$$
h_{LV} < 0.
$$

Similarly, normality of $w$ means that indifference curves become flatter moving horizontally. A horizontal movement corresponds to an increase in $L$ combined with an increase in $v$ that serves to keep $w$ constant. The appropriate condition is then

$$
h_{ LL} - h_{LV} \frac{\partial v}{\partial L} > 0,
$$

where $\frac{\partial v}{\partial L}$ gives the required change in $v$. Since $\frac{\partial v}{\partial L}$, normality of $w$ requires

$$
h_{ LL} - h_{LV} \frac{h_{L}}{h_{V}} > 0.
$$

Although the employer's indifference map is unusual in that the utility level is higher on lower indifference curves, $L$ and $w$ will be viewed as "normal" when the curves become flatter moving vertically and steeper moving horizontally in the $L-w$ plane. Since these properties are the reverse of those exhibited by the union's indifference curves, repetition of the above argument gives

$$
\frac{\partial g}{\partial L} < 0
$$

$$
\frac{\partial g}{\partial L} - \frac{\partial g}{\partial L} \frac{\partial g}{\partial L} < 0
$$
as the conditions for normality of $L$ and $w$ respectively (note that $g_{Lu}$ is negative instead of positive since a vertical movement corresponds to a decrease rather than an increase in $u$).

With the discussion of the $h$ and $g$ functions complete, the analysis of the contract curve can now begin. The contract curve is defined by the following system of simultaneous equations:

\[ w = g(L, a, u) \]  \hspace{1cm} (7)

\[ w = h(L, \beta, v) \]  \hspace{1cm} (8)

\[ g_u(L, a, u) = h_u(L, \beta, v) \]  \hspace{1cm} (9)

Equations (7) and (8) indicate that employer and union indifference curves intersect, and (9) says that the intersection involves a tangency. For this tangency to represent a Pareto-efficient bargaining outcome, it must be the case that $g_{LL} < h_{LL}$, so that the employer's indifference curve is less convex than the union's.\(^\text{1}\)

The endogenous variables in the system (7)-(9) are $w$, $L$, $u$, and $v$, and since there are only three equations to solve for them, the system is underdetermined. However, the contract curve is found by treating $L$ as fixed and solving for the remaining variables. The resulting $w$ solution, which can be written

\[ w = w(L, a, \beta), \]  \hspace{1cm} (10)

is the equation of the contract curve.\(^\text{2}\) The goal of the analysis is to sign the partial derivatives of the function in (10).

The derivative $\partial w / \partial L$ gives the contract curve's slope. Treating $L$ as exogenous and totally differentiating the system (7)-(9), this derivative is given by
\[ \frac{\partial w}{\partial L} = g_L + \frac{g_{LL} - h_{LL}}{h_{LV}/h_v - g_{Lu}/g_u} \]

\[ = \frac{[g_{LL} - g_{Lu}/g_v] - [h_{LL} - h_{LV}h_L/h_v]}{h_{LV}/h_v - g_{Lu}/g_u}. \] (11)

The sign of (11) and thus the slope of the contract curve depends on whether \( L \) and \( w \) are normal goods in the employer and union utility functions. If \( w \) is normal in both cases, then the numerator of (11) is negative (recall (1) and (6)). If \( L \) is normal in both cases, then the denominator is also negative given that \( h_v > 0 \) and \( g_u < 0 \) (recall (3) and (5)). Normality of both goods therefore implies that (11) is positive and that the contract curve is upward sloping. If on the other hand, \( w \) is inferior and \( L \) is normal for both the employer and the union, then (4) and (6) are reversed. The numerator of (11) then becomes positive, and the contract curve is downward sloping. Similarly, if \( w \) is normal but \( L \) is inferior, then (3) and (5) are reversed, the denominator of (11) becomes positive, and the contract curve is again downward sloping. Finally, if \( w \) (alternatively \( L \)) is neither normal nor inferior for both the employer and union, implying that equality holds in (3) and (5) (in (4) and (6)), then the contract curve is vertical (horizontal). In all admissible circumstances other than those just listed, the sign of (11) is indeterminate and the contract curve could slope up or down.

