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Is Collective Bargaining Pareto Efficient? A Survey of the Literature

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Abstract

It would be difficult, even today, to argue that labour unions are not important economic institutions, and it is this importance that makes their consequences for efficiency so substantial. Interest in the economic analysis of unions was revived in the early 1980s, in large part by a paper by Ian McDonald and Robert Solow, which formalized ideas first expressed in the context of labour markets 35 years earlier by Wassily Leontief. The standard textbook model of the labour union treats the union as a conventional monopoly seller of labour, selecting the wage while the firm chooses the level of employment; McDonald & Solow, however, drew from Leontief's work to suggest an alternative in which the firm and union negotiate to a Pareto efficient contract. Further theoretical work followed, and a still-growing empirical literature began to develop; a wide variety of empirical procedures and tests have been attempted, with a diverse and contradictory range of findings. Given the importance of the question of union contract efficiency, an up-to-date survey of the literature may be useful in synthesizing past results and pointing the way to future research, and it is this role which the current paper will attempt to fill.

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1 Introduction

It would be difficult, even today, to argue that labour unions are not important economic institutions. They represent a sizable portion of the workforce in all developed countries, with union density rates in 2001 ranging from 12.8% in the United States to 85.1% in Iceland; Canada's union density rate climbed from 27.6% in 1963 to 36.6% in 1983, although it has since declined to a rate of 28.2% in 2002.[1] In fact, these statistics likely underestimate the importance of unions, since in many (particularly European) countries, unions negotiate wages for many employees who are not officially members of unions.[2] Clearly, unions are important, and it is this importance that helps make their consequences for efficiency so substantial.

The literature on the economics of unions is an old one, but a quiet one through most of the 20th century, until the 1980s, when interest in the economic analysis of unions was revived.[3] Part of the impetus for this revival was a paper in 1981 by Ian McDonald and Robert Solow which formalized, algebraically and graphically, ideas which were first expressed in the context of labour markets 35 years earlier by Wassily Leontief. The standard textbook model of the labour union treats the union as a conventional monopoly seller of labour, selecting the wage while the firm chooses the level of employment, which is equivalent to the union choosing their most preferred point on the firm's labour demand curve. McDonald and Solow (1981), however, drew from the realization of Leontief (1946) that such an outcome is not Pareto efficient, to suggest an alternative in which the firm and union negotiate to an outcome in which neither party could be made better off without making the other worse off.

Further theoretical work followed, and a still-growing empirical literature began to develop, a significant portion of it dedicated to testing McDonald and Solow's model against the traditional labour demand curve theory. A wide variety of empirical procedures and tests have been attempted, with a diverse and sometimes contradictory range of findings;

[1] Statistics on union density are from Trade Union Density (2004). High union density rates are much more common in Europe than anywhere else; 2001 rates include 53.6% in Norway, 55.8% in Belgium, 73.8% in Denmark, 77.8% in Finland, and 78.0% in Sweden.

[2] See Economic Performance (1997).

[3] Excellent surveys of the larger field of research into the economics of unions are provided by Farber (1986), Pencavel (1991), Kuhn (1998), and Kaufman (2002).

meanwhile, some new models as well as refinements of the two canonical models have also appeared in recent decades. Given the aforementioned importance of the question of the efficiency of union contracts, an up-to-date survey of the literature may be useful in synthesizing past results and pointing the way to future research, and it is this role which the current paper will attempt to fill.

The rest of the paper is organized as follows. Section 2 outlines the basic economic theory of the two principal models of union behaviour. Section 3 surveys the literature on empirical testing between these models. Section 4 describes two alternative approaches to modelling collective bargaining, and assesses their potential for future research. Section 5 concludes.

2 Economic Theory of the Labour Union

It is widely acknowledged that the theoretical economic analysis of wage and employment determination in unionized labour markets originated with the work of Dunlop (1944).[4] His formulation of the problem assumes that the union is limited to choosing a point on the firm's labour demand curve;[5] this formed the basis of what is now commonly referred to as the Monopoly Union (MU) model, a model that would be further developed by Fellner (1947), Cartter (1959) and Oswald (1982). The following two subsections will lay out, at a very aggregated level, the basic theoretical framework of the Monopoly Union model, and that of its main competitor, the Efficient Bargaining model.

2.1 The Monopoly Union Model

In the Monopoly Union model, the union first chooses the wage, and then the firm chooses employment subject to that wage; in what follows in this section, the basic notational approach of McDonald and Solow (1981), with some simplifications, will be adopted.

[4]For a brief but informative discussion of the history of the economic theory of labour unions, see MaCurdy and Pencavel (1986).

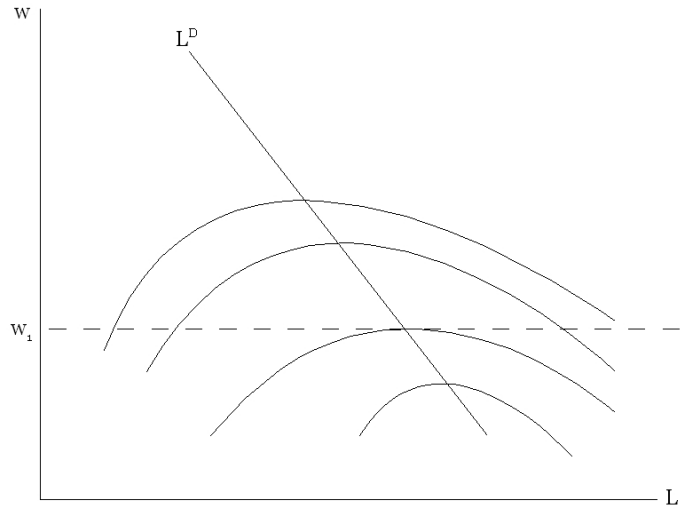
[5]Perhaps the most cited passage from Dunlop's book states that "An economic theory of a trade union requires that the organization be assumed to maximize (or minimize) something ... But the model is not so easily constructed since the crucial question Whose wage bill? remains." Aside from the assertions by Ross (1948) that the trade union is a political institution that is not suited to economic analysis (he claimed that "the traditional market forces are not of compelling significance under collective bargaining. Ideas of equity and justice ... move in different channels from supply and demand"), this assessment has been widely accepted, although, as we shall see later, Dunlop's "crucial question" of what the union maximizes remains a controversial one.

Let L represent employment and w the wage, and let us assume that the firm's revenue is some concave function $R(L)$ of employment. The firm's profit is then $\pi = R(L) - wL$, and subject to the wage chosen by the union, the firm will choose L to satisfy:[6]

$$R_L = w. \tag{1}$$

This implicitly defines the firm's labour demand curve; a sketch of this result can be seen in Figure 1 below.

