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UNION WAGES, TRAINING COST AND UNEMPLOYMENT

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Abstract: The explanation of unemployment in terms of noncompetitive wage determination involving unions needs to suppose high training costs that prevent unemployed union members from acquiring the skills of other sectors and then from bidding jobs away from employed workers of the sectors. But, how can the supposition of the prohibitively high training cost be consistent with the presence of workers already having the skills? This paper answers this question. Though workers without any skill can fully realize the income stream from a skill, those already with other skills can only partly do so. This makes the former obtain a skill, but not the latter. This answer is a corollary of the natural, but not necessarily well recognized fact of the decreasing marginal productivity of human capital.

1. INTRODUCTION

Unemployment is sometimes explained in terms of high wage rates set by unions.[1] Hart (1982) and Oswald (1982) are recent examples of such approach. In this explanation, unless there is an economy-wide monopoly union, unemployed workers of a sector must be assumed unable to move to other sectors underbidding high union wage rates there. Otherwise, high union wage rates are not sustainable and unemployment disappears. The usual justification for the immobility of unemployed workers is the presence of high training costs. The economy is segmented into sectors according to industries, professions and so on. Workers who want to work in any sector must obtain necessary skills specific to the sector. Sufficiently high training costs of the skills prevent unemployed workers of a sector from entering into another sector and bidding away jobs from union members there.

This is yet an unsatisfactory justification for the immobility of unemployed workers. It must be noticed that each sector is inhabited by workers already having necessary skills for the sector. This means that, for these incumbent

Acknowledgement. I am indebted greatly to a referee of *Keio Economic Studies* for improving the style, exposition and content of an earlier version of this paper. Of course, remaining errors are mine, if any.

[1] The same problem to be explained below exists even when wages are determined by negotiation between the firm and the union as in McDonald and Solow (1981). For simplicity, this paper considers the case of the unilateral union wage setting.

workers, the present (expected) value of incomes from the skills exceeded the training cost of the skills when they were trained. Then, why can the training cost in an industry be high enough to prevent unemployed workers in other industries from coming in the first industry, while it was low enough to have already attracted incumbent workers to the industry? Is the assumption of the high training cost responsible for the immobility of unemployed workers consistent with the presence of incumbent workers already having necessary skills? An explanation of this puzzle should be simply that the union of a sector somehow controls the training of the skills necessary for the sector, and hence that it excludes from the training process unemployed workers who are anticipated to underbid the union wage rate. This is a trivial explanation, though not an unlikely reason for the puzzle as in the case of medieval guilds. The purpose of this paper is to seek another less trivial explanation of the puzzle.

The marginal productivity of human capital like other factors of production decreases as the capital increases, especially because the increase must be associated with a given amount of time a man has. This paper explains the puzzle as a corollary of this natural, but not necessarily well recognized fact. More specifically, the paper shows that due to the time constraint, unemployed workers already having skills for some sector can realized only part of the income stream from the investment in the skills specific to another sector, while workers without any skill can do so fully. It is then possible that, while a sector is populated by workers having skills needed there, no unemployed workers of other sectors want to obtain the skills to bid away jobs from workers of the sector. Unions then can set their wages at their desired high levels without regard to the underbidding by unemployed workers.

Section 2 introduces the model of the segmented and unionized labor market. Section 3 shows that equilibrium of the model in Section 2 produces no incentive for unemployed workers to learn the skills of the other sector and then to bid away jobs from workers there.

2. THE MODEL

There are two symmetrical sectors. They are referred to as sector a and sector b. These two sectors may be interpreted to represent different industries, professions, and so on. Any worker who wants to work in either of the two sectors must undergo the training to learn skills necessary in that sector. For simplicity of the argument, the training is assumed instantaneous, so that workers trained in the beginning of a period can start to work from that period. The training cost is T. Workers bear the cost.[2]

We assume that each sector is inhabited by N workers already having the

[2] There are many firms in each sector. Therefore, the skills are, though specific to each sector, general ones in the terminology of human capital theory, so that the training cost should be borne by workers.

necessary skills of the sector. These workers in each sector do not have the skills for the other sector. The workers in each sector are organized. Their unions in sectors a and b are referred to as union a and union b, respectively. We will see whether the presence of the union in each sector creates incentive for unemployed union members of one sector to obtain the skills for the other sector.

