NBER WORKING PAPERS SERIES

LABOR MARKET SEGMENTATION, WAGE DISPERSION AND UNEMPLOYMENT

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Working Paper No. 4073

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
May 1992

This paper was supported in part by a Sloan Faculty Research Fellowship (Lang) and the Institute of Industrial Relations, Berkeley (Dickens). We are grateful to Gustavo Gonzaga for excellent research assistance and to Olivier Blanchard, Lawrence Katz, Douglas Orr, James Rebitzer, Robert Rosenthal, Andrew Weiss and participants in seminars at Berkeley, Boston University, McGill and the NBER for helpful comments and discussion. This paper is part of NBER's research program in Labor Studies. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

NBER Working Paper #4073
May 1992

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ABSTRACT

This paper briefly reviews the empirical evidence on labor market segmentation and presents some new results on the similarity of the pattern of segmentation across 66 different countries. The paper goes on to consider how unemployment might be understood in a labor market segmentation framework.

Existing models of unemployment in a dual labor market suggest that unemployment should be concentrated among those who are ultimately employed in high wage jobs. In fact, unemployment seems to be concentrated among workers who are more likely to be found in low wage jobs. This happens even though at least some workers find low wage jobs easy to obtain. We develop a segmented labor market model capable of explaining these facts and then explore its implications for the aggregate unemployment rate. We find that it fits well with the facts.

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Labor market segmentation is not as naturally part of a discussion of unemployment as it may at first seem. On the one hand, in some of its versions, labor market segmentation is much broader than a theory of unemployment. It is a research program with an agenda that differs markedly from that pursued by most economists. On the other hand, in its more narrow form, it is a theory of wage determination and of the allocation of workers to jobs with different wages, and not a theory of unemployment.

As a consequence, we begin by developing a model of labor market segmentation and exploring its consequences for unemployment. The model is simultaneously concerned with the microeconomic aspects of unemployment - who is unemployed —, and with the macroeconomic aspects — what determines the aggregate level of unemployment. We find that unemployment will be more prevalent among low skill workers who also end up disproportionately in low-wage jobs. At the macroeconomic level, unemployment will be positively correlated with the average wage and the fraction of low productivity workers. In terms of observable variables, unemployment is, under certain circumstances, positively correlated with the average wage and the fraction of workers in the low-wage sector.

In our previous work, we have stressed that labor market segmentation models share two key elements. The first is a theory of wage determination where wages for similar workers differ among sectors of the economy. Early advocates of labor market segmentation models argued that the labor market could be usefully described as consisting of a small number of segments with different patterns of wage determination. However, more recent work which is more closely linked with mainstream traditions has placed more emphasis on the differences in wages across segments than on the frugality of the segmentation approach.

In addition to a theory of wage determination, every model of labor market segmentation requires a theory of how workers are allocated to sectors. It is here that labor market segmentation theory departs most sharply from mainstream economics. Jobs in high-wage sectors are not allocated by strict price rationing. Some people who are qualified for and who desire jobs in the high-wage sectors are unable to get them.

These two elements are not sufficient to generate unemployment. It is possible for high and low-wage sectors to coexist without any unemployment ensuing. Workers who were unable to get high-wage jobs might simply accept employment in low-wage sectors. Indeed many development economists believe that labor market segmentation is an important aspect of labor markets in developing countries even though open unemployment may be very low. Those excluded from the modern sector find employment in the informal sector.

This is not to say that discussions of unemployment are absent from the literature on labor market segmentation. On the contrary, some of the early work on labor market segmentation was motivated by the desire to explain high rates of unemployment among young blacks. Thus although labor market segmentation theories were interested in unemployment, the emphasis was on who is unemployed rather than on the level of unemployment. One of our objectives is to formalize the insights from this tradition.

Piore (1975, formalized by Rebitzer and Taylor, 1991) argues that labor market segmentation is a response to flux and uncertainty. The primary (high-wage) sector is organized so as to shelter workers and firms from that uncertainty. The brunt of the flux is felt in the secondary (low-wage) sector where jobs are frequently short-term. In good times, therefore, unemployment consists primarily of what neoclassical economists would call frictional unemployment among workers in the secondary sector although there may be an

absolute shortage of jobs in the secondary sector in bad times. Workers in the secondary sector may experience frequent spells of unemployment interrupted by relatively short-term employment in low-wage jobs.

Wial (1991) finds that, at least for young white working class males, low-wage jobs appear to be readily available. Vacancy rates in these jobs are high. The short duration of employment may reflect the low value placed on holding such jobs as well as the demand fluctuations emphasized by Piore. High-wage jobs are much more difficult to obtain and being hired by a high-wage employer appears to be largely a matter of luck.

To summarize the insights from this literature — unemployment is concentrated among the types of workers who are disproportionately represented in the low-wage sector. Ironically, this finding is readily accommodated by market-clearing models of unemployment. Workers whose wages are low are likely to have a value of leisure near there wage. Fluctuations in their value of leisure will cause them to move in and out of the labor force. Unemployment arises if nonemployment spells are misclassified as unemployment or if labor force reentry is associated with short-term unemployment.