Figure 1: Labour Demand Curve



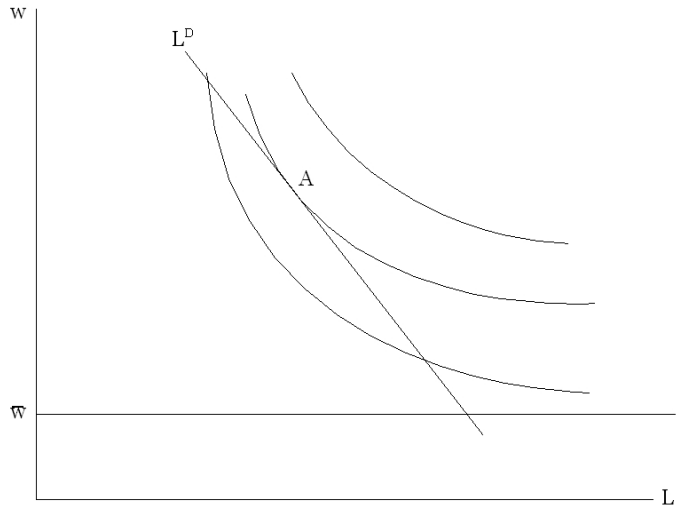
Defining the objective function of the union is, as Dunlop noted, rather more difficult. The most general way to proceed is simply to assume that the union has some utility function $U(w, L)$ (with U_w, $U_L > 0$) over the contract wage and the level of employment; then the union will select w to maximize U, which is equivalent to choosing w and L subject to $R_L = w$, and this gives us the result:

$$\frac{-U_L}{U_w} = R_{LL}. \tag{2}$$

This result means that the union will choose the point where the firm's labour demand curve is tangent to one of their indifference curves in (w, L) space, as at point A in Figure 2.

[6]Subscripts will represent derivatives.

Figure 2: Tangency of Labour Demand Curve and Union Indifference Curve



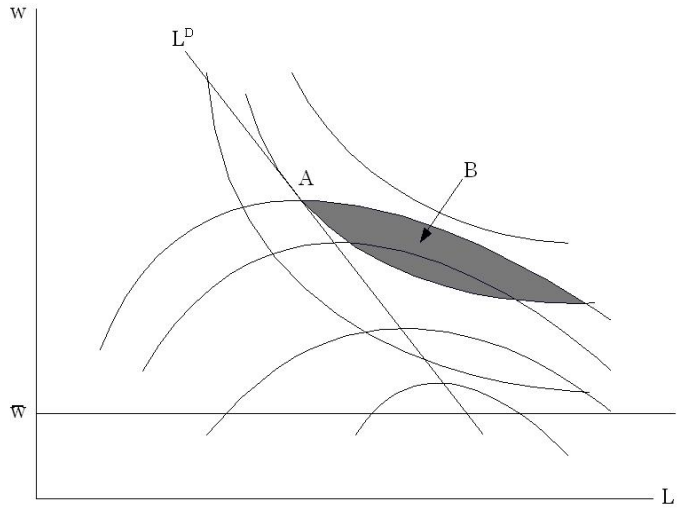
The Monopoly Union model has proven to be very popular as a description of union wage and employment outcomes, partly because the underlying game structure seems to correspond with reality; most collective bargaining processes typically do provide employers with considerable discretion over the quantity of employment.[7] However, the outcome of the MU model is clearly not Pareto efficient; there are wage-employment combinations that lie off the labour demand curve which could make both firm and union better off. This was first noted, in the context of labour markets, by Leontief (1946), and developed further by Fellner (1947), before being given a more thorough algebraic and graphical treatment by McDonald and Solow (1981).

Figures 1 and 2 are combined in Figure 3, allowing us to see this inefficiency graphically; the result is a region of wage-employment combinations, labelled B, in which at least one of the firm and union can be made better off than at point A without making the other worse off. This arises because the labour demand curve is defined as the locus of points at which the firm's isoprofit curve is horizontal, whereas the union's indifference curve is always

[7]This rationale for the popularity of the Monopoly Union model is identified by MaCurdy and Pencavel (1986), among others.

downward-sloping, as long as the union prefers higher employment at a given wage.[8] Pareto efficiency requires tangency of the firm's isoprofit curve and the union's indifference curve, which does not occur along the labour demand curve.

Figure 3: Inefficiency of Monopoly Union Outcome



As a result, an alternative model has been developed, in which the firm and union bargain to an allocation that is Pareto efficient; the rationale for such a model is that economic agents in a one-on-one negotiation would not leave unexploited gains from trade on the table.[9] This model will be referred to as the Efficient Bargaining (EB) model, and will be outlined in the next subsection.

2.2 The Efficient Bargaining Model

A Pareto efficient allocation of labour, as discussed above, will occur only when the isoprofit and union indifference curves are tangent to each other; in other words, when:

$$\frac{-U_L}{U_w} = \frac{R_L - w}{L}. \tag{3}$$

[8] As will be noted later, a median-voter model can result in indifference curves which are horizontal over some range, presenting the possibility that Pareto efficiency could coincide with the labour demand curve.

[9] Pencavel (1991) argues that "most economists ... are inclined to the view that union-management bargaining will not leave unexploited any opportunities to raise one party's welfare that do not reduce the other party's welfare." However, Pencavel (1984) notes that this assumes the absence of transaction costs. Fellner (1947) explains that there may be institutional obstacles preventing union and firm from reaching efficiency, such as the firm wanting to avoid the risk inherent in specifying employment in advance.

In the special case studied by McDonald and Solow (1981), additional structure is imposed on union preferences by assuming that all union members are identical, and that the union maximizes the expected utility of an individual member who faces some probability of unemployment. Under this assumption, we can write $U(w, L) = L[u(w) - u(\overline{w})]$,[10] where $u(\cdot)$ is a standard concave income utility function, and $\overline{w}$ represents the generic unemployment alternative, including unemployment benefits and utility from leisure.[11] In this case, we can write (3) as:

$$\frac{-[u(w) - u(\overline{w})]}{u_w} = R_L - w. \tag{4}$$

Both of these expressions define a locus of Pareto efficient wage-employment combinations, which, in the literature, is commonly referred to as the contract curve; an example is illustrated in Figure 4. If we use (4), we can see that the contract curve will intersect the labour demand curve only at $w = \overline{w}$, because at any point on the labour demand curve, $R_L - w = 0$, and the left-hand side of (4) is only zero when $w = \overline{w}$.[12] If $\overline{w}$ is the alternative wage, representing either the wage in an alternative job or the unemployment alternative (including utility from leisure), then $w = \overline{w}$ represents the competitive equilibrium (in our simplified partial-equilibrium model).