Workers are homogeneous, and live for an infinite number of periods. The assumption of infinitely living workers is meant to exclude the obvious case in which short remaining life prevents acquisition of new skills.

The demands for labor in slumps and booms in each sector are given by $L_0(W)$ and $L_1(W)$ where W is the wage rate. $L_i'(W)<0$ for $i=0, 1$. Slumps and booms hit the both sectors at the same time. Since this paper considers a problem of the labor market in a macroeconomic context, slumps and booms are aggregate shocks as opposed to local shocks. Booms hit the sectors with the probability of p.

To simplify the story, this paper assumes that each union unilaterally sets the wage rate for its members. Let R_{ij} designate the reservation wage of unemployed workers of union j ($j=a, b$) to work in the other sector in a slump when $i=0$, and in a boom when $i=1$. That is, R_{ij} is the wage rate only at more than which unemployed workers of union j want to work in the sector associated with the other union in state i. We will later examine how R_{ij} is determined. Each union sets the wage rate at the level that maximizes $WL_i(W)$ subject to $L_i(W)\leq N$ ($i=0, 1$) and $W\leq R_{ij}$. We assume $WL_i(W)$ is strictly concave.

The meaning of the first constraint in the above maximization problem should be obvious. The second constraint represents the restriction on the union's wage policy arising from the presence of unemployed workers in the other sector. A union would like to take the wage policy of setting its wage at its desired level, namely, the solution of the maximization problem only with the first constraint. The second constraint means that the presence of unemployed workers in the other sector, however, might not allow the union to take the desired wage policy. If union j sets its wage rate above R_{ik} ($k\neq j$), unemployed workers of union k possibly move to sector j, and underbid the wage of union j, so that the union shall lose jobs in the sector to the unemployed workers.

Two comments on the above formulation of the union's behavior are in order. First, since the union's decision on the wage in a period does not affect any variable in subsequent periods, the period-by-period wage bill maximization also maximizes the expected present value of wages for each union member, namely, $W_{ij}L(W_{ij})/N+\{(1-p)W_{0j}L_0(W_{0j})/N+pW_{1j}L_1(W_{1j})/N\}/r$ subject to the constraints, where r is the interest rate, and W_{ij} denotes the j union's wage rate in state i ($j=a, b$ and $i=0, 1$).

Second, the second constraint in the union's optimization problem appears to reduce to triviality the question over the union wage setting stated in the beginning of this paper, that is, the question of why unemployed members of a union do not underbid the wages of other unions to work in the other sectors. Given the constraint, one can say that it is simply because the union avoids the

underbidding by setting its wage low enough. To be meaningful, therefore, the question must be more carefully restated as why the presence of unemployed workers does not restrict the union's behavior, in other words, why it does not force the union to set its wage at a low level creating only small unemployment. More specifically, the question is how the second constraint can get non-binding at the solution of the union's maximization in a way for the union of a sector to set its wage at the desired level, namely, the level which maximizes $WL_i(W)$ only subject to the first constraint of $L_i(W) \leq N$, even when there are unemployed workers in the other sector.

It is an unsatisfactory answer also to the above restated question that the training cost prevents unemployed workers of a sector from moving to another sector. As emphasized in Introduction, one must then explain why there are already trained incumbent workers in the second sector. We will solve the puzzle stated in the introduction in the context of explaining why unemployed workers in the other sector do not constitute the restriction on union's wage policy.

Let W_i $(i=0, 1)$ be the solution of the union's maximization problem without the second constraint. W_i is the desired wage rate in the sense that a union sets its wage at that rate if there is no threat of the underbidding by unemployed workers. We assume that all members of each union are employed in booms, but not in slumps if there is no threat of the underbidding, in other words, if the second constraint for the maximization is not binding; that is, we assume

ASSUMPTION 1. $L_0(W_0) < N$ *and* $L_1(W_1) = N$.