However, the relation between potential earnings and unemployment is not as easily explained within the context of models in which markets do not clear. Therefore, one of the objectives of this paper is to develop a formal model with this implication. Having developed such a model, we then ask whether it is capable of explaining empirical regularities with regard to the aggregate unemployment rate. Our findings are quite supportive of the model.

Obviously, the relevance of these models depends on the importance of labor market segmentation. Consequently, our first step is to establish the importance of sectoral wage differentials. To a large degree this has been accomplished in previous work (Dickens and Katz, 1987a&b; Katz and Summers,

1990). We review this work only briefly. Instead, we concentrate on the international evidence. We find strong evidence of a widely-shared pattern of interindustry wage differentials.

We then develop our theoretical model in steps. In section II, we develop a simple bilateral search model with homogeneous firms and workers. This section is intended to make it clear how segmentation can be generated in the model and to show how technical detail can be handled so that discussion of technical detail can be dispensed with in later section. Section III considers the case of heterogeneous firms and homogeneous workers. Although this represents a natural step along the way to our model with heterogeneous workers, the section serves primarily to clarify some issues regarding the desirability of activist policy in the presence of labor market segmentation. We suggest that this case is much weaker than some authors have previously claimed. Section IV considers the case of heterogeneous workers and shows that for some parameter values low-productivity workers will have higher unemployment rates than more productive workers. Moreover wage differentials will often exceed differences in productive potential. In section V, we show that owners of capital are made better off and all workers worse off if employers make arbitrary distinctions among workers. Section VI develops the macroeconomic implications of the model and compares them with empirical findings.

I. The International Pervasiveness of the Industry Wage Structure

There is a large and growing literature on interindustry wage differentials. The resurgence of this literature (Dickens and Katz, 1987a&b; Krueger and Summers, 1987, 1988; Katz and Summers, 1990) began in the United States, but has been widely replicated since then. The universal finding is

that there are large wage differentials across industries within a country. Where it is possible to conduct such tests, the wage differentials cannot be accounted for by measurable individual characteristics or by working conditions. It, of course, remains possible that the wage differentials are accounted for by unmeasured worker or job characteristics, but we argue elsewhere (Dickens and Lang, 1992) that this is unlikely.

Industry is only imperfectly correlated with labor market segment. Most industries have a mix of types of workers. Automobile assembly may be carried out almost exclusively by workers in the high-wage sector, but manufacture of some components may involve workers in the low-wage sector. Janitorial and security personnel may be high paid and integrated into the firm's internal market or may be low paid contract workers. Nevertheless, since industries which pay high wages tend to pay high wages to workers in all occupations, industry is likely to be at least a reasonable proxy for sector of employment.

Our first task is therefore to determine the extent to which it is possible to talk about a single "industry wage structure." Previous research has suggested that the wage structure is quite similar in countries such as the United Kingdom and the Soviet Union with very different economies (Krueger and Summers, 1987; Dickens and Katz, 1987). However, other countries show much lower rates of correlation. Is this because there are a few different patterns around which countries cluster or because countries differ in the extent to which they conform to a common pattern? In the latter case, it will be easier to consider the effect of labor market segmentation on unemployment.

To answer this question we collected data on wages paid in 32 one and two digit industries in 66 countries for the year 1985. We conducted a maximum likelihood factor analysis of these data. We could easily reject the hypothesis of no common factors (Chi-square statistic of 1,116 with 97 degrees

of freedom, $p<.0001$) A single factor explains 47% of the standardized variance in the wages for these countries. This is remarkable when one considers that a high fraction of the variance -- particularly in developing countries — is probably measurement error due to different definitions of the industries and different composition of the relatively highly aggregated industries in different countries. The single factor is nearly perfectly correlated with the vector of average wages in each industry across countries. Only thirteen of the 66 countries have loadings less than .5 on the factor. Most of these are LDCs. We have begun to search for correlates of the loadings and it appears that they are positively correlated with real GDP per capita and investment as a fraction of GDP.

We could also reject the hypothesis of only one common factor with a high degree of confidence (Chi-square statistic of 436 with 96 degrees of freedom). However the second factor explains only 12% of the standardized variance in our wage data set. The first factor of the two factor model continues to have all the properties of the factor from the single factor model. The second factor shows no obvious pattern either for the industry values or for the countries which load on it. None of the variables we have explored are correlated with it. Table 1 presents the values of the standardized orthogonal factors for the 32 industries. Table 2 contains the loadings for all countries for both factors. These results suggest that we can talk about a common pattern of labor market segmentation to which countries conform to differing degrees.

II. The Basic Model

The basic model, which is extended in later sections, draws on the model sketched in Lang (1991) and formalized in Montgomery (1991). It is

essentially a large economy version of the model developed in the latter paper.

There are N identical workers and bN identical firms where N is assumed to be large. Initially, we do not formally model the determination of b. Later we will assume free entry until the point that expected profits are zero but will not otherwise model the firm's entry decision. Each firm has exactly one job available. Firms announce the wages they will pay to any worker they hire and cannot credibly promise to hire excess workers even where this is an optimal strategy. Workers each apply to a single firm. If a firm receives only one application, it hires that worker. If it receives more than one application, it chooses randomly among the applicants.

