On Wages and Employment

Anjan Mukherji*
Centre for Economic Studies and Planning
Jawaharlal Nehru University

This version: December 2005
PRELIMINARY

Professor V. B. Singh

Professor V. B. Singh was a multifaceted personality: a freedom fighter and patriot, a great teacher, institution builder, and a true patron of the Indian Society of Labour Economics; he played a major role in the running of the Indian Journal of Labour Economics. He had a long association with the University of Lucknow, Department of Economics and was the founder Director of the Giri Institute of Development Studies. He was a Member of the Rajya Sabha and left his mark on generations of students and researchers. I am greatly honored to be allowed to speak on this occasion and offer my tribute to his memory; I thank the members of the Organization Committee of ISLE 2005 and specially the President, Professor Prabhat Patnaik for providing me with this opportunity.

*I am deeply indebted to Manmohan Agarwal, Krishnendu Ghosh Dastidar, Dipankar Dasgupta, Subrata Guha, Satish Jain and Amal Sanyal for comments and helpful suggestions. This constitutes the text for the Professor V. B. Singh Memorial Lecture at the Meetings of the Indian Society of Labour Economics (ISLE), December 15-17, 2005, at Jawaharlal Nehru University, New Delhi.
1 Introduction

Exactly 100 years ago, a textbook entitled “Labor Problems” written by two economists from the University of Wisconsin, Thomas Adams and Helen Sumner, appeared with the stated aim of presenting a collection of facts which “will facilitate the study and teaching of the American Labor problem”\(^1\). Apparently the phrase “Labor Economics” appeared much later in the title of a book published in 1925\(^2\). However, to continue, the book whose centenary we could have been celebrating, had two parts: one part was named “Evils” and the other, “Remedies”. The first section contained chapters on women and child labor, immigration, the sweating system and poverty\(^3\). Remedies included chapters on unions, profit sharing, cooperation, industrial education, labor laws and the material advancement of the working class\(^4\): should we attempt to write such a textbook today, our point of focus need not be too altered: among the evils, we need to replace the word immigration by globalization and we should be quite contemporary. Thus in a sense, while a lot of work has certainly been carried out in the last 100 years, the problems have remained largely unresolved; while we are more or less agreed on what the evils are, we are perhaps not close to a resolution or what is more worrying, we may not be even close to obtaining an understanding of what the remedies might be.

I shall not attempt a history of the development of the neoclassical tradition and its critique but to those interested, the Boyer and Smith paper is highly readable and informative. I cannot resist quoting a statement recorded there and attributed to Richard Coase: “In my youth it was said that what was too silly to be said, may be sung. In modern economics, it may be put into mathematics.”\(^5\) Had Coase been writing today, he might have been tempted to be more specific by replacing mathematics by game theory! Incidentally

\(^3\)See Boyer and Smith (2001), page 201.
this is also by way of an indicator of things to come; since in spite of Coase’s cynicism, I would prefer to follow the dictates of Francis Bacon in the Novum Organum, citius emergit veritas ex errore quam ex confusione or that truth emerges sooner from error than from confusion.”6.

To return to the text of 100 years ago, I would like to submit that there is a section missing; this could have been entitled “Puzzles” or perhaps the more acceptable “Paradoxes” and what I shall proceed to talk about may be thought of as a chapter in that missing section. In this category, one of more enduring ones is that the real wages are unable to clear the market and that even in the face of unemployment, no corrective adjustment of real wages take place. In fact this is a puzzle only if one believes that there is a definite connection between real wages and employment: many continue to assume that employment and real wages are inversely related and consequently, any sign of unemployment must be due to high real wages.7 It is this aspect that shall be our principal concern.