Even though an explicit proof has not appeared in the literature, the above results are generally known. The effects of the demand and supply variables \( \alpha \) and \( \beta \) on the position of the contract curve are, however, less well understood. The following analysis develops the minimal prior restrictions that can be placed on these effects. Total differentiation of (7)–(9) shows that
\[
\frac{\partial w}{\partial a} = \frac{g_L - g_L u g_a / g_u}{h_{LV}/h_v - g_L u / g_u}
\tag{12}
\]
\[
\frac{\partial w}{\partial \beta} = -\frac{h_L \beta - h_{LV} h \beta / h_v}{h_{LV}/h_v - g_L u / g_u}
\tag{13}
\]

With the numerators of (12) and (13) positive by (1) and (2), the signs of the expressions depend on the sign of the common denominator. From above, normality of \(w\) implies that the denominator expression is negative. Under these circumstances, \(\frac{\partial w}{\partial a}\) is negative and \(\frac{\partial w}{\partial \beta}\) is positive, indicating that the contract curve shifts down (up) as \(a\) (\(\beta\)) increases. Note that this statement holds regardless of whether the curve is upward or downward sloping.

In the reverse case where \(w\) is inferior for both the employer and union, (12) and (13) are respectively positive and negative and the contract curve shifts up (down) with an increase in \(a\) (\(\beta\)).

Although the direction of demand and supply effects thus depends on unobservable features of preferences, (12) and (13) do impose one mild restriction on these effects. In particular, the contract curve's shift in response to an increase in the demand variable must be in the opposite direction to the shift caused by an increase in the supply variable. If the curve shifts down in response to an increase in \(a\), then it must shift up in response to an increase in \(\beta\), and vice versa. While this restriction is useful in evaluating the consistency of empirical results, a stronger restriction is in fact available in the case where the contract curve is upward sloping. To derive the restriction, note that (12) and the first line of (11) together imply
\[ \frac{\partial w}{\partial L} - g_L = \frac{g_{LL} - h_{LL}}{g_{La} - g_{La} g_u g_B} \frac{\partial w}{\partial a}. \]  

(14)

Since the denominator of (14) is positive and \( g_{LL} - h_{LL} < 0 \) must hold for the tangency point to be optimal, it follows that

\[ \text{sgn}\left(\frac{\partial w}{\partial a}\right) = -\text{sgn}\left(\frac{\partial w}{\partial L} - g_L\right). \]  

(15)

Since \( \frac{\partial w}{\partial a} \) and \( \frac{\partial w}{\partial \beta} \) must have opposite signs, it also must be true that

\[ \text{sgn}\left(\frac{\partial w}{\partial \beta}\right) = \text{sgn}\left(\frac{\partial w}{\partial L} - g_L\right). \]  

(16)

To interpret (15) and (16), note that the right-hand side depends on the difference between the slope of the contract curve and the (negative) slope of the indifference curves at the tangency point. While this difference can have either sign when the contract curve is downward sloping, the difference must be positive when the curve is flat or upward sloping. Therefore, in the flat and upward-sloping cases, (15) and (16) imply that \( \frac{\partial w}{\partial a} \) and \( \frac{\partial w}{\partial \beta} \) are respectively negative and positive. When the contract curve is downward sloping, this result is preserved provided that the curve is flatter than the indifference curves, in which case \( \frac{\partial w}{\partial L} > g_L \). However, the reverse impacts occur when the contract curve is steeper than the indifference curves (in this case \( \frac{\partial w}{\partial a} \) and \( \frac{\partial w}{\partial \beta} \) are respectively positive and negative). These results, which do not depend on any assumptions about preferences, are summarized as follows:

Proposition. When the contract curve is flat or upward sloping, an increase in the demand variable shifts the curve down (\( \frac{\partial w}{\partial a} < 0 \)) and an increase in the supply variable shifts it up (\( \frac{\partial w}{\partial \beta} > 0 \)). These results also apply in the downward-sloping case provided that the contract curve is flatter than the indifference curves. The reverse impacts (\( \frac{\partial w}{\partial a} > 0 \) and \( \frac{\partial w}{\partial \beta} < 0 \)) occur otherwise.
Note that while the proposition provides strong restrictions in the flat and upward-sloping cases, the fact that indifference curve slopes are unobservable means that only the weak restriction discussed above is available in the downward-sloping case. In this case, all that can be said is that demand- and supply-induced shifts in the contract curve must be in opposite directions. As a final point, note that the proposition can be restated in terms of the expression \( h_{LV} h_v - g_{Lu} / g_u \) in the denominator of (12) and (13). Recalling that the numerator of (12) is positive, the proposition implies that \( h_{LV} / h_v - g_{Lu} / g_u < (>) 0 \) holds as \( \partial w / \partial L > (<) g_L \).

The proposition is illustrated in Figures 2 and 3, which show the effect of an increase in the demand variable (recall that this flattens the employer's indifference curves). Figure 2 illustrates the downward shift of an upward-sloping contract curve, case A in Figure shows the same outcome in the case of a relatively flat downward-sloping curve, and case B shows the upward shift of a steep downward sloping curve. Note that cases A and B are based on different union indifference maps.

Using the prior restrictions from the proposition, Brueckner and O'Brien (1988) rejected the efficient bargain model for three national cross-section samples of fire, police, and sanitation workers. Table 1 shows estimated log-linear contract curves for the three samples. These equations were estimated by two-stage least squares, as explained further in the next section of the paper. The main demand variables in the equations are community population (POP), population density (POPDEN), median income (INC), and the percentages of the population nonwhite (NONWHT) and holding a high-school degree (HSDEG). Supply variables are the alternative wage (taken to be the county manufacturing wage, MFGW) and the state unemployment rate (UNEMP). The percentage of municipal revenue from outside sources (IGOVREV) is included to control for
grant-induced variation in the effective price of public services, and median house value (MEDVAL) captures demand differences in high and low cost-of-living areas. The community-competition variable COMP, which equals the number of municipalities in the county containing the given community, is included to test for the self-interested behavior on the part of government bureaucrats engaged in the collective bargaining process. Heightened community competition is expected to restrain the pursuit of self-interest, reducing the bureaucrat's demand for labor.  

Since the significantly negative L coefficients in Table 1 indicate that the estimated contract curves are downward sloping, demand and supply effects are indeterminate but must be of opposite sign. This restriction is violated, however, by the estimated coefficients for POP (arguably the most important demand variable) and MFGW (a key supply variable). As can be seen in Table 1, all the POP and MFGW coefficients are positive and all except for the sanitation MFGW coefficient are significant. Thus, instead of shifting the contract curve in opposite directions, increases in these demand and supply variables yield identical upward shifts in the curve. With the efficient-bargain model rejected on the basis of these results, Brueckner and O'Brien (1983) pursued an alternative approach based on the demand-constrained bargaining model.  

Given their interest in supply effects, Brown and Ashenfelter (1986) did not report demand variable coefficients for their newspaper-industry contract curves. While this rules out complete evaluation of their results, the effects of supply variables can be checked against the prior restrictions. Faced with alternative ways of measuring variables of interest, Brown and Ashenfelter estimated a large number of equations with the same basic specification. In their preferred regressions (the 22 equations in Tables 3C and 3D of their
paper), the performance of a key supply variable (one minus the unemployment rate), is consistent with the restrictions implied by the proposition. This variable’s coefficient is consistently negative and significant, indicating that a decrease in the unemployment rate shifts the contract curve to the left (the curves are estimated with \( L \) as the dependent variable). This effect is consistent with the proposition for those regressions where the contract curve is upward-sloping or vertical (the latter situation, which arises when the \( w \) coefficient is not significantly different from zero, is an extreme version of case 3 in Figure 3). A negative coefficient is also consistent with the proposition for the downward sloping regressions, for which the predicted shift is indeterminate.