Assumption 1 should be a natural assumption to characterize boom and slump.

The second constraint of the union's maximization implies that only members of union j $(j=a, b)$ are employed in sector j $(j=a, b)$, and also that the wage the union sets in a boom is less than or equal to W_1. Then, it follows from $L_1'(W) < 0$ and the second part of Assumption 1 that all union members are employed in a boom.

We assume that obtaining skills specific to each sector yields to a union member the income stream the present value of which exceeds the training cost of the skills, provided that unemployed workers in the other sector do not restrict the union's policy. Specifically, letting e be $L_0(W_0)/N$, that is, the employment rate in slumps in the absence of the threat of the underbidding, we assume:

ASSUMPTION 2. $eW_0 + \{pW_1 + (1-p)eW_0\}/r > T$.

If the union's wage policy is somehow unrestricted by the presence of unemployed workers in the other sector, Assumption 2 rationalizes the presumption that each sector is inhabited by workers already having the skills necessary for the sector.

Unemployed workers can get a job in a sector by underbidding the union wage of the sector only slightly. Hence, Assumption 2 assures that unemployed workers' investment in new skills yields enough return to cover its cost if a union sets its

wage at its desired level. Does it then follow from Assumption 2 that a union setting its wage at its desired level must fear that unemployed workers of the other sector obtain skills necessary for its own sector, and bid away jobs from its employed members? In consequence, must the unions set their wage rates at low levels with a few unemployment? Mathematically, is R_{ij} always lower than W_i under Assumption 2? We will see in the next section that the answers to these questions are no under the following Assumption 3.

ASSUMPTION 3. $W_0+(1-p)(1-e)W_0/r \leq T$.

Given that the threat of the underbidding by unemployed workers does not restrict the wage policy of union a, the LHS of the above inequality gives the expected present value of lost union wages in slump periods for unlucky union members who are not employed in the current slump.

3. THE UNRESTRICTED UNION WAGE POLICY

Suppose that the unions set their wages at their desired levels without regard to the underbidding of unemployed workers, that is, $W_{ij}=W_i$, and also suppose that the initial period is in a slump with some union members in the both sectors being unemployed. Consider an unemployed member of union a who has obtained the skills necessary for sector b in the initial period. By underbidding the wage rate of union b slightly, he can be employed in sector b as an outsider of union b in that period as well as in subsequent periods.[3] After the first period, booms and slumps hit sector b with the probabilities of p and $1-p$. Then, he will be able to earn from sector b the income stream whose expected present value is:

$$W_0'+\{(1-p)W_0'+pW_1'\}/r\,, \tag{1}$$

where W_i' $(i=0, 1)$ is the outsider's wage in state i.

Assumption 2 implies that, with some W_i' only slightly less than W_i, the above present value, (1), exceeds the training cost T. In other words, as already observed in the last section, an unemployed member of union a who has obtained the skills for sector b can earn enough income to cover the training cost. From this, however, it does not necessarily follow that the desired wage policy of union b leads an unemployed member of union a to acquire skills for sector b, and invites their underbidding the wage rate of union b.

If a boom comes back in a future period, a union-a member who was not employed in sector a in the initial period can be employed as a member of union a in that sector. Having the skills for sector b, he can be employed also in sector b in the boom. If he returns to his original sector a in the boom, he as a union

[3] A member of union a may join union b after obtaining the skills of sector b. This alternative does not restrict the wage policy of union b, and hence we do not consider it. Furthermore, for a member of union a, joining union b is a choice inferior to becoming an outsider of union b. We will explain this in footnote 4.