Let me add that some years ago, Amal Sanyal and I had studied the question of relationship between real wages and employment in a Malinvaud-type framework8. The rigidity in money wages had been introduced there from outside and then given this rigidity, we had shown that if price-flexibility was not adequate to ensure full employment, then the only sure way of reducing unemployment was through a shift in demand in contrast to the claims in Benassy (1982) and Malinvaud (1977)9. We had shown that the link between real wages and employment may be snapped if money wages were rigid. This, of course, was a

---

7See, for instance, Mankiw, N.G. 1992, Macroeconomics, Worth, New York, p. 126-132; a familiar real wage employment diagram is drawn with a downward sloping labor demand curve and an inelastic supply curve.
result which laid bare the micro-foundations of the Keynesian\textsuperscript{10} claims.

Relatively more recently, I had looked at the Goodwin growth cycle and shown the lack of robustness in its construction\textsuperscript{11}. The central point of these and related models was the predator-prey relationship between the share of workers and the employment ratio and the economic story was based on these two chasing one another perpetually. The inverse link between real wages and employment also played a major role in these classes of models. According to Frank Hahn and Robert Solow (1997)\textsuperscript{12}, of the two main approaches in modelling labour markets, the types discussed so far belong to the MC class of models: where MC stands for rather innocuous ‘market-clearing’.

Today I shall try to enquire if there is any reason to expect that real wages and employment are inversely related. And according to the Hahn and Solow (1997) classification, we shall be investigating the implications of the ‘R’ class of models, where ‘R’ stands for ‘realist’. We shall soon see what the realist models are all about but instead of the Hahn and Solow claim of there being these two major lines of approach to modelling the labor market, we shall provide an unified approach to be explained as we proceed below.

A related query that will be of some concern is what happens to employment in the face of a binding minimum wage. The conventional theory in this regard is quite straightforward: a rise in minimum wage, other things remaining the same, will lead competitive employers to cut back employment (given the usual inverse relationship: the MC case); yet a relatively recent empirical study by Card and Krueger (1994)\textsuperscript{13} found no indication that a rise in


\textsuperscript{12}Frank Hahn and Robert Solow, (1997), A Critical Essay on Modern Macroeconomic Theory, Basil Blackwell, Oxford; Chapter 5 of this book contains a very interesting discussion on the labour market.

minimum wages reduced employment. Finally, we shall try to address the question of what determines wages. These three inter-related strands constitute the puzzle that we shall try to solve.

We shall attempt to show that the unique link between wage-rate and the level of employment depends crucially on the competitiveness of the labour market; if this market is non-competitive, this link is snapped; moreover, in the face of non-competitive conditions, wage determination has to depend on a variety of other factors some of which we shall try to pin down. And finally, therefore, there was no particular reason why a rise in minimum wages would affect employment.

2 An Attempt to Unravel the Puzzle

One of the reasons we felt that it may be worthwhile to attempt this exercise, is because we found that other theoretical attempts in this direction were somewhat unsatisfactory.

Consider for example, Manning (1995)\textsuperscript{14}. A firm according to this paper has the revenue function \( R(w, N) \) where \( N \) stands for employment and \( w \) the wage rate; the firm chooses both \( w \) and \( N \) in order to maximize \( R(w, N) - wN \) leading to standard first order conditions:\textsuperscript{15}

\[ R_w(w, N) = N \quad \text{and} \quad R_N(w, N) = w \]

Assuming for the moment that these first order conditions are enough, one may hopefully determine \( w^* \), and \( N^* \); the author calls \( w^* \), the efficiency wage. The next step involves imposing a binding minimum wage \( w > w^* \) and investigating the effect of this on employment \( N \); assuming small changes, the author differentiates the second equation totally to obtain the following:

\[
R_{NN}(w^*, N^*) \frac{dN}{dw} + R_{Nw}(w^*, N^*) = 1
\]

which is then dressed up in terms of an elasticity condition to ensure that the derivative \( \frac{dN}{dw} \) is positive.