Results are less encouraging for the alternative wage, which has an insignificant coefficient in the vast majority of Brown and Ashenfelter’s cases. While this outcome is unexpected, it constitutes a less serious violation of the prior restrictions than the significantly positive MFGW coefficients in Brueckner and O’Brien (1988). Given the poor performance of the alternative wage variable, Brown and Ashenfelter rejected the hypothesis of “strong efficiency,” under which employment depends on the alternative wage but is insensitive to the contract wage.

3. Estimation Strategy

With derivation of the prior restrictions completed, the discussion now considers the choice of a strategy for contract curve estimation. The key to understanding the estimation problem is to note that since the system (7)-(9) is underdetermined, more information is needed to find the point on the contract curve that actually emerges from the bargaining process. A natural way of providing the missing equation is to note that the bargaining outcome will depend on the relative bargaining strengths of the union and employer.
Letting $\delta$ denote a vector of bargaining-strength variables, the system (7)-(9) can be closed by adding the equation

$$u = f(\delta),$$

which indicates that the employer's achieved utility level depends on the values of the bargaining-strength variables.  

To focus on the estimation issue, suppose that parts of the augmented system consisting of (7)-(9) and (16) are stochastic. Suppose first that the tangency condition (9) holds with error, with $\varepsilon_0$ denoting the relevant error term (the error could be additive or multiplicative, depending on the specification). The contract curve equation (10) will then involve $\varepsilon_0$, so that $w = w(L, \alpha, \beta, \varepsilon_0)$. Next, suppose that (16) holds with error, so that $\mathbf{u} = f(\delta, \varepsilon_1)$, where $\varepsilon_1$ is the relevant error term. Recognizing that (7)-(9) yield a solution that has the same functional dependence as the $w$ solution (10), it follows that a relationship of the form $\mathbf{u} = u(L, \alpha, \beta, \varepsilon_0)$ must also hold when (9) is stochastic. Substituting this relationship into $\mathbf{u} = f(\delta, \varepsilon_1)$ then yields the equation $u(L, \alpha, \beta, \varepsilon_0) = f(\delta, \varepsilon_1)$. This equation can be solved for $L$, giving $L = L(\alpha, \beta, \delta, \varepsilon_0, \varepsilon_1)$. The reduced simultaneous system determining $w$ and $L$ is thus

$$w = w(L, \alpha, \beta, \varepsilon_0)$$

$$L = L(\alpha, \beta, \delta, \varepsilon_0, \varepsilon_1).$$

The above system is recursive, suggesting that OLS estimation of (17) might be permissible. However, this ignores the fact that a common stochastic element appears in both equations. Since it is well known that OLS estimation of a recursive system with correlated errors leads to inconsistent estimates, an instrumental variables approach to estimation of (17) is appropriate. Brueckner and O'Brien (1988) estimated the contract curves in Table 1 using
two-stage least squares, with the bargaining-strength variables $\delta$ appearing along with the demand and supply variables in the reduced form equation for $L$. These bargaining-strength variables included a dummy variable indicating the form of the municipal government (city-manager governments were expected to be tougher bargainers) and a variable equal to the percentage of public employees unionized in the state. Brown and Ashenfelter (1986) also used a two-stage procedure, but they did not explicitly rely on the bargaining-strength approach underlying (17) and (18).