In Figure 4, the contract curve is drawn as upward-sloping, which is the most common depiction; however, there is no guarantee that this will be the case. In McDonald and Solow's expected-utility formulation, the contract curve will necessarily be upward-sloping, but other union preference structures could result in a vertical contract curve, as in an earlier paper by Hall and Lilien (1979), or even a downward-sloping curve.[13]

Additionally, if a collective bargaining agreement places a contract on the contract curve, the location of the point on the contract curve is not determined by the theory so far described, although numerous ways of determining the equilibrium have been proposed, the

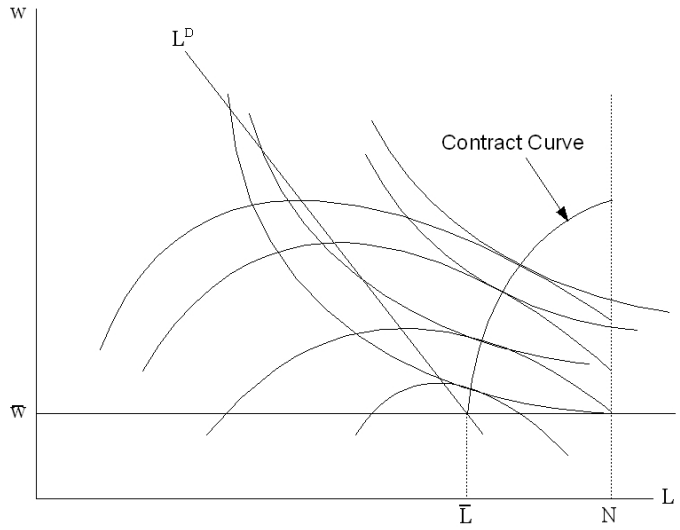
[10] Initially, union utility is written as $U(w, L) = N^{-1}[Lu(w) + (N - L)u(\overline{w})]$, where N represents the membership of the union; however, since N and $\overline{w}$ are, we presume, fixed for the purpose of union wage setting, the simplified version follows immediately.

[11] This is slightly different from the notation used by McDonald and Solow; in their initial model, they separate unemployment income from disutility of work, although they later recombine them.

[12] This is true more generally in (3) as long as $U_L = 0$ at $w = \overline{w}$, which seems plausible.

[13] Hall and Lilien's vertical contract curve is a result of their assumption of zero income elasticity of labour supply; see McDonald and Solow (1981), who also demonstrate that a downward-sloping contract curve would be the result if the union acted as a commune or family. Brueckner (2001) analyses various cases in which we can specify which way the contract curve slopes.

Figure 4: Contract Curve



most popular of which is the asymmetric Nash bargaining solution.[14]

The Efficient Bargaining model draws its appeal from the fact that, unlike the Monopoly Union model, it does not imply a situation of unexploited gains from trade in a bilateral negotiation. However, the main criticism of the Efficient Bargaining model is that its fundamental structure does not appear to correspond to reality as strongly as the Monopoly Union model does; we generally do not observe firms and unions negotiating directly over the quantity of employment as well as wages. On the other hand, collective bargaining does often cover issues which may proxy for employment, such as crew size, manning rules, and seniority wage structures.[15]

[14]As discussed in Pencavel (1991), the asymmetric Nash bargain is that which maximizes $(U - \overline{U})^{\alpha}(\pi - \overline{\pi})^{1-\alpha}$, for some union bargaining power α and disagreement values $\overline{U}$ and $\overline{\pi}$. Models using the two-stage collective bargaining structure proposed by Manning (1987) (discussed in Section 3.2) generally make use of an asymmetric Nash bargain over each of wage and employment. McDonald and Solow (1981), meanwhile, suggest a number of other possible methods of determining the equilibrium, including the existence of a dominant union or dominant firm, or some historically-determined "fair shares" division of surplus.

[15]McDonald and Solow (1981) suggest that, if it is not practical to specify the level of employment in a contract, manning agreements and "featherbedding" may allow for an approximation of the efficient outcome. Johnson (1990) and Oswald (1993) both discuss the occurrence of such procedures in reality. However, as will be discussed later, several authors have cast doubt on the idea that bargaining over such measures can actually approximate an efficient outcome.

The MU and EB models represent the two most popular alternative economic representations of the wage-employment outcome of collective bargaining,[16] and deciding between these two models is not just an issue of curiosity; there are some clear normative implications which arise from the two models. If the Monopoly Union model is correct, employment in unionized firms will be inefficiently low and wages will be too high; in a simple efficiency analysis, unions would be socially inefficient institutions and a weakening of union power would likely enhance social welfare (assuming that non-unionized labour markets are and would remain relatively competitive; chapter 12 of Manning (2003) discusses how monopsony in the labour market can alter the analysis of unions[17]). If Efficient Bargaining is a better description of reality, these conclusions may not be true; if the contract curve is vertical, the employment level will be determined efficiently,[18] and otherwise employment will either be too high or too low for social efficiency, but will likely be less socially inefficient than the Monopoly Union outcome.[19] At any rate, it is certainly the case that the policy recommendations that one would make with regard to labour markets will differ depending on which model (if either) is correct. As a result of these normative considerations, a growing empirical literature has attempted to test between these two hypotheses (and others); the following section will examine the more common empirical testing procedures used, and the findings of this literature.

[16]Perhaps the third most popular representation is the median-voter model, which will be discussed in Section 4.1. Also, numerous papers have emphasized the role of seniority beyond a simple median-voter framework, including Frank (1985), Kuhn (1988) (the focus of Section 4.2), and Kuhn and Robert (1989), who analyse a simple two-worker example of Kuhn (1988).

[17]For instance, once we allow for monopsony, labour supply may be a constraint even at union wages, and for small increases in wages due to unions (ie. remaining below the intersection of supply and demand), both the EB and MU models would predict increased employment.

[18]However, it is possible that the quantities selected of other inputs could be inefficient; when the union raises wages about the competitive level, this could provide the firm with incentive to change their use of capital inputs, possibly to use relatively more capital due to its lower relative price. Hirsch and Prasad (1995), however, argue that unionized firms will in fact have a *lower* capital-labour ratio, as unions impose what they term a "union tax on capital," since the union effectively shares in some of the quasi-rents that make up the normal return to capital. Manning (1987) also identifies a potential for unions to cause underinvestment in capital.