\textsuperscript{14}How do we know that real wages are too high?, Quarterly Journal of Economics, November 1995

\textsuperscript{15}Subscripts will refer to partial derivatives.
However notice that in all of the above, the availability of labor plays no role; consequently it would be natural to take the supply of labor to be inelastic and fixed, willing to work for any wage. Further, when the wage rate is being fixed from outside, and the firm is being asked to determine the level of employment, given a wage rate, the firm’s response has to be the well known demand curve for labor; if the above derivative is positive, then around \((w^*, N^*)\), the demand curve for labor must be upward rising; in a competitive set-up, profit maximization entails that the derived demand for any factor cannot be upward rising; so the elasticity condition hides some special feature of the efficiency models which is not transparent. In any case, to say that if the demand curve is upward rising, then the level of employment and wage rate are positively related does not help matters at all. But this attempt carries one important signal and that is we must seek beyond the confines of competitive markets if we are to explain fully the relationship between wages and employment.

3 A Formulation

We shall provide a small model within the context of which we shall carry out the entire discussion. I hope that such a discussion will illuminate the difficulties involved.

The model is made up of a firm and another party we shall call the union; the firm needs labor to produce output and the union provides the labor. The firm has a production function \(y = f(\ell)\) where \(y\) is output and \(\ell\) stands for employment; and since we are assuming everything else is being held fixed, it would be appropriate to assume that \(f'(\ell) > 0, f''(\ell) < 0\) and the usual boundary conditions hold. The union on the other hand finds the provision of labor to be costly affair and to provide \(\ell\) units of labor it has to incur a cost of \(C(\ell)\) which is assumed to be strictly convex i.e., \(C'(\cdot) > 0\) and \(C''(\cdot) > 0\); we use the output as the unit of account so that with \(w\) as the real wage, the firm is interested in the maximization of ‘profit’, given by

\[
\pi_f = f(\ell) - w\ell
\]  

The union, on the other hand, is interested in the maximization of the net wage bill which
is given by

$$\pi_u = w\ell - C(\ell) \quad (3.2)$$

The setup is perhaps not particularly novel; similar models have been discussed in the literature; for an example, the interested reader may look at Blanchard and Fischer (1989)\textsuperscript{16}, or at the contribution by McDonald and Solow (1981)\textsuperscript{17}. We should mention that while the expression (3.1) requires little by way of explanation, the other expression, viz., (3.2) perhaps need some justification. First of all, the union should be interested in not only the wage rate but in the level of employment as well; the simplest manner of accommodating this fact is to introduce the wage bill; often whenever a union is mentioned, its membership is also taken into consideration; we take this into account implicitly via the cost function where the cost of supplying beyond some level could become infinite. Also in comparison, see for instance the objective of the union in Blanchard and Fischer (1989):

$$\frac{\ell}{\bar{\ell}}U(w) + (1 - \frac{\ell}{\bar{\ell}})U(r) \text{ if } \ell < \bar{\ell}$$

where $\bar{\ell}$ constitutes the total membership of the union; consequently one may consider the fraction $\ell/\bar{\ell}$ to be the probability of being employed; $r$ is the reservation wage. Thus what is being optimized is the representative worker's expected utility; the expression will collapse to $U(w)$ in case $\ell \geq \bar{\ell}$. It is quite another matter of course that a lot of the discussion is carried out within the context of the case when $U(w) = bw$ which as one may readily see, is not too different from what we have in (3.2).

We shall investigate the consequence of differing market forms on the equilibrium outcome in the market for labor.

\textsuperscript{16}O. J. Blanchard and S. Fischer, (1989), \textit{Lectures on Macroeconomics}, MIT Press, Cambridge, Mass. Chapter 9 of this book contains a discussion of various forms of the labor market and the usual assumptions regarding them. Our set up is simpler than most and we hope that this simplicity will enable us to carry out discussions which are of some consequence.

3.1 The Alternative Equilibria

3.1.1 The Competitive Outcome

The competitive outcome is of course the standard benchmark and involves the two parties to believe that they have no influence on the prices. Consequently, each maximizes its respective objective by taking the wage \((w)\) as given; this leads to, on the one hand:

\[
f'(\ell) = w: \text{ the demand curve}
\]

and

\[
w = C'(\ell): \text{ the supply curve}
\]

The second order conditions, are easily verified by virtue of our assumptions and hence ensure that we do have proper maxima defined by these conditions. The situation is as depicted in Figure 1.