To make the derivation of (17) and (18) more concrete, consider the following example. Let the employer's indifference curves be linear over the relevant range, so that (7) becomes $w = u - a(a)L$, where the slope expression $a$ is a decreasing function of the demand variable. Then let the union utility function be Cobb-Douglas, so that (8) is $w = vL^{-b(\beta)}$, where $b$ is a decreasing function of the supply variable. With $\varepsilon_0$ multiplicative, the stochastic tangency condition becomes $a(a) = \varepsilon_0 v b(\beta) L^{-b(\beta)}$. Finally, let $\delta$ be a scalar, with (16) becoming $u = \varepsilon_1 \delta^C$ ($c$ is a constant). Under these assumptions, log versions of (17) and (18) are

\begin{align*}
\log w &= \log a(a) - \log b(\beta) - \log L - \log \varepsilon_0 \\
\log L &= \log b(\beta) - \log a(a) - c \log \delta - \log \omega, \quad (19) \quad (20)
\end{align*}

where $\omega$ is an error term given by

$$\omega = \varepsilon_1 / (b(\beta) + \varepsilon_0^{-1}) \quad (21)$$

Since $L$ is positively influenced by $\varepsilon_0$ by (20) and (21), it follows that $L$ is negatively correlated with the error term in (19). This leads to inconsistent OLS estimates, necessitating use of a procedure such as two-stage least squares.
To relate this example to the discussion of Section 2, note that the contract curve in (19) is upward sloping, with the coefficient of log L identically equal to one. In this case, the prior restrictions require that an increase in $a \beta$ shifts the contract curve up (down). Recalling that the functions $a$ and $b$ are both decreasing in their arguments, it is clear that (19) satisfies these restrictions.

4. Conclusion

This paper has analysed the effects of demand and supply variables on the position of the contract curve and developed prior restrictions on the directions of these effects. Estimated contract curves must conform to these restrictions to be consistent with the underlying model. The paper has also suggested a two-stage methodology for contract curve estimation. It is hoped that these contributions will prove useful to researchers engaged in empirical implementation of the increasingly-popular efficient-bargain model.
Table 1
2SLS Contract Curve Estimates
from Brueckner and O'Brien (1988)
(Log-Linear Equations)

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Dependent variable is the wage; L is endogenous
t-ratios in parentheses

The sample sizes for the police, fire, and sanitation equations are 310, 283, and 37 respectively.
Figure 1.
The Effect of an Increase in the Demand Variable
Figure 2.
Shift of an Upward-Sloping Contract Curve
Figure 3.
Shifts of Downward-Sloping Contract Curves
References


Footnotes

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1 Satisfaction of this condition is not guaranteed and must be assumed.

2 Alternatively, the equation could give L in terms of w. The choice of dependent variable is immaterial.

3 Gyourko and Tracy (1988) derive a result analogous to the first of these statements in the context of a specialized model. The result is never used, however, since their empirical work is devoted to estimating reduced-form wage and employment equations.

4 Recall that \( g_L = h_L \) at the tangency.

5 Since this statement implies that \( h_v - g_v g \) must be negative when the contract curve is upward sloping, it follows that the numerator of the slope expression (11) must also be negative in this case. The case where both the numerator and denominator of (11) are positive is thus ruled out (this would lead to an upward-sloping contract curve with the wrong sign for \( h_L v / h_v - g_L u / g_u \)). This case can also be ruled out from first principles since positivity of both terms in (11) can be shown to imply \( g_L > h_L \), in violation of the condition for the optimality of the tangency point.

6 Similar community competition variables have been used by other papers to test for labor market monopsony effects. See Brueckner and O'Brien (1988) for a discussion of the relationship between the two uses of these variables.

7 The approach involved estimation of a labor demand curve instead of a contract curve. The right-hand variables in the demand regression included all the variables in Table 1 with the exception of the supply variables MFGW and UNEMP.

8 Since \( u \) automatically determines \( v \) along the contract curve, \( v \) could just as well have appeared on the left-hand side of (16). Note also that the function \( f \) is not invariant to the scaling of the employer's utility function.