member earns the wage rate of union a, W_{1a}. If he remains in sector b, he as an outsider of union b earns only less than W_{1b}. Otherwise, he cannot be employed in sector b. Then, in a symmetric equilibrium with $W_{1a}=W_{1b}$, he will return to sector a, and work there when a boom comes back in future. For the same reason, he will do the same when he is lucky enough to be employed in sector a in future slumps. It follows that, for an unemployed union-a member who learns new skills necessary for sector b in a slump period, the expected present value of additional income from the skills is given not by (1), but by

$$W_0'+(1-p)(1-L_0(W_{0a})/N)W_0'/r\ .^{4} \tag{2}$$

The above consideration means that unemployed members of union a want to acquire the skills of sector b, and to work there if and only if $W_0'+(1-p)\{1-L_0(W_{0a})/N\}W_0'/r$ exceeds T. The reservation wage of an unemployed member of union a in a slump, R_{0a}, thus equals $T/[1+(1-p)\{1-L_0(W_{0a})/N\}/r]$. On the other hand, by the definition of W_{0b}, $W_{0b}=W_0$ when $W_0\leqq R_{0a}$ and $W_{0b}=R_{0a}$ when $W_0>R_{0a}$. Therefore, one has:

$$T/[1+(1-p)\{1-L_0(W_{0a})/N\}/r]=W_{0b}<W_0\ ,$$

or

$$T/[1+(1-p)\{1-L_0(W_{0a})/N\}/r]\geqq W_0=W_{0b}\ .$$

When Assumption 3 holds, note that $T/[1+(1-p)\{1-L_0(W_0)/N\}/r]\geqq W_0$, and hence that $W_{0b}=W_0$ when $W_{0a}=W_0$. This determination of W_{0b} given W_{0a} is depicted by the B–B curve in Figure 1. The A–A curve in the same figure depicts the corresponding determination of W_{0a} given W_{0b}. The intersection of the two curves gives the Nash equilibrium of our model. The A–A and B–B curves do not intersect with each other below W_0. (The reason for this will be seen in footnote 5.) Hence, the equilibrium is unique.

As Figure 1 shows, $W_{0a}=W_{0b}=W_0$ in equilibrium under Assumption 3. The reservation wage of unemployed workers is high enough to allow unions to take their desired wage policies that create large unemployment. Thus, even though the necessary skills of sector b create the income stream in the sector enough to cover the training cost of the skills (Assumption 2 holds), the presence of unemployed workers in the other sector does not restrict the wage policies of the unions, that is, the unions need not fear inflow of the unemployed workers into the union's sector and their underbidding of the union's wage.

While members of union a must underbid the wage rate of union b to work in

[4] (2) means that an unemployed member of union a does not join union b after acquiring the skills of union b. Doing so improves the member's probability of being employed in future slumps from $L_0(W_{0a})/N$ to $L_0(W_{0a})/N+(1-L_0(W_{0a})/N)L_0(W_{0b})/N$. This improvement in the probability is much smaller than the one from becoming an outsider of union b in which case the member can be employed in slumps for certainty. On the other hand, the outsider's wage must be only slightly lower than the union wage. Thus, becoming an outsider of union b dominates joining union b.