![Figure 1: The Competitive Outcome](image)

Under the restrictions on \(f(.),C(.),\) the demand curve is downward sloping and the supply curve is upward rising; we assume that there is an equilibrium. If so, such an equilibrium is unique and we denote that by \((\ell^*, w^*)\). At this equilibrium, the firm earns profits given by:

\[
\pi_f^* = f(\ell^*) - w^* \ell^*
\]
whereas the union earns
\[ \pi_u^* = w^* \ell^* - C(\ell^*) \]
and the aggregate profits, add up to the surplus
\[ S^* = \pi_f^* + \pi_u^* = f(\ell^*) - C(\ell^*) \tag{3.3} \]

The wage rate \( w^* \) is the common value of the marginal product of labor and the marginal cost of providing this labor, \( f'(\ell^*) = C'(\ell^*) \): there is no unemployment since demand and supply match.

**Proposition 3.1** Under competitive conditions, the wage rate is thus capable of equilibrating the market; the introduction of a binding minimum wage in this context will mean the insistence of a \( w > w^* \): at such a configuration, unemployment rises on two counts: first demand falls (along the demand curve) and secondly, supply increases (along the supply curve).

The inverse relationship between the wage rate and the level of employment is very much evident.

### 3.1.2 The Monopsony Case

Traditionally monopsony refers to the case when the buyer can control the price; the seller, let us assume remains as a price-taker so that the supply curve remains as before:
\[ w = C'(\ell); \]
the firm’ profit, using the above and (3.1), may now be written as:
\[ \pi_f = f(\ell) - C'(\ell)\ell \]
and its maximization leads us to solve the equation:
\[ f'(\ell) = C'(\ell) + C''(\ell)\ell \tag{3.4} \]
since the right hand side is greater than $C'(\ell)$, we have as in Figure 2, the solution to (3.4) is given by $\ell_m < \ell^*_{18}$; consequently the wage rate $w_m < w^*$: as to be expected.

Since the equilibrium is on the supply curve, there is no unemployment: those who are willing to work always find work; notice however the demand for labor is greater than what is supplied at the wage rate $w_m$; consequently, a binding minimum wage rate ($> w_m$) would increase the level of employment. We conclude therefore:

**Proposition 3.2** Under monopsony, there is no problem of unemployment; the wage rate is the marginal cost of providing the level of employment and is less than the marginal product of labor; further, any binding minimum wage in the range $(w_m, w^*)$ will raise the level of employment (along the supply curve).

Notice that the inverse relationship between the wage rate and employment does not exist while the link between the marginal product of labor and the wage rate is also destroyed.

---

18 We shall assume that the second order conditions are satisfied; there is an added complication in the fact that the third derivative of the function $C(.)$ is involved on which no restriction has been placed and we shall assume that this does not upset the solution to (3.4) from solving the maximization problem.
This, of course, is the natural outcome of there not being a demand curve for labor, i.e., under monopsony, the buyer considers what the seller is agreeable to and then chooses the best possible configuration from its own point of view.

3.1.3 The Monopoly Equilibrium

This is the polar opposite of the monopsony situation, with the seller controlling the wage rate and the buyer being competitive. Thus we have the demand curve

\[ f'(\ell) = w \]

and using this together with (3.2) we have:

\[ \pi_u = f'(\ell)\ell - C(\ell) \]

so that its maximization entails solving the equation:

\[ f'(\ell) + f''(\ell)\ell = C'(\ell) \] \hspace{1cm} (3.5)

assuming as before that second order conditions are satisfied\(^{19}\). Figure 3 below will indicate since the left hand side of the (3.5) is \( < f'(\ell) \) the solution \( w^m, \ell^m \) in this case will entail, \( w^m > w^* \) and \( \ell^m < \ell^* \): notice now, the wage rate has not been able to equilibrate the market, since demand is less than supply. A binding minimum wage rate, \( w > w^m \) will increase the level of unemployment, both because of a lower demand and an increased supply as in the competitive case. Thus:

**Proposition 3.3** Under monopoly, the equilibrium is as in the competitive case with the additional existence of unemployment at the equilibrium. The wage rate reflects marginal product of labor and a binding minimum wage will lower employment (along the demand curve).

