Chapter 1
Labour supply

Labour supply decisions, in conjunction with the demand side of the labour market, affect the production output and thereby the goods and services available for consumption in the society.

"The labour force participation can be regarded as a "two-part" decision: firstly, whether or not to participate in the labour market, and secondly, given a decision to participate, how many hours to supply"[1]

This chapter will first concentrate on a simple neo-classical model of an individuals' labour supply choice at a given point in time and in the absence of trade unions (taxes is not considered). However, the last section in this chapter will carry out a "short examination" on how wages are determined in the presence of trade unions.

1.1 How Many Hours to Supply: The Basic Model

Assuming an individual, in order to maximising his "well being" (utility) can choose whether to supply how many labour-hours or not to participate in the labour market at all. That is consumption of goods (*X*) and hours of non-working in the labour market (*N*)[2].

Assume that an individuals utility function is:

$$U = U(X, N) \qquad (1.1)$$

An individual's budget constraint is then:

$$X = Lhv_L + Y - C \qquad (1.2)$$

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[1] Peter Fallon and Donald Verry, The Economics of Labour Markets (Oxford: Phillip Allan Publishers Limited, 1988), p 17.

[2] "Hours of non-working in the labour market" should not be interpreted as idleness but as hours spent at leisure, housework, etc.

Lh: labour hours.

v_L: real hourly wage paid for labour work (henceforth called "wage").

C: cost of working, is considered as transportation, working expenses, and time cost.

Y: non-labour income, such as unemployment benefit, tax reduction, etc.

With the time constraint:

$$T = Lh + N \qquad (1.3)$$

Where T: total hours available per day.

Considering that the non-labour income paid can be decomposed into $Y = y + y'N$, and cost of working can be decomposed into $C = c + c'Lh$. Hence, y' and c' are dependent on hours worked.

$$X = Lh\, v_L + (y + y'N) - (c + c'Lh) \qquad (1.4)$$

y: real non-labour assistance, considered independent of hours of market work.

y': real non-labour benefit, considered dependent of hours of market work.

c: real fixed cost of working, and

c': real variable costs of working

Setting up the Lagrangian expression for optimising the utility $U(X,N)$ given the budget constraint (from *equation 1.4*): $X = v_L T - v_L N + y + y'N - c - c'T + c'N$:

$$L^* = U(X,N) + \lambda[(T - N)\, v_L + y + y'N - c - c'(T - N) - X] \qquad (1.5)$$

$$\frac{\partial L^*}{\partial N} = \frac{\partial U}{\partial N} - \lambda\,(v_L + y' - c') = 0 \Rightarrow \lambda = \frac{\partial U}{\partial N}\,\frac{1}{v_L - y' - c'} \qquad (1.6)$$

$$v_L - y' - c' = \frac{\partial U / \partial N}{\partial U / \partial X} = MRS \qquad (1.8)$$

Where *MRS* is the marginal rate of substitution between *N* and *X*.

(i) Under the assumption that non-labour income and cost of working is independent of labour-market-hours ($y'=0$, $c'=0$). Maximising utility given the wage (v_L), an individual should (due to *equation 1.8*) choose to work that number of hours (*Lh*) for which the marginal rate of substitution of non-working (*N*) for consumption is equal to the wage (v_L).

(ii) Under the assumption that non-labour benefit and cost of working is dependent of labour-hours ($y'>0$, $c'>0$). Maximising utility given v_L, y', and c', an individual should choose to work that number of hours (*Lh*) for which the marginal rate of substitution of non-working (*N*) for consumption is equal to $v_L - y' - c'$

We can then conclude: the supply of labour-hours (*Lh*) is a function of v_L, *Y*, *C*, and *T*.

The appearance of *y* and *c* shift the budget constraint outward or inward so that an individual reach a different utility level[3], but *y* and *c* has no effect on the *MRS*. Hence, *y* and *c* have no influence on how many hours to supply but, as we shall see in the next section, influences whether or not an individual will participate in the labour market.

1.2 An Individual Supply of Labour Hours

By determining the amount of labour hours an individuals choose to supply, at each wage rate an individual's supply curve is derived. The shape of the supply curve depends on v_L, *Y*, *C*, and *T* but especially also on whether *X* and *N* are normal, inferior, or luxury goods.

[3] Fallon and Verry, The Economics of Labour Markets. p. 19.