[19]Fellner (1947) identifies reasons why full social efficiency is unlikely to result. Brown and Ashenfelter (1986), Johnson (1990), and Swanson and Andrews (2007) provide a good explanation of some of the efficiency consequences of the distinction between the MU and EB models.

3 Empirical Methodologies and Results

This section will discuss the variety of empirical approaches which have been used to test between the MU and EB models, and the strengths and weaknesses of each approach. The first two subsections will describe, in some detail, the methodologies and results of the two most popular empirical approaches; the third discusses a range of other empirical methods and their results.

3.1 Brown and Ashenfelter (1986)

The most commonly adopted empirical methodology used to test between the MU and EB models is the one initially suggested by Brown and Ashenfelter (1986). This procedure is based on results (1) and (3) above: if the MU hypothesis is correct, then we are on the labour demand curve, and it must be that $R_L = w$; if EB is correct, result (3) tells us that:

$$R_L = w - \frac{LU_L}{U_w}. \tag{5}$$

Therefore, with some assumptions about the union's utility function, the Monopoly Union model can be evaluated with a test between two nested equations. This test generally involves a regression of employment on (among other things) the contract wage and the alternative wage; if the MU model is correct, the coefficient on the alternative wage will be zero, whereas if the EB model is correct, the alternative wage will have a negative coefficient (and the contract wage will have a zero coefficient if the contract curve is vertical).

We will now outline the specific approach used by Brown and Ashenfelter (1986). They begin by observing that a Pareto efficient contract must satisfy a condition equivalent to (5) above, which they restate as:

$$R_L = w(1 + \epsilon_{w,L}) \tag{6}$$

where $\epsilon_{w,L} = \frac{-U_L}{U_w}\frac{L}{w}$ represents the elasticity of wages with respect to employment along the relevant union iso-utility locus. Meanwhile, a contract on the labour demand curve will satisfy the familiar condition given by (1).

To proceed further, some functional forms for marginal revenue product and for the union's preferences must be adopted; Brown and Ashenfelter suggest for the workers' MRP:

$$\log(R_L) = \alpha_0 + \boldsymbol{\alpha_1}\mathbf{X} - \alpha_2 \log(L) \tag{7}$$

where $\mathbf{X}$ represents a vector of variables that could affect MRP other than the employment level. If the MU model is correct, we can therefore substitute (1) into (7), and rearrange to obtain:

$$\log(L) = \frac{\alpha_0}{\alpha_2} + \frac{\boldsymbol{\alpha_1}}{\alpha_2}\mathbf{X} - \frac{1}{\alpha_2}\log(w). \tag{8}$$

In order to derive the comparable equation for the EB model, a structure for union preferences must be specified; Brown and Ashenfelter suggest two alternatives. The first of these is a generalized Stone-Geary function:[20]

$$U(w, L) = k(w - \overline{w})^{\beta} L^{1-\beta} \tag{9}$$

where $\overline{w}$ represents the union members' alternative wage. The second functional form proposed is an expected utility function of the "typical" union member, identical to that proposed by McDonald and Solow (1981):

$$U(w, L) = \frac{L}{N}u(w) + \left(1 - \frac{L}{N}\right)u(\overline{w}) \tag{10}$$

where N represents the total union membership.

Using these specifications, Brown and Ashenfelter derive a pair of wage-employment equations, one for each utility function. However, upon estimating these equations, they find that their results are "uniformly poor," with large standard errors and parameter values that are of unexpected sign and magnitude; consequently, they decide to use a first-order approximation given by:

$$\log(L) \approx \frac{\alpha_0}{\alpha_2} + \frac{\boldsymbol{\alpha_1}}{\alpha_2}\mathbf{X} - \frac{\gamma}{\alpha_2}\log(\overline{w}) - \frac{1-\gamma}{\alpha_2}\log(w). \tag{11}$$

A negative coefficient on $\log(w)$ and a statistically insignificant coefficient on $\log(\overline{w})$ would be consistent with the Monopoly Union model, while a statistically significant negative coefficient on $\log(\overline{w})$ would be consistent with Efficient Bargaining; Brown and Ashenfelter divide this latter model into two alternatives, *weak efficiency*, under which there could be a

[20]The Stone-Geary specification is commonly used for union preferences, and covers a wide range of preference structures and possible hypotheses about union preferences; for example, Andrews and Harrison (1998) note that, if $\beta = \frac{1}{2}$ (or, equivalently, if $U = k(w - \overline{w})L$), a vertical contract curve would be the result of efficient bargaining. Johnson (1990) shows that the contract curve will be negatively sloped if $\beta > \frac{1}{2}$, and positively sloped if $\beta < \frac{1}{2}$.

significant coefficient on $\log(w)$, and *strong efficiency*, which requires a statistically insignificant coefficient on $\log(w)$, and which implies the special case of a vertical contract curve. As a final addition to their model, Brown and Ashenfelter relax the implicit assumption that unemployed union members can immediately obtain employment at the alternative wage, and include the natural logarithm of one minus the unemployment rate as a regressor. This variable, they explain, should have a negative coefficient if Efficient Bargaining is the correct model, and a zero coefficient under the Monopoly Union model.

Using data on locals belonging to the International Typographical Union during 1948-65, Brown and Ashenfelter (1986) find some evidence in favour of the Efficient Bargaining model, but are forced to reject the hypothesis of a vertical contract curve. Their approach was also subsequently used, with alterations, by Card (1986), Bean and Turnbull (1988), Currie (1991), Gavosto (1997), and Dimova (2006). Card (1986), analyzing the contracts for American airline mechanics, alters Brown and Ashenfelter's procedure to use a dynamic framework, with current alternative wages affecting future contract wages; he rejects both EB and MU in favour of a general contracting alternative. Bean and Turnbull (1988) reject the MU model, and state that their evidence is consistent with the EB model; however, the external validity of their findings may be limited by the source of their data, the (at that time) nationalized British coal industry in the period of 1967-83. Currie (1991) finds support for strong efficiency in the labour market for school teachers in Ontario - but then also estimates a simple supply/demand model, which ignores the usual objectives of unions, and finds that this also cannot be rejected. Gavosto (1997) uses data on workers covered by the British Dock Labour Board to reject the MU model in favour of EB, and even finds strong support for a vertical contract curve. Finally, Dimova (2006), in an application to an economy in transition (specifically Bulgaria), finds support for weakly efficient contracts. Therefore, while the results are not generally conclusive in any direction, the majority of the papers using this empirical approach seem to provide support for the EB model, at least in the form denoted by Brown and Ashenfelter as weak efficiency.