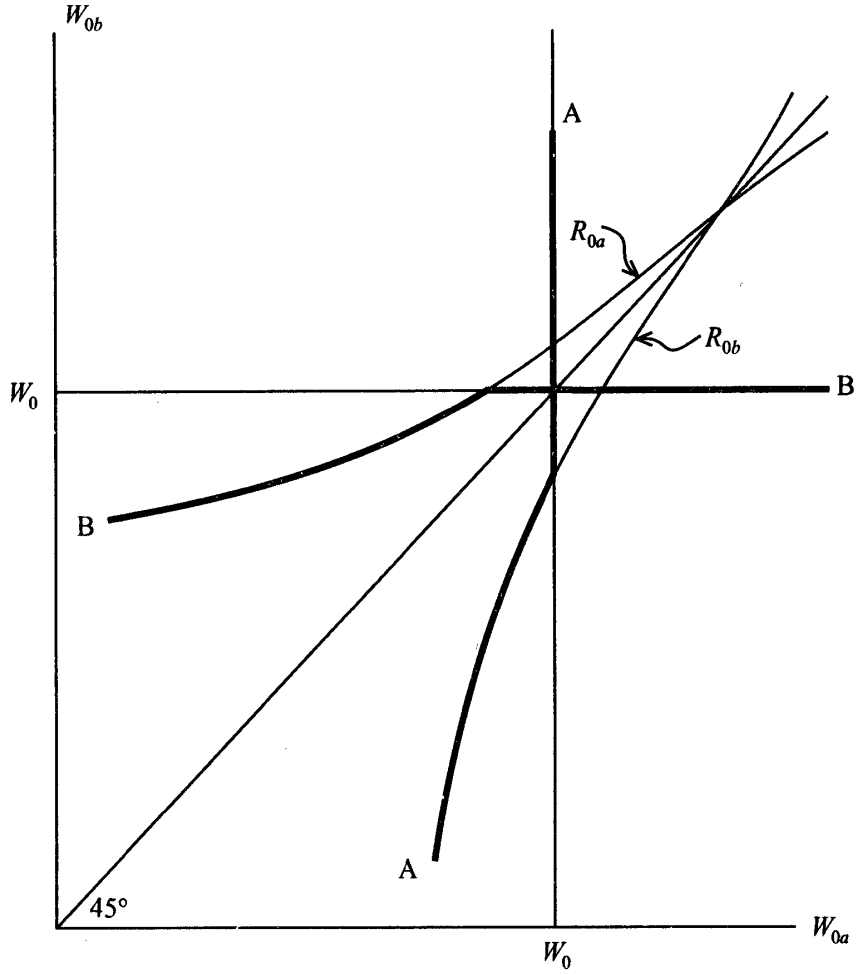

Fig. 1.

sector *b*, they can earn the wage rate of union *a* when employed in sector *a*. Since sector *a* and *b* are symmetric, the wage rates of the two unions are equal to each other. Hence, when members of union *a* can be employed in both sectors, they choose to work in sector *a* where they earn more as union members. Thus, the workers do not always use the skills for sector *b*, and do not receive the full income stream that the skills create. Therefore, the present value of the *additional* income from acquiring the skills of sector *b* is much smaller for unemployed workers already having the skills for sector *a* than for workers without any skill. It follows that for the unemployed workers, it does not necessarily pay to invest in the skills of the other sector, while for workers without any skills such as young workers, the investment pays as they can fully realize income from the set of skills necessary in a sector. Thus, each sector is inhabited by workers having the skills needed in the sector, while unemployed workers in other sectors do not acquire the skills to work there. The union wages are then not underbid.

The puzzle of unemployed workers not acquiring new skills to work elsewhere

despite the existence of workers already having those skills is, after all, due to the decreasing marginal productivity of human capital. Given the constant cost of acquiring additional human capital, its decreasing marginal productivity does not justify having large human capital (the skills of both of the two sectors), while it does having small one (the skills of either of the two sectors). The cause of the decreasing marginal productivity of human capital, in turn, is that a larger human capital must be combined with the fixed amount of worker's available time, in other words, the human capital-labor time ratio rises as human capital increases.

We now turn to the case where Assumption 3 does not hold. In the case, $R_{0b} < W_0$ when $W_{0a} = W_0$. Graphically, we have the Nash equilibrium as in Figure 2 rather than the one in Figure 1. The intersection of the A–A and B–B curve