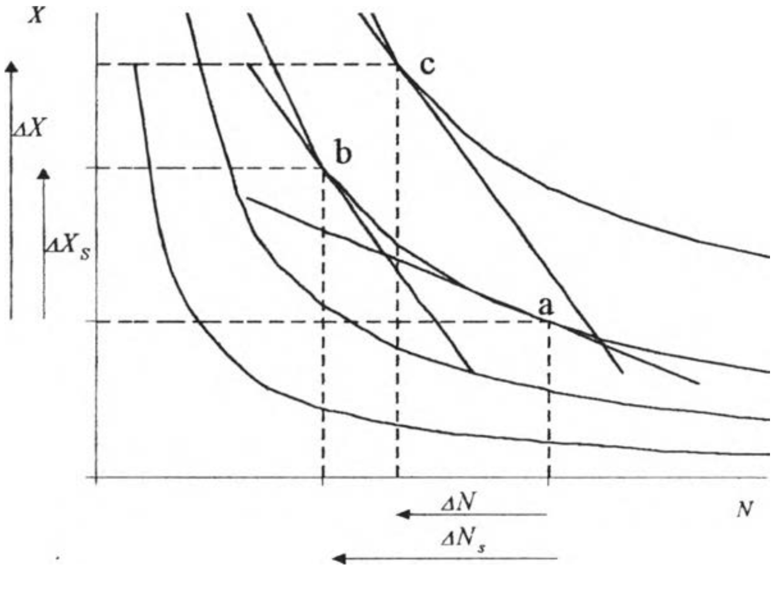
Substitution and Income Effect

Since an individual is a supplier of labour hours, the income and substitution effect of an increase in the wage (v_L) works in opposite directions on the hours of work[4].

Regarding the substitution effect, the slope of the budget constraint is equal to $v_L - y' - c'$ (*equation 1.8*). Therefore, any increase in the wage (v_L) will have a substitution effect away from non-working-hours (N) and toward labour-hours (Lh).

The example given in *Figure 1.1*, shows how an increase in the wage of 3.5 -e.g. DKK- ($\Delta v_L = 3.5$) alter the slope of the budget constraint. The slope changes from −1.5 to −5 and cause a substitution effect (from *point a* to *b*) of $\Delta N_s = -3$ and $\Delta X_s = 7.5$.

Figure 1.1 Substitution and Income effect on an individual's Lh-supply



The increase in the wage ($\Delta v_L = 3.5$) shifts the budget curve outwards. Hence, the income effect of an increase in wage works, *ceteris paribus*, in direction of increasing N and therefore, because of the constraint $T = Lh + N$, reducing labour hours.
The combined effect of substitution and income is (a movement from point *a* to point *c*) $\Delta N = 4-6 = -2$, and $\Delta X = 20-7.5 = 12.5$. Hence, in this example the substitution effect outweighs the income effect with regards to labour hours.

[4] Walter Nicholson, Microeconomic Theory (The Dryden Press, Harcourt Brace College Publishers, 1998), p. 669.

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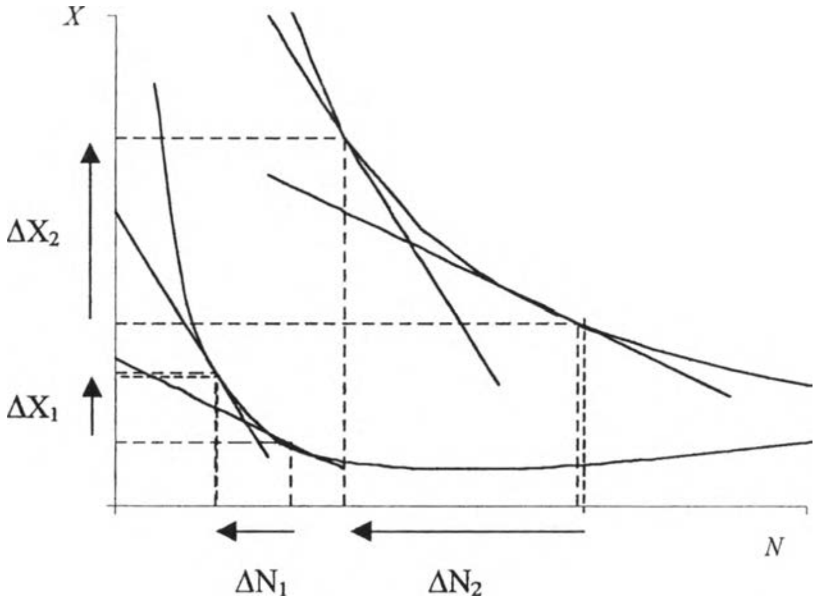
Shape and shallowness of utility curves

The shape and shallowness of the utility curves along any ray through the origin determine the substitution effect as income changes. That is, if the preferences of an individual change with income (that is *X* or/and *N* is considered as non-normal good(s)), then the shape or/and shallowness of the curves also change with changing income.