The Brown and Ashenfelter empirical procedure has the virtue of simplicity, but it has come under some considerable criticism. The main concern is about the nested nature of the test; as Martinello (1989) points out, although equations (1) and (5) are nested, the MU

and EB models are inherently not nested, and there are several conditions on $U(w, L)$ which must be met for the test to work effectively.[21]

Additionally, if the null is rejected, this would normally cause us to accept the alternative hypothesis, but in this case it is not clear what the alternative hypothesis should be. A number of authors have identified reasons why the wage-employment outcome could be between the strict Monopoly Union and Efficient Bargaining outcomes,[22] and if this is the case, it could be that both models are incorrect, but the Brown and Ashenfelter procedure can only test between them.

Another complication that has arisen in some cases is that, while the theory can explain a negative or insignificant coefficient on $\log(\overline{w})$, a significant positive coefficient does not seem to follow from either model; and yet this result was found by Brown and Ashenfelter, who were unable to identify a convincing explanation. Nickell and Wadhwani (1988) and Nickell and Wadhwani (1991), however, argue that such a result may be indicative of efficiency wages, since a decrease in the alternative wage would lead to increased effort, which would allow the same amount to be produced with fewer workers.

Finally, Dunlop's "crucial question" of what the union maximizes remains largely unanswered today;[23] an empirical method like Brown and Ashenfelter's, which requires that a functional form be specified for union utility, is therefore potentially problematic. As a re-

[21] Specifically, union preferences must depend on alternative wages, and alternative wages cannot be weakly separable from wages and employment in the union utility function. Andrews and Harrison (1998) add that the MU and EB models require different sets of instrumental variables for the contract wage; they also point out that, if the union does not care about employment, the contract curve will coincide with the labour demand curve, as will be discussed in Section 4.1, but a nested test cannot distinguish between this possibility and a Pareto inefficient result off the contract curve.

[22] Clark (1990) and Johnson (1990) both demonstrate that bargaining measures that may appear to approximate bargaining directly over employment, such as featherbedding and agreements over crew size and work-intensity, may actually lead to outcomes that are not fully efficient. Other reasons for expecting the EB model to result in outcomes that are not Pareto efficient are discussed by Layard and Nickell (1990), Heywood (1993), Manning (1994), and Chezum and Garen (1996).

[23] Blair and Crawford (1984) demonstrate that a union's preferences, if expressed through majority voting, generally will not have a von Neumann-Morgenstern representation. It is partly for this reason that numerous papers (including Dertouzos and Pencavel (1981), Pencavel (1984), MaCurdy and Pencavel (1986) and Brown and Ashenfelter (1986)) have analysed data from the International Typographical Union; Brown and Ashenfelter suggest that aggregating union preferences is less problematic when, as is the case with the ITU, union members are relatively homogenous and the union is highly democratic. An excellent survey and analysis of the difficulties of specifying and estimating union preferences is provided by Pencavel (1985), as well as Pencavel (1991). Empirical analysis of union preferences given a median-voter model is performed by Farber (1978), and for a general MU model by Dertouzos and Pencavel (1981), Pencavel (1984) and Carruth and Oswald (1985).

sult, several alternative testing procedures have been developed to meet these criticisms; the next subsection will discuss the most prominent of them.

3.2 Alogoskoufis and Manning (1991)

Manning (1987) develops a two-stage collective bargaining game to address the question of employment and wage determination. In his preferred framework, the union and firm negotiate first over the wage, and then over employment, and the union may have different degrees of bargaining power at the two stages.[24] This framework allows both the EB and MU models to be expressed as special cases of a more general bargaining model; if the union's employment bargaining power is $q \in [0,1]$ and their wage bargaining power is $p \in [0,1]$, it can be shown that the Monopoly Union model implies $p = 1$ and $q = 0$ (and the related "Right-To-Manage" model, in which the firm sets employment but the union may not have complete power over the wage, implies $p < 1$ and $q = 0$), while the Efficient Bargaining model requires $p = q$. It is therefore possible to estimate a general bargaining equation, which nests the Monopoly Union and Efficient Bargaining models as special cases and allows us to test each model against a general alternative. An additional benefit, noted by Manning, is that, if suitable proxies can be found for p and q, it is not necessary to specify a functional form for union utility, thereby avoiding the drawback faced by models such as that of Brown and Ashenfelter (1986). Manning's paper, however, was purely theoretical, so this subsection will draw on the first attempt to use the model empirically, that of Alogoskoufis and Manning (1991).

To begin with, the preferences of the firm and union are modelled very generally; the employer profit function is $\Pi(w, L; \mathbf{X_1}, \mathbf{X_2})$, and the union utility function is $U(w, L; \mathbf{X_2}, \mathbf{X_3})$, where $\mathbf{X_1}$ is a vector of variables that only affect the profit function, $\mathbf{X_2}$ is a vector of variables that affect both profit and union utility, and $\mathbf{X_3}$ is a vector of variables that only affect union utility. In the second stage of bargaining, after the wage has been determined, employment will be chosen to satisfy:

$$L(w; q; \mathbf{X_1}, \mathbf{X_2}, \mathbf{X_3}) = \arg\max_{L} \ \Pi(w, L; \mathbf{X_1}, \mathbf{X_2})^{(1-q)} U(w, L; \mathbf{X_2}, \mathbf{X_3})^{q}. \tag{12}$$

[24] It is possible to reverse the order of the stages, but Manning finds that the resulting employment-wage sequential bargain must then reach an Efficient Bargaining outcome regardless of the levels of bargaining power; as a result, Alogoskoufis and Manning (1991) focus on the wage-then-employment ordering.