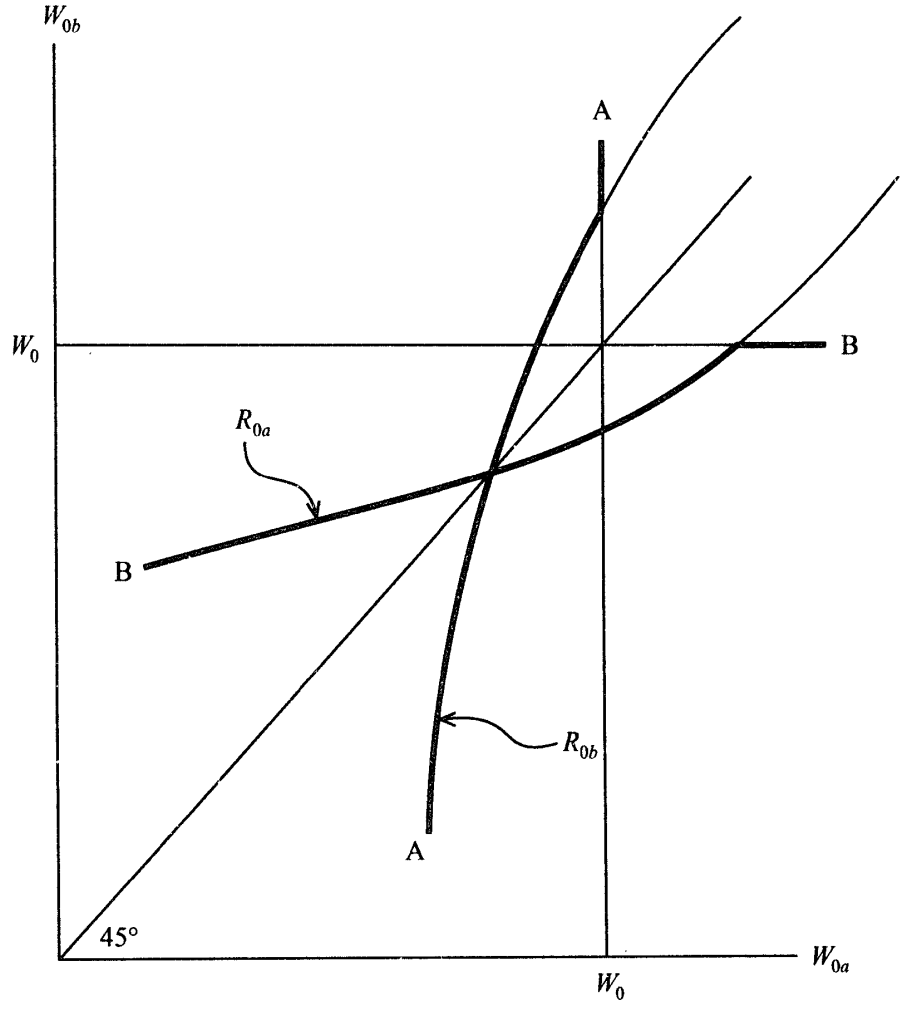

Fig. 2.

uniquely exists.[5] The union's wage policy is here restricted by the presence of unemployed workers. The unions cannot set their wages at their desired levels. The threat of the underbidding forces the unions to set their wages at low levels. This is the case in which the threat of the underbidding reduces unemployment.

4. CONCLUSION

In theories of unemployment involving noncompetitive wage determination such as the union wage setting, unemployed workers are assumed unable to move to another sector and to work there by underbidding union wage rates in the sector. Otherwise, high wage rates are not sustainable, and unemployment would disappear. The unemployed workers' immobility is typically attributed to the training cost of skills specific to each sector; the training cost of skills needed in each sector is high enough to prevent unemployed workers from moving from other sectors into that sector. However, is the prohibitively high training cost for entering into a sector consistent with the presence of incumbent workers having the skills needed in the sector?

This paper answered the above question. Workers without any skills, such as young workers, can fully realize income stream from a set of skills. Therefore, their investment in the skills are justified and hence there are incumbent workers in each sector. By contrast, workers having skills of some sector realize only part of income stream from skills needed in a new sector. For, they work in a new sector at underbidding wage rates only in slump periods when they cannot be employed in their original sectors. Because they can be employed and earn higher union wages in their original sector in boom periods, they return to the sector in booms. A small realizable income does not justify those workers' investment in new skills. Thus, unemployed workers do not move to other sectors and underbid wages there, allowing unions there to set their wages at the desired high levels and to create large unemployment.

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[5] The intersection of the A–A and B–B curve is the solution of $W+(1-p)\{1-L_0(W)/N\}W/r=T$. The LHS is non-positive when $W=0$, and it is strictly convex because of strict concavity of $WL_0(W)$. If the LHS is decreasing when it is positive, it follows from the first property of the LHS that it must have a local maximum. This contradicts strict convexity of the LHS. Hence, the LHS is increasing when it is positive. This means the solution of the equation uniquely exists. The solution is less than W_0 when Assumption 3 does not hold. When the assumption holds, the solution is more than or equal to W_0; in other words, the A–A and B–B curve do not intersect with each other at W less than W_0.

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