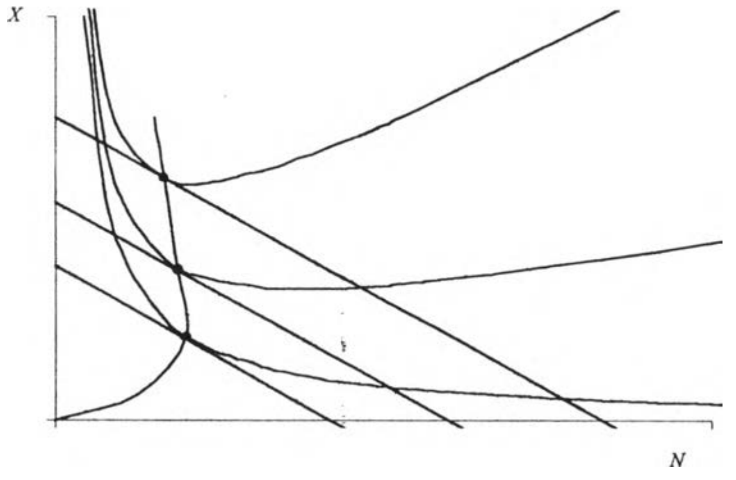
Figure 1.2 illustrates an individual's utility curves changing shape and shallowness as income change. We can see how the shares of income devoted to *N* change in response to increasing income of, as in above example, 3.5 ($\Delta v_1=3.5$). For the utility level U_1 the substitution effect is $\Delta N_1=-1$ and for U_2: $\Delta N_2=-3$. This is the substitution effect that works toward increasing labour-hours with an increase in an individual's income.

Figure 1.2 Changes in substitution effect as income change



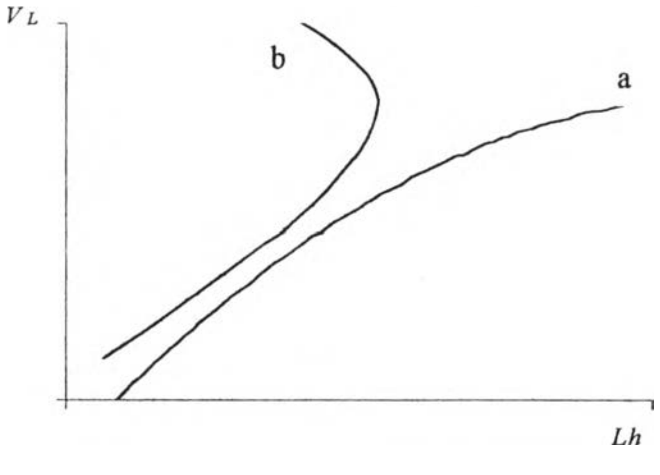
Moreover, if an individual considers *N* an inferior good over a wide income spectra and *Lh* is a normal good over the same income spectra, then the consumption path may look like *Figure 1.3*.

Figure 1.3 Consumption path for 'N' as an inferior good



If the substitution effect, because N is an inferior good, increasingly outweighs the income effect, then the supply curve will be concave (as *curve a* in *Figure 1.4*). However, if Lh is an inferior good and the income effect can outweigh the substitution effect, then we will observe a backward bending supply curve, as curve *b*.

Figure 1.4 An individual's supply of Lh



Elasticity of substitution

A powerful tool to get insight to the substitution effect is the *elasticity of substitution* (σ) (the concept is discussed in section 2.1). The elasticity of substitution tells us how the shares of income devoted between X and N change in response to changing economic conditions, as is shown in *equation 1.10*.

Technically speaking, the elasticity of substitution is defined as: the proportionate change in X/N-ratio as a result of proportionate change in the marginal rate of substitution (MRS).

$$\sigma = \frac{percent\ change\ (X / N)}{percent\ change\ (MRS)} \qquad (1.9)$$

Because v_L - y'- c'= MRS (from *equation 1.8*).

$$\sigma = \frac{percent\ change\ (X / N)}{percent\ change\ (v_L + y' - c')} \qquad (1.10)$$

The utility curve's shape and shallowness determine the numerator and therefore influences the magnitude of the substitution effect.