Then, moving backwards to the first stage, the wage will be chosen to satisfy:

$$w(p, q; \mathbf{X_1}, \mathbf{X_2}, \mathbf{X_3}) = \arg\max_{w} \ \Pi(w, L; \mathbf{X_1}, \mathbf{X_2})^{(1-p)} U(w, L; \mathbf{X_2}, \mathbf{X_3})^{p}$$

$$s.t.\ L = L(w; q; \mathbf{X_1}, \mathbf{X_2}, \mathbf{X_3}). \tag{13}$$

Equations (12) and (13) result in reduced-form wage and employment equations:

$$w = w(p, q, \mathbf{X_1}, \mathbf{X_2}, \mathbf{X_3}) \tag{14}$$

$$L = L(p, q, \mathbf{X_1}, \mathbf{X_2}, \mathbf{X_3}). \tag{15}$$

As stated above, the MU model requires $p = 1$ and $q = 0$, while the EB model requires $p = q$. However, as Alogoskoufis and Manning comment, p and q are likely to be unobservable in any empirical setting, so (14) and (15) must be altered before they can be used empirically. Alogoskoufis and Manning suggest that we assume that p and q are functions of $\mathbf{X_4}$, which combines a subset of $\mathbf{X_1}$, $\mathbf{X_2}$, and $\mathbf{X_3}$, with a vector $\mathbf{Z}$ of variables that do not affect profit or utility. Then, assuming that (14) and (15) are log-linear, the generalized bargaining model can be written as:

$$\log(L) = \alpha_0 + \boldsymbol{\alpha_1}\mathbf{X_1} + \boldsymbol{\alpha_2}\mathbf{X_2} + \boldsymbol{\alpha_3}\mathbf{X_3} + \boldsymbol{\alpha_4}\mathbf{Z} + u_1 \tag{16}$$

$$\log(w) = \beta_0 + \boldsymbol{\beta_1}\mathbf{X_1} + \boldsymbol{\beta_2}\mathbf{X_2} + \boldsymbol{\beta_3}\mathbf{X_3} + \boldsymbol{\beta_4}\mathbf{Z} + u_2. \tag{17}$$

Finally, to allow for estimation by instrumental variables, Alogoskoufis and Manning rewrite (16) and (17) in a form that allows employment to be expressed as a function of the wage, by replacing in the employment equation one of the elements of $\mathbf{Z}$, which they call Z_1 (making it necessary that there be at least two variables in $\mathbf{Z}$), with its solution from the wage equation:

$$\log(L) = (\alpha_0 - \gamma\beta_0) + (\boldsymbol{\alpha_1} - \gamma\boldsymbol{\beta_1})\mathbf{X_1} + (\boldsymbol{\alpha_2} - \gamma\boldsymbol{\beta_2})\mathbf{X_2} + (\boldsymbol{\alpha_3} - \gamma\boldsymbol{\beta_3})\mathbf{X_3} + (\boldsymbol{\alpha_{4(1)}} - \gamma\boldsymbol{\beta_{4(1)}})\mathbf{Z_{(1)}}$$

$$+\gamma\log(w) + (u_1 - \gamma u_2) \tag{18}$$

$$\log(w) = \beta_0 + \boldsymbol{\beta_1}\mathbf{X_1} + \boldsymbol{\beta_2}\mathbf{X_2} + \boldsymbol{\beta_3}\mathbf{X_3} + \boldsymbol{\beta_4}\mathbf{Z} + u_2 \tag{19}$$

where $\mathbf{Z}$ has been partitioned into $\{Z_1, \mathbf{Z_{(1)}}\}$, and the parameter vectors $\boldsymbol{\alpha_4}$ and $\boldsymbol{\beta_4}$ into $\{\alpha_{41}, \boldsymbol{\alpha_{4(1)}}\}$ and $\{\beta_{41}, \boldsymbol{\beta_{4(1)}}\}$ respectively, and $\gamma = \frac{\alpha_{41}}{\beta_{41}}$. Since Z_1 is the only additional instrument used, this is an exactly identified model.

In this framework, if the Monopoly Union model is correct, the variables in $\mathbf{X_3}$ and $\mathbf{Z}$ only affect employment through their effect on the wage, so this implies that the coefficients on $\mathbf{X_3}$ and $\mathbf{Z_{(1)}}$ in (18) should be zero. Meanwhile, if the Efficient Bargaining model is correct, then $\mathbf{X_1}$, $\mathbf{X_2}$,and $\mathbf{X_3}$ determine the position of the contract curve, and $\mathbf{X_4}$ and $\mathbf{Z}$ determine the point reached by collective bargaining; therefore, if the position of the contract curve is held constant and $\mathbf{Z}$ varies, the change in employment will be related to the change in the wage only through the slope of the contract curve, γ. Therefore, variables in $\mathbf{Z}$ only affect employment through their effect on the wage, which implies that the coefficients on $\mathbf{Z_{(1)}}$ in (18) should be zero. It is therefore straightforward to test the EB and MU models as simple F-tests of these two null hypotheses against a general alternative.

As Alogoskoufis and Manning point out, the employment equation implied by the MU model is a special case of that implied by the EB model, with $\mathbf{X_3}$ excluded, which allows us to also perform a test of the MU model against the EB model; however, as they state, this suffers the same limitations as the Brown and Ashenfelter (1986) test, in that a rejection of one model does not imply acceptance of the other.

Alogoskoufis and Manning (1991), using data from the U.K. aggregate labour market, reject both the EB and MU models in favour of the generalized alternative bargaining model. Their two-stage bargaining game approach is used empirically by numerous other papers; Vannetelbosch (1996), using Belgian aggregate labour market data (and a considerably more complex econometric approach), reaches a similar conclusion, rejecting the EB and Right-to-Manage models in favour of the general alternative. Nickell and Wadhwani (1991) use a model which allows for the possibility of efficiency wages, and find that their data, from U.K. manufacturing firms, supports that interpretation. Andrews and Harrison (1998), using data from U.K. industries, find insufficient evidence to reject either the MU or EB model.

Finally, alternative non-nested equation models are suggested by Martinello (1989), who is unable to reject either MU or EB, using data on the International Woodworkers of America and the British Columbia wood products industry, and Christofides (1990), whose data on other Canadian industries supports a rejection of MU in favour of some form of efficient bargaining.

Therefore, as with the Brown and Ashenfelter-style tests discussed in the previous sec-

tion, contradictory and inconclusive findings have been the norm, with many papers either rejecting both the EB and MU models, or failing to reject either. The weight of the evidence is against the Monopoly Union model, with minimal support for Efficient Bargaining and substantial evidence to suggest that neither model explains the data particularly well.