\(^{19}\)See the last footnote. This entails that the third derivative of the function \( f(\cdot) \) does not have the wrong sign.
Thus the operation of a demand curve as in the competitive case brings back the entire set of results that we saw in the competitive case.

3.1.4 The Case of Bilateral Monopoly

Outcomes of the type analyzed in the last two sections are, as we shall see, inefficient and had been noted to be as such by Leontief (1946)\(^{20}\). In search of efficient outcomes, we consider the bilateral monopoly model. With the firm and the union both struggling for control of the market, it is clear that we cannot proceed as before\(^{21}\). We need to analyze first what could be possible agreements between the two parties. Notice that before we proceed to analyze the possible situations which may emerge, it has to understood that it is being assumed that binding agreements are possible between the two parties; further that unless alternatives exist which benefits one without adversely affecting the other, the proposal may in principle, be acceptable.

Consequently, notice that in the plane \(w - \ell\), any proposal \((w, \ell)\) provides a level of profit for the firm as well as the union. We need to analyze the nature of the iso-profit contours


\(^{21}\)The set-up to be described below, is due to A. Bowley, (1928), ‘Bilateral Monopoly’ *Economic Journal*, 38, 651-9.
of the two parties.

Consider the firm first and recall (3.1); an iso-profit contour for the firm will thus be provided by the following equation:

$$\pi_f(w, \ell) = f(\ell) - w.\ell = \text{some constant} \quad (3.6)$$

so that along an iso-profit curve, we must have:

$$\frac{dw}{d\ell} \bigg|_{\pi_f} = \frac{f'(\ell) - w}{\ell};$$

notice that this derivative vanishes exactly along $f'(\ell) = w$, which was the demand curve in the competitive case; thus with axes as drawn in Figure 1, for example the iso-profit contours will have horizontal tangents along the erstwhile demand curve; to the right of this curve, the iso-profit contour will have a negative slope while to the left, the iso-profit contour will have a positive slope. Thus the iso-profit curves will have a single hump with the humps placed along the curve which appeared as the demand curve and the situation will be as depicted in Figure 4A. Also note that the closer to the $\ell$-axes, the higher would be the level of profits for the firm.

![Figure 4A: Iso-profit contours for the Firm](image-url)
Consider next, the union. recall, (3.2); an iso-profit contour for the union then will be given by the function:

$$\pi_u(w, \ell) = w\ell - C(\ell) = \text{some constant}$$

(3.7)

so that along an iso-profit contour for the union we must have:

$$\left. \frac{dw}{d\ell} \right|_{\pi_u} = \frac{C'(\ell) - w}{\ell};$$

notice now that this derivative vanishes exactly along $C'(\ell) = w$: which was the supply curve in the competitive case. And once more with axes as in Figure 1, the iso-profit contours will have horizontal tangents along the earlier supply curve; to the right of the curve, the iso-profit contours will have positive slopes while to the left the iso-profit contours will have a negative slope. Thus the iso-profit contours will have single troughs with the troughs placed along the previous supply curve and the situation will be as depicted in Figure 4B. Also note that the further the iso-profit contour is from the $\ell$-axis, the higher will be the profit level for the union.

Figure 4B: Iso-profit Contours for the Union

Notice then that all points of the $w-\ell$ plane have now been classified according to the level of profits to each participant. Notice that any such pair can either be a point of intersection of the iso-profit contours or a point of tangency. Notice that any point of
intersection should never be a point of agreement since there would be ‘better’ (for both) proposals: see for instance a point such as \( Z \) in Figure 4C.