Regarding wage changes:
If $\sigma=1$: X/N will change in exactly the same proportion as v_L does. Therefore, shares of income devoted to X and N will stay constant.
Is $\sigma<1$: X/N will change less than v_L does. Therefore, shares of income devoted to X will fall as v_L increases.
Is $\sigma>1$: X/N will change more than v_L does. Therefore, shares of income devoted to X will rise as the v_L increases.

Participation in the labour market

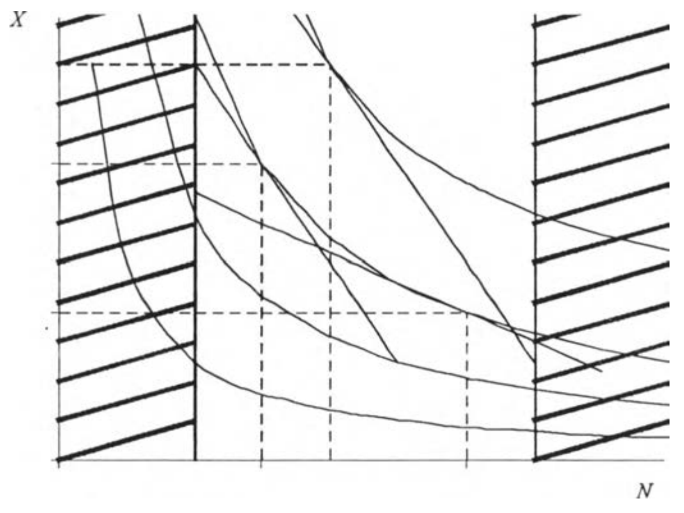
(i) Non-labour assistance; (ii) fixed cost of working; and (iii) maximum and minimum working hours, among many others, influence the decision on when an individual will choose to enter the labour market.

(i) The existence of non-labour-assistance (y) shifts the budget constraint outward and enables an individual to reach a higher utility level. Hence, any decrease in non-labour assistance (y) will move an individual to a lower level of utility, *ceteris paribus*. In order to obtain the previous or desired utility level an individual must enter the labour market and/or increase labour-hours.

(ii) It is immediately apparent that fixed cost of working (c) pulls in the opposite direction of non-labour-assistance (y) and has the same influence only with opposite sign.

(iii) The presence of legal maximum and minimum working hour constraints an individual from an introduction into the labour market under the required minimum, and limits an individual from an optimum choice beyond the maximum working hours. This constrained optimisation choice is depicted in *Figure 1.5* where *Figure 1.1* is reproduced with the maximum and minimum working hour boundaries. Assuming a wage increase, *ceteris paribus*, an individual is constrained to a choice inside the *feasibility region*.

Figure 1.5 Constrained utility maximisation

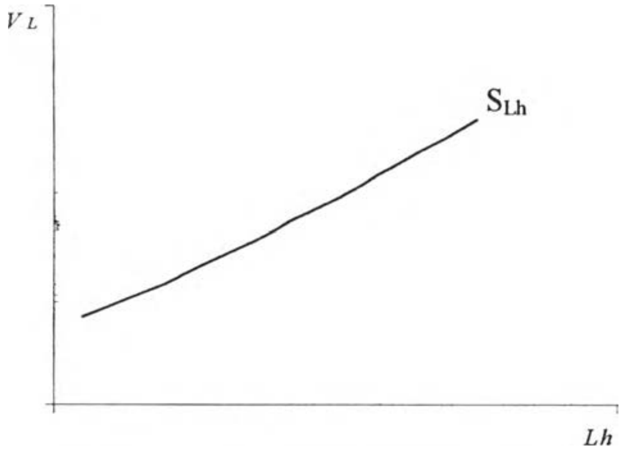


Deriving the market supply curve

By calculating the number of hours an individual chooses to supply at each wage rate (including that rate at which an individual chooses to participate in the labour market) an individual's supply curve can be drawn. It may look like curve *a* or *b* in *Figure 1.4*.

The market supply curve (S_{Lh}) is determined by aggregating the supply curves for all individuals (horizontal summarisation). This could look like in *Figure 1.6*:

Figure 1.6 Market supply of Labour-hours



The labour-hours supply is represented by the function:

$S_{Lh} = g(v_L) - v_L$, or as (*1.10.a*)

$v_L = v_L + f(Lh)$ (*1.10.b*)

1.3 The Presence of Trade Unions: The Basic Model

Trade unions are usually set up because it is advantageous to join in order to pursue goals that are more efficiently accomplished by a group[5]. In countries with a long tradition of co-operation between the employer's federation, trade union, and the government, such goals are usually social welfare contributions, job security, and wages.