3.3 Alternative Empirical Methodologies

The empirical literature on this subject has become increasingly sophisticated, and a wide variety of other innovative empirical frameworks have been proposed; among them are the following. Eberts and Stone (1986) find that the difference between the union wage and the marginal revenue product is positively related to the level of employment security provisions, which they interpret as evidence in favour of the EB model. MaCurdy and Pencavel (1986) estimate production and utility functions, and compare the ratio of the marginal products of inputs to the ratio of prices; they find evidence in favour of the EB model, although they reject a vertical contract curve. Svejnar (1986) constructs an asymmetric Nash bargaining model, which he uses to estimate parameters for union risk aversion and bargaining power, and finds that unions are generally either risk-neutral or risk-loving (ie. a vertical or downward-sloping contract curve), but cannot accept the hypothesis that the outcome is on the labour demand curve, and in many cases cannot reject the hypothesis of a vertical contract curve. Abowd (1989) tests whether collective bargains maximize the sum of shareholder and union wealth, and finds that, at the time of contract renegotiation, stock values move in the opposite direction from unexpected changes in labour costs, and at approximately a one-to-one rate, which is consistent with strong efficiency. Wessels (1991) tests whether employment at unionized firms is higher, for a given wage, than that suggested by that firm's estimated labour demand curve, and finds that only certain specifications of his model support this hypothesis. Bughin (1993) considers a translog production function model which allows simultaneous estimation of the firm's product market power and the union's bargaining power, and concludes that the Belgian chemical industry features oligopolistic rents and labour contracts on a vertical contract curve. Swanson and Andrews (2007) use a stochastic cost frontier approach and find that more heavily unionized industries are more likely to operate off their labour demand curve, a result that is inconsistent with the MU model.

Finally, a unique representation of the collective bargaining process is that of Espinosa and Rhee (1989), who model it as a dynamic repeated game. In this model, in each period, the union first chooses the wage, and then the firm chooses employment; then the game repeats in subsequent periods. In spite of the Monopoly Union structure of the game, at least in the static sense, this framework can result in a cooperative steady-state equilibrium somewhere between those predicted by the Monopoly Union and Efficient Bargaining models; if discount rates are low enough, full efficiency may even be supported as an equilibrium. de la Rica and Espinosa (1997) test between the static (Monopoly Union and Efficient Bargain) models and the dynamic framework, and find that a generalized dynamic model is supported by their data.

4 Other Models of Collective Bargaining

Our earlier analysis identified potential theoretical weaknesses of both the Monopoly Union and Efficient Bargaining models. The MU model leads to outcomes that are not Pareto efficient, which would seem to require the existence either of transaction costs or institutional obstacles to agreement, or irrational behaviour on one or both sides of the bargaining table; meanwhile, the EB model corresponds imperfectly to a reality in which we rarely observe direct negotiation over employment. Furthermore, the empirical findings discussed in the previous two subsections, particularly those using the Alogoskoufis and Manning approach, indicate that neither model seems to fit perfectly with the datasets on which they have been tested. A natural question, therefore, is whether models have been proposed which combine the better features of each, allowing the firm to freely choose the quantity of employment while still achieving something approximating Pareto efficiency.

In this section, we will consider two alternative models of collective bargaining which attempt to achieve this synthesis, and assess their empirical performance and potential for further research. The two models in question are the Median-Voter model, and the seniority wage profile model of Kuhn (1988).

4.1 The Median-Voter Model

One approach to solving the difficulties of specifying a union utility function has been to treat the decisions of union leadership as the result of a median-voter process, with union members distributed along a continuum of seniority. As mentioned in footnote 16, the Median-Voter (MV) model is probably the third most common specification used for modelling the collective bargaining process, and it satisfies a general intuition about unions: that they care more about wages when their sector is steady or growing, and more about employment when their sector is in decline. For example, we might think that a union member (and therefore the median voter) cares only about wages when their own job is secure, but is much more concerned about preserving employment when they themselves are in danger of being laid off, as suggested in Oswald (1993).[25]

In such a model, as Oswald (1993) demonstrates (and as briefly discussed in footnote 8), union indifference curves will be flat, at least starting at the employment level of the median voter, and so the contract curve will coincide with the labour demand curve; in most circumstances, the union is effectively indifferent to the level of employment. This model simultaneously achieves Pareto efficiency for the firm and union (if we define the union's preferences as those of the median voter[26]), and rationalizes the stylized fact of the firm freely choosing the level of employment;[27] it can also generate wage rigidity in normal economic times along with wage concessions in serious recessions.

Kaufman and Martinez-Vazquez (1990) discuss and contrast the MV model with the EB and MU models; they analyze how each model addresses a number of theoretical and empirical issues, and their conclusion is that, although each model has shortcomings, the Median-Voter model is superior to both the EB and MU models. This conclusion is strongly influenced by the fact that the EB and MU models generally just assume a union utility function, whereas the MV model describes a process whereby heterogeneous preferences of

[25] An alternative form of a shifting rate of substitution between wages and employment, using an insider-outsider approach, is presented by Carruth and Oswald (1987).

[26] As discussed in Kaufman and Martinez-Vazquez (1990), this raises the question of how we define Pareto efficiency in such a case; Kaufman and Martinez-Vazquez (1990) reject the idea that an MV outcome on the labour demand curve represents an efficient contract, on the grounds that it is not optimal for all members of the union.

[27] In his paper, Oswald provides anecdotal and survey evidence to illustrate this fact, as well as the fact that firms, including non-union firms, commonly take seniority into account when making employment decisions.

members are aggregated into a union objective function; no formal statistical evidence is provided, so a skeptic might conclude that their most convincing argument is that "the predictive ability of all three models is significantly impaired by major theoretical or conceptual shortcomings."

Meanwhile, discouraging statistical evidence is provided by Carruth, Oswald, and Findlay (1986), who use a methodology which is similar to that of Brown and Ashenfelter (1986), and find that unemployment benefits and rates of unemployment are statistically significant in wage and employment equations, and so reject the flat indifference curve hypothesis. Also, since the outcome of the wage bargain is on the labour demand curve, the main empirical tests discussed in Section 3 will not be able to distinguish the Median-Voter model from the Monopoly Union model; thus, the empirical evidence discussed earlier, which did not generally support the MU model, is also not especially favourable to the MV model.

The Median-Voter model of unions does present an intuitive description of the bargaining process, and has provided a number of insights, especially into the ways in which union preferences can be derived from theory; given the limited attempts at directly testing such a model, and the comment by Oswald (1993) that the results of Carruth, Oswald, and Findlay (1986) are "open to the objection that bargaining forces may explain what are interpreted as utility parameters," further empirical work in this area would be welcome. Other models, however, have gone in a slightly different direction in attempting to combine firm control over employment with Pareto efficiency, as the following subsection will illustrate.