![Figure 4C: Bilateral Monopoly](image)

Thus the only proposal which may be found agreeable is one where the iso-profit contours are tangential that is, a \((w, \ell)\) combination where

\[
\frac{dw}{d\ell} |_{\pi_f} = \frac{dw}{d\ell} |_{\pi_u};
\]

notice that this means that

\[
f'(\ell) = C'(\ell) \rightarrow \ell = \ell^*.
\]

Thus the employment level is uniquely determined under the bilateral monopoly conditions with our formulation. Now there is a \( \bar{w} \) such that \( \pi_f(\bar{w}, \ell^*) = 0 \); notice that from (3.6), \( \bar{w} = f(\ell^*)/\ell^* \); similarly, there is a \( w \) such that \( \pi_u(w, \ell^*) = 0 \) i.e., from (3.7), \( w = C(\ell^*)/\ell^* \). Also note that it follows that \( \bar{w} > w \). The wage rate could be anything in this range: that is \( w \leq w^b \leq \bar{w} \) so that the possible equilibria could be anywhere between these two levels.\(^{23}\)

The range of possible equilibria are depicted in Figure 4C.

\(^{22}\)It may be noted too that \( \bar{w} > w^* > w \).

\(^{23}\)We are assuming that should negotiations break down the return to both is zero; it is this level which is used to define the extreme wage-rates.
We may thus conclude:

**Proposition 3.4** Under bilateral monopoly, employment is fixed at \( \ell^* \): the competitive level. The wage rate could be anywhere in the range \([w, \bar{w}]\) where these quantities are as defined above. There is no link between the wage rate and level of employment. However whatever the wage rate is, the aggregate surplus is \( S^* \), as defined in the competitive case and the wage rate determination amounts to a division of this surplus among the two parties.

Notice that we have not been able to pin down what the wage rate will be in such situations. But the primary purpose of establishing that the link between the wage rate and employment is tenuous to say the least has been completed. We turn next to investigate how the wage rate may be determined. Obviously the bargaining power of the two need to be taken into account.

### 3.2 The Wage Rate Under Bilateral Monopoly

As the last proposition indicated, we need to investigate what are the possible ways of dividing \( S^* = f(\ell^*) - C(\ell^*) \) between the two. Any \( w \in [w, \bar{w}] \) defines the share \( \pi_f = f(\ell^*) - w\ell^* \) to firm and the remaining \( \pi_u = w\ell^* - C(\ell^*) \) to the union since for any choice of \( w, \pi_f + \pi_u = S^* \).

The choice of \( w \) could be done either through a cooperative mechanism or through a non-cooperative mechanism and we shall examine an example of each kind.

#### 3.2.1 The Nash Bargaining Solution

Notice that the setting is tailor-made for the application of the Nash bargaining solution\(^{24}\), the fixed threat solution\(^{25}\) obtained by choosing \( w \) so as to solve

\[
\max \{ f(\ell^*) - w\ell^* \}, \{ w\ell^* - C(\ell^*) \} \text{ subject to } w \in [w, \bar{w}]
\]


\(^{25}\) The threat point being the origin, in this case. In this connection see the treatment in Hahn and Solow (1997), referred to above, as well.
Consequently, the situation is as depicted in the Figure 5 below with the solution depicted by the point of tangency.

\[ w^N = \frac{f(\ell^*) + C(\ell^*)}{2\ell^*} = \frac{1}{2}(\bar{w} + w) \]

so that each receives \( S^*/2 \): which may be described as the epitome of cooperative solution: share the generated total surplus, equally. Incidentally, even among the class of cooperative solutions, there are other alternatives; such an alternative may involve providing the maximand in the problem above, with a different form: it remains a product of the pay-offs but each pay-off is now raised to some power reflecting their bargaining power. We shall end up with a somewhat different point on the frontier \( \pi_f + \pi_u = S^* \) but the essential characteristic of the wage rate will not change.
3.2.2 The Rubinstein Solution

We present next, a non-cooperative solution\textsuperscript{26} to the distribution of the surplus $S^*$ among the two participants. The relationship between the firm and the employers need to be placed in a dynamic context in order for us to describe the solution.