The following assumptions are made to simplify the introduction of the trade unions into the supply model simple.

[5] Nicholson, Microeconomic Theory, p. 682.

(i) There are no such things as differences in wages between union members and non-members within a company.

(ii) There is no wage discrimination in hiring e.g. between men and women.

(iii) The alternative cost of working in a company is the market wage rate, which is represented by *equation 1.10.b*.

Note: The market wage rate is not necessarily significantly different from the union wage rate.

The firm's demand for labour hours

Let us assume the firm is a sole employer of the labour group in question (monopsonist) and the cost of labour-hours are the wage rate (there is no non-wage-labour-cost). The profit maximising firm will, as we shall see in section 2.1, hire labour hours until the marginal physical product of labour hours (MRP_{Lh}) is equal to the marginal expense of hiring new labour hours (ME_{Lh}).

$$ME_{Lh} = MRP_{Lh} \qquad (2.15.a)$$

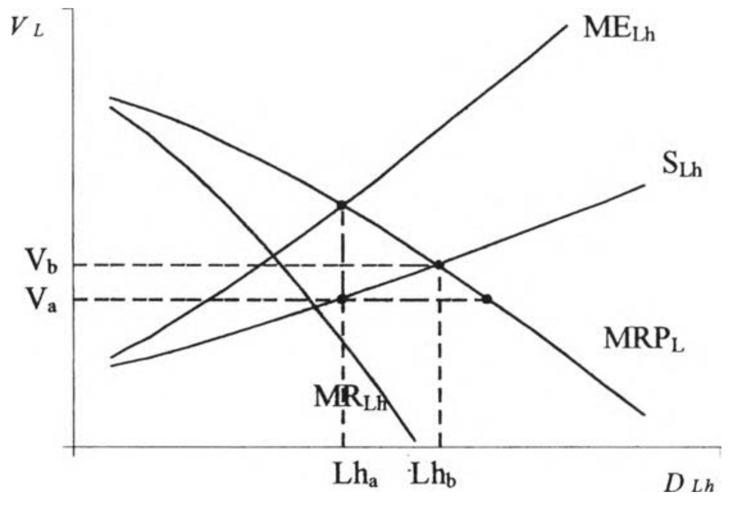
Hence, the firm's optimum will then be determined where $ME_{Lh} = MRP_{Lh}$, resulting in the hiring of labour hour; $Lh=Lh_a$ at the wage rate; $v_L=v_a$ (as depicted in *Figure 1.7*).

If the firm a price taker in the labour market, marginal expenses of hiring additional labour hours is equal to the wage rate, $ME_{Lh} = v_L$, hence; it follows that

$$v_L = MRP_{Lh} \qquad (2.16.a)$$

The firm's optimum will then result in hiring hire labour hour; $Lh = Lh_b$ at the wage rate; $v_L = v_b$, (as depicted in *Figure 1.7*).

Figure 1.7 The firm's optimum employment of Lh



Hence, the monopsonist buys less labour hours than would be bought if the labour market were perfectly competitive, and the wages paid is significantly lower.

The Union's Optimum Wage Rate

If we now assume the union is the sole supplier of the labour hours in question (monopolist), the union will supply *Lh* to maximise its goal. However, as the goal toward which the union strives is defined, the union's optimum wage rate can be determined. – Again, the use of the utility function to explain the behaviour is appropriate.

If the goal of the union is in some sense, an adequate representation of the goal of its members. Then we can aggregate the member's utility curves into a "union utility curve", where the shape and shallowness, again, is determined by the preferences, and the market demand curve is the constraint.

Note: Peter Fallon and Donald Verry explain that the shape and shallowness is closely related to an individual attitude toward risk[6]. However this study is not in a position to "judge' the unions attitude toward risk, but just states that the union can choose its goal between the two extremes of maximising the economic rent that workers receive and of maximising the number of labour-hours employed. This is discussed last in this chapter.

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[6] Fallon and Verry, The Economics of Labour Markets. p. 180.

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Assume the union members aggregated utility curve is expressed as:

$$U_U = U_U(X_U, N_U) \qquad (1.11)$$

Given the market demand curve for labour, this is the MRP_{Lh}-curve of the firm (as discussed in section 2.1):

$$D_{Lh} = MRP_{Lh} = MR\,MP_{Lh} = MR\frac{\partial q}{\partial Lh} \qquad (1.12)$$

Where q is the production possibilities, and a function of factor inputs and technical progress: $q = f(A(t), x_i, x_j, \ldots, x_k)$. $-Lh$ is a factor input and MRP_{Lh} is a function of Lh. Therefore with the constraint: $Lh = T\text{-}N$ then: $MRP_{Lh} = f(q, N)$.