4.2 Kuhn (1988) and Seniority Wage Profiles

There have been several models which have aimed to combine Pareto efficiency with firm autonomy over the quantity of employment, but without resorting to a median-voter approach. The first of these was likely that of Hall and Lilien (1979), who demonstrate that the union, instead of only specifying a wage, could require that the total wage bill be a function of employment, in such a way as to ensure that the firm's profit maximizing choice of employment would be the efficient amount. Specifically, if $R(L)$ is the firm's revenue function, and $V(L)$ is opportunity cost of labour, the efficient quantity of employment L^* would be the one at which $R_L = V_L$; meanwhile, if the union sets the total wage bill as $B(L)$, they know the firm

will choose the quantity of employment at which $R_L = B_L$. In that case, if the union designs the wage bill function so that $B_L = V_L$ at $L = L^*$, they can induce the firm to choose the efficient level of employment; the firm would still be free to choose any level of employment they may prefer, but they would necessarily choose the efficient quantity.[28]

While certainly a useful attempt, Hall and Lilien's model has some shortcomings; in particular, it assumes that the union cares about the total wage bill and not its distribution among members, or alternately that the union can make unlimited lump-sum transfers between union members, and neither of these assumptions seem entirely realistic.

However, this critique was addressed by Kuhn (1988), who proposed a model in which the union can specify a seniority wage profile. Instead of a general wage-bill function, the union chooses a wage schedule and a seniority assignment rule; the firm is free to choose the quantity of employment, but the union dictates the wage that must be paid to each individual worker and the order in which they must be hired and/or fired. In this way, just as in Hall and Lilien (1979), the union defines a marginal wage as a function of employment. In a situation of perfect information, it is easy to see that it would be possible for the union to achieve the efficient employment outcome by setting the marginal wage equal to marginal revenue at the efficient quantity; in effect, the union can act as a first-degree price discriminating monopolist, setting a non-linear price for labour.

In practice, however, Kuhn assumes that the output price is not determined until after the union chooses the wage schedule, so the firm's revenue function is not known with certainty at the time of bargaining. Additionally, Kuhn assumes that the firm can shut down ex post and avoid any payments to the union; as a result, union employment will be lower than first-best, and will tend to be more cyclically volatile than in non-union firms, whereas the average union/non-union wage differential will move countercyclically. However, even in this case it can be shown that, under fairly general conditions, the optimal union strategy is to establish a seniority index, to assign workers with greater firm-specific skills to the more "senior" positions in that index, and to charge a higher markup on higher-seniority workers (thus providing a justification for the seniority rule which is often simply assumed in the

[28]Martinello (1989) discusses an industry (the British Columbia wood products industry) in which such a situation could be a reality, due to the granting of many benefits which are independent of hours worked.

median-voter framework).

Kuhn's model was the first to apply non-uniform pricing to unions, and the model appears intuitively satisfying; it seems realistic, in that it corresponds well to common perceptions of how unions behave. The model also solves several potential problems with other approaches: Kuhn shows that, under a few conditions, conditional on a particular seniority ranking, the wage schedule will be unanimously approved by the union members, which obviates the need for strong assumptions about union preferences, assumptions which tend to be controversial for reasons discussed earlier; nor do we need to allow the union to engage in transfers between members.

However, there have been few attempts to adapt the model for direct empirical testing; Kuhn acknowledges some difficulties in doing so, in particular the fact that the prediction of higher wage markups on high-seniority workers may be complicated by possible differences in human capital accumulation between union and non-union firms. An indirect test which attempts to defeat this complication is provided by Kuhn and Sweetman (1999), who find that, among workers displaced from unionized jobs (and opposite to the result for non-union workers), re-employment wages decline with tenure on the lost job. This result implies that the alternative options of more senior union workers are lower, and thus, although Kuhn and Sweetman find that union tenure-wage profiles are flatter than those of non-union workers, their findings are consistent with the prediction of unions charging higher markups on more senior workers.

Another attempt to assess the empirical validity of the Kuhn model can be found in Booth and Frank (1996), which distinguishes firms (both union and non-union) with and without incremental wage scales with automatic progression by seniority. Although they find no overall difference in the return to seniority between union and non-union firms, among those with automatic progression by seniority, union wage differentials increase with seniority, whereas this is not true at firms without such automatic progression; this result is cited as support for the "discriminating monopoly model" of the union.

The empirical techniques discussed in Section 3 would require some rethinking before they could be used to evaluate the model of Kuhn (1988), largely because we can no longer assume a single wage. With an entire profile of wages, we can in principle identify values

such as the marginal wage and the average wage, but it may be difficult to use such data to separate the Kuhn model from other generalized representations of union bargaining; for instance, we would expect employment to be negatively related to the average wage, whereas the sign of the alternative wage appears likely to be zero or negative[29] - findings which Brown and Ashenfelter (1986) would associate with either the MU or weak EB models! We have to conclude that, while the findings of Kuhn and Sweetman (1999) and Booth and Frank (1996) are suggestive, further work seems merited on testing such a seemingly plausible and promising theoretical model.

5 Conclusions

This paper has surveyed and analysed the theoretical and empirical literature on the wage-employment outcomes of collective bargaining. We have identified a variety of empirical approaches used to test the main hypotheses, many of which fit into two main categories, those inspired by, or in the style of, Brown and Ashenfelter (1986), or Alogoskoufis and Manning (1991). Those in the former category tend to support the EB model over the MU model, whereas papers in the latter category, designed to meet criticisms levelled at the Brown and Ashenfelter approach, are more equivocal in their findings, with many rejecting both the EB and MU models or failing to reject anything. There are other empirical papers which are hard to fit into either category, and despite their differences in approach, they tend to provide evidence in favour of EB and against MU. This range of findings has helped motivate study of alternative models, such as the Median-Voter model and the seniority wage profile model of Kuhn (1988), but direct empirical testing of these models has been relatively limited.

Therefore, if pressed to take any final conclusions from our survey, we would say that the Monopoly Union model fares quite poorly in the empirical literature. We must allow for the possibility that different industries, and different unions, behave differently, but the weight of the evidence seems to suggest that Efficient Bargaining may be a reasonable approximation

[29]It initially seems likely that employment should be negatively related to the alternative wage - if $\overline{w}$ exogenously increases, it will cut the firm's marginal revenue curve at a lower L, reducing the feasible range of employment; but this may already be captured by resulting changes in the average wage. Additionally, the membership of the union may be such that the marginal wage is always above the alternative wage.

in some cases, whereas in many and perhaps most cases, some other explanation not easily categorized into the two main models we have examined may be superior. A promising line of future research, it would seem, lies in developing econometric approaches to allow us to test more recent and hopefully more realistic models of union wage-employment negotiation, such as that outlined by Kuhn (1988), in the hopes of providing further insight into a question which remains a highly important one in the field of labour economics.

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