The firm and the union together can produce, as we have seen, $S^*$; the firm makes an offer of a share $\lambda S^*$ to the union where, naturally $0 < \lambda < 1$; if the union accepts the offer that is the end of the game; if on the other hand, the union rejects, then the union can make an offer but it takes time to make this offer; let us consider this time as the period of time of unit length; let union’s offer be $\lambda' S^*$ to the firm and the remaining $(1 - \lambda') S^*$ it wants to keep. Given the discount factor (common to both, say $\delta < 1$), this offer is worth $\delta (1 - \lambda') S^*$ to the union and $\delta \lambda' S^*$ to the firm; if the firm accepts the game ends; otherwise the firm can make another offer but that takes time and hence the story unfolds. Rubinstein (1982) has shown that there is a unique sub-game perfect Nash Equilibrium for this game given by the firm offering (and the union accepting)

$$\frac{\delta}{1 + \delta} S^*$$

and hence keeping

$$\frac{1}{1 + \delta} S^*$$

for itself.

It may be noticed that as $\delta \rightarrow 1$ the shares approach the shares in the Nash Bargaining Solution.

Notice that this game has a first mover advantage since $\delta < 1$, the share for the firm is larger than the share for the union. Alternatively, if instead of the firm moving first, the union moved first, the unique sub-game perfect equilibrium will involve the union getting the larger share $1/(1 + \delta).S^*$. Notice that each such share of the total involves a unique wage rate: so that determining a share is equivalent to the determination of a wage rate.

\textsuperscript{26}A. Rubinstein, (1982), Perfect Equilibrium in a Bargaining Model, \textit{Econometrica}, 50, 97-109. See also the discussion in Hahn and Solow (1997) as well.
The extension to discount factors which are different is also straightforward\textsuperscript{27}.

Notice then that in any case the wage rate implied does not relate to the marginal product directly; nor does the marginal product seem to determine what the wage rate should be: it may all depend on who moves first, for example.

### 3.3 A summing-up

First of all, \textbf{except the competitive and monopoly situations}, in all cases:

- the ties between the wage rate and the employment levels are snapped.

- an imposition of a binding minimum wage will not decrease employment; if it affects employment, then employment increases.

- in the case of bilateral monopoly, in particular, a binding minimum wage will have no effect on employment and will serve only in increasing the share of the union.

The classical connections between the wage rate and the employment level are thus only in the case of perfect competition and monopoly. It would appear that the presence of the demand curve for labor was driving these results.

However if the monopoly situation is affected somewhat by the presence of say another union, the situation becomes infinitely more complicated. Since the unions are providing the same type of labor for which there is a demand curve (assuming the firm is competitive), we need to worry about the existence of a solution for this situation\textsuperscript{28}. It appears there will always be a mixed strategy Nash Equilibrium for this case.

In the set up discussed by Maskin, each firm quotes a price and a quantity that they would wish to sell; then under some mild restrictions, there are probability distributions

\textsuperscript{27}With discount rates $\delta_f, \delta_u < 1$ and the firm moving first, the share to the firm will be $\frac{1 - \delta_u}{1 - \delta_f \delta_u}$ and to the union $\delta_u \frac{1 - \delta_f}{1 - \delta_f \delta_u}$.

(µ̂_i^*, i = 1, 2) over such price-quantity pairs, such that given the choice of µ̂_2^*, firm 1 maximizes expected utility by choosing µ̂_1^* and vice versa.

Applying this result to the case at hand, with two unions, say with identical costs functions, there is a probability distribution µ̂* over some set of (w, ℓ) (which constitutes the support of the distribution) with the above mentioned ‘good against one another’ property, in the sense that each maximizes expected utility of a union given the other. Notice that given this state of affairs, it will be difficult to say whether the unions land up on the demand curve for labor in the situation of what Maskin calls ‘production in advance’. In such situations, each union plans to supply some labor ℓ_1 at some wage rate w_1; however if the actual employment is x_1, the pay-off to each is w_1x_1 - C(ℓ_1). Note that x_1 = min{ℓ_1, d_i(w_1, ℓ_1, w_2, ℓ_2)} when each union proposes w_1, ℓ_1. The function d_i provides the demand facing the i-th union given some industry demand curve when the unions quote the pairs (w_1, ℓ_1, w_2, ℓ_2). For our purpose, note that it is possible that x_1 = ℓ_1 < d_i at least for some i and that the equilibrium configurations may involve points off the demand curve and consequently even in this case, the link between the wage rate and employment level may be distorted.