Given the demand curve as the constraint, the utility maximising function is:

$$L^* = U_U(X_U, N_U) + \lambda[MR\,MP_{Lh} - D_{Lh}] \qquad (1.13)$$

$$\frac{\partial L^*}{\partial N} = \frac{\partial U_U}{\partial N} - \lambda\left(MR\frac{MP_{Lh}}{\partial N}\right) = 0 \Rightarrow \lambda = \frac{\partial U_U}{\partial N}\left(MR\frac{\partial MP_{Lh}}{\partial N}\right)^{-1} \qquad (1.14)$$

$$\frac{\partial L^*}{\partial X} = \frac{\partial U_U}{\partial X} - \lambda \Rightarrow \lambda = \frac{\partial U_U}{\partial X} \qquad (1.15)$$

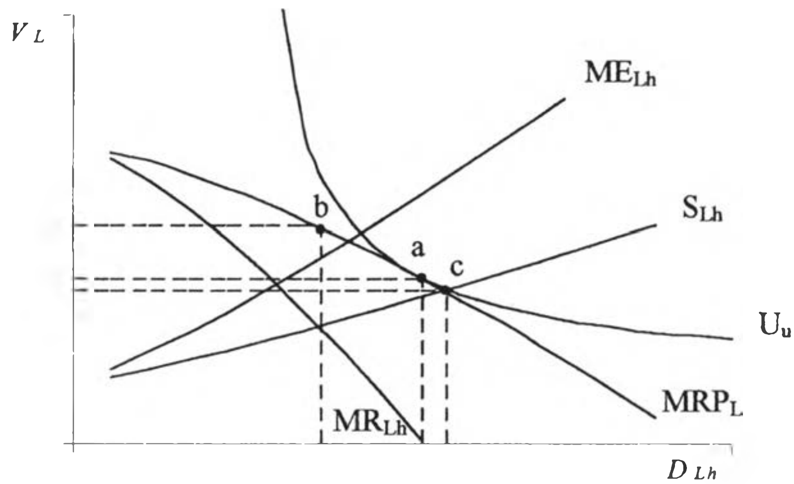
$$MR\frac{\partial MP_{Lh}}{\partial N} = \frac{\partial U_U / \partial N}{\partial U_U / \partial X} \qquad (1.16)$$

The last term in *equation 1.16* is equal to *MRS* as expressed in *equation 1.8*. Hence, the union's optimum utility, given the market demand curve is:

$$\frac{\partial MRP_{Lh}}{\partial N} = MRS \qquad (1.17)$$

The optimisation problem is illustrated in *Figure 1.8*. Given the market demand curve; the optimum is determined where the slope of the demand curve is equal to the slope of the union's utility curve (*point a*), at the wage rate v_a and employment level Lh_a.

Figure 1.8 The trade-union's optimum wage



The union's goal

If the union's goal is to maximise the economic rent workers received (the members are risk neutral), the union can be treated analogously to a profit maximising firm. Hence, the optimum will be where marginal revenue is equal to the non-union wage (equivalent to marginal cost or opportunity cost). This is illustrated in *Figure 1.8, point b*. Stated in mathematical terms: $\partial MRP_{Lh}/\partial Lh = S_{Lh}$.

If the union's goal is to maximise its members' labour-hours employed (the members are risk averse), the union aims at lower wage rate and higher employment, that is, the movement toward *point c* in *Figure 1.8*. Stated in mathematical terms: $MRP_{Lh}=S_{Lh}$.

The Wage Bargaining

In the preceding section it was discussed how the union as a sole supplier (*monopolist*) would supply labour hours and how the firm would employ labour hours if it were the sole employer (*monopsonist*).

"The fact that both the competitive and union supply contracts differ significantly from the monopsonist-preferred contract indicates that the ultimate outcome here is likely to be determined through bilateral bargaining"[7].

In practice trade unions negotiate with both; (i) the single firm; and (ii) with the employers federation –for issues like social security, sick leave, job security, etc. In both, cases the outcome arise from a bilateral bargaining process, and will lie on the MRP_{Lh}-curve between *point b* and *c*, as discussed in section 3.1.

[7] Nicholson, Microeconomic Theory, chapter. 22.