4 Concluding Remarks

As our summing-up would have indicated, even in simple situations when market imperfections exist, the relationship between wage rate and employment levels is indeterminate. Also the wage rate itself may be difficult to pin down. However, broadly speaking, we can say that the determination of the wage rate involves a valuation of what is being produced, the relative bargaining powers of the parties concerned and the rules of conduct or the protocol within which the strategic interactions occur. And finally, to obtain the so called ‘standard’ conclusions about the wage rate and the level of employment, we need competitive conditions. The Nash bargaining solution and the Rubinstein solutions have also been used in Hahn and Solow (1997) somewhat differently; our advantage lay in the fact that whatever method is used, the surplus is clearly defined and the matter reduces to choosing
a division of this between the two parties. Thus we are able to clearly see that employment may be fixed and not vary with wages whenever markets exhibit imperfect competition.

We would like to end by presenting some examples of wage determination in Arthashastra, by way of comparison with the methods we have discussed above.

It seems that Chanakya was very clear about what the salaries of various functionaries should be. And in some cases he offers an explanation of why this should be so. Apart from these being of independent interest, it would be revealing to examine these explanations and compare them with what we have found above.

First of all, Chanakya stated that the main principle behind the fixation of Salary of various categories should be according to the capacity to pay by the City and the countryside and the total salary bill for the State shall be 1/4 of the Revenue earned by the State. The salary scales shall be such as to enable the accomplishment of state activities by attracting the right type of people and shall be adequate for meeting the bodily needs of state servant and shall not be in contradiction to the principles of dharma and artha. Salaries should be fixed in accordance with the above principles taking into account each one’s level of knowledge and expertise in the work allotted.

We provide some examples of what Arthashastra recommends for salaries for some of the higher grades; by way of comparison, an annual salary of 60 panas was treated to be equivalent as one adhaka of grain per day or what was enough to provide an Arya male with 4 meals.

- The highest grade of 48000 panas annually were for the the Officiating Priest, King’s Guru, Crown prince, King’s Mother and the Queen, Civil Service Councillors, Chief of Defence. By way of explanation it is said that this amount would be enough to prevent them from succumbing from temptation or rising in revolt.

- Annual salary of 24,000 panas were for Palace officials, the Chancellor and the Treasu-
surer to make them efficient in their work.

- Annual Salary of 12000 panas were for Palace persons such as Princes (apart from the Crown Prince), Queens (apart from the senior most) and persons in Civil Service, Armed Forces Personnel such as City Commandants. This was thought to be enough to ensure that they remain loyal and powerful to the King.

- Annual Salary of 8000 panas were for Civil Service magistrates and for Armed Forces Chief Commanders. This was described as being adequate for for “them to carry their men with them”.

- Annual Salary of 4000 panas was for lower ranked Civil Service Officials and Armed forces divisional commanders.

Notice that in each case, wage determination was made up of several points of consideration: for some it was a question of ensuring that they did not revolt and join the enemy; for some it was to attract the appropriate efficient persons; to keep them loyal was yet another consideration; and finally, the compensation was decided on the basis of being able to carry their men with them.

Notice too, the clear strategic basis of the determination of wages at each level. Clearly, in each case, an attempt was made to find out what the total surplus was and then to take whatever steps that were thought to be necessary to ensure that the surplus remained secure. There is no indication that by lowering the wage rate one could attract more persons. If more persons were needed at a particular level, then they were employed without affecting the wage rate. We hope to have provided some indicators to what may be the theoretical underpinning for such a scheme.