We denote firm i's profits by

$$(1) \quad \pi_i = F_i(v-w_i) - d$$

where F is the probability that the firm fills its vacancy, v is the value of the worker's output, w is the wage and d is the cost of looking for a worker.

Claim: The following is a sub-game perfect equilibrium. All workers apply randomly to firms with the probabilities assigned to each firm identical for all workers. A worker's probability of applying to firm i satisfies the following conditions:

$$(2) \quad EM_i w_i = K \qquad\qquad w_i > K$$

where EM is the probability of getting a job and apply to the firm with probability equal to zero if $w \leq K$.

All firms offer a wage equal to

$$(3) \quad w = -K(\ln K - \ln v)/(1- K/v).$$

Before passing to a proof of this claim, it is important to be clear that although (2) can be interpreted as an equilibrium condition, at this stage it is a statement about strategies. Given that all workers use the same mixed strategies, equation (2) tells us the probability of applying to each firm given any combination of wage offers by the firms.

Proof: It is obvious that given the strategies of the other workers, no worker can make himself better off by choosing a different strategy. Equation (2) ensures that the worker gets the same expected wage wherever he applies except for firms which pay less than K and where he would be worse off if he applied.

To show that the optimal wage for firms to set is given by equation (3), we derive expressions for F and EM, the filled job and employment rates.

Let q be the probability that each worker applies to a given firm. Then the probability that a worker who applies to that firm will be employed is

$$(4) \quad EM = (1-(1-q)^N)/Nq.$$

Let $z = Nq$, the expected number of applicants to the firm. Then as N gets large,[1]

$$(5) \quad EM \simeq z^{-1}(1-e^{-z}),$$

where z is the expected number of applicants at the firm.

The probability that a firm fills its position is given by

[1]This is just the Poisson approximation to the binomial distribution.

(6) $F = 1 - (1-q)^N$

which tends to

(7) $F = 1 - e^{-z}$

as N gets large.

Substituting for F and w in equation (1) yields

(8) $\pi_i = (1-e^{-z})v - Kz - d.$

Maximizing with respect to z gives

(9) $K/v - e^{-z} = 0$

Solving for z and substituting for z in (5) and then for EM in (2) gives equation (3). The value of K can be derived from the zero profit condition (assuming free entry ensures zero profits), and is unique, but has no closed-form solution and is of no intrinsic interest.

It is easily verified that w is increasing in v (holding K fixed) so that if firms differ with respect to v, those with higher values of output will pay higher wages. These results parallel those derived by Montgomery (1991). Nevertheless, when employment is endogenous, it must be interpreted with caution. One response of firms with more productive workers will be to hire more workers, thereby lowering their marginal product. Our point here is only to derive the basic behavior of workers faced with wage differences across firms and to point out that such differentials can be endogenous within our framework.

We have concentrated on this equilibrium, because we find it the most plausible. We expect that there are equilibria in which both workers and

firms play mixed strategies but none in which all workers play pure strategies. An equilibrium in which firms, at least, play pure strategies seems preferable.

III. Two-Sectors/Homogeneous Workers

The standard Harris-Todaro model and its more recent efficiency wage variants (Bulow and Summers, 1986) assume that workers are homogeneous and that there are two sectors which either pay different wages for exogenous reasons or for reasons related to technology. Typically the low-wage sector is assumed to be a market-clearing sector. Unemployment occurs among individuals trying to obtain employment in the high-wage sector. There are some small differences between the implications of the Harris-Todaro models in which jobs are allocated by lottery and the Bulow-Summers model in which individuals essentially wait in line for a high-wage job. We will return to these differences shortly.

To show the relation between our model and the standard models, we begin by considering the case of two sectors with exogenously determined wages. All firms within a sector are identical. All workers are identical. In the equilibrium in which all workers have the same strategies, workers randomize where they apply with equal probability of applying to each firm within a sector, but apply with greater probability to any single firm in the high-wage sector than to any single firm in the low-wage sector. Thus unemployment rates are higher among workers who apply to high-wage firms, and vacancy rates are lower in that sector.

So far, the model is a minor variation on the Harris-Todaro model. There is, in effect, a lottery for jobs in both sectors. However, even in this form, the model has implications which depart from previous models. In the

standard Harris-Todaro model increasing employment in the high-wage sector increases the desirability of queuing for employment in the high-wage sector and therefore increases unemployment. Equilibrium is achieved by expanding queuing in the high-wage sector until unemployment in that sector equals what it would have been in the absence of the employment expansion. In the Harris-Todaro model, while the unemployment rate in each sector (by assumption zero in the low-wage sector) is unchanged, the shift of applications towards the high-wage and high unemployment increases the unemployment rate. Essentially the same argument applies to the Bulow/Summers waiting-time model.

It is worth noting in models of this type that shifting one worker from applying to the low-wage sector to applying to the high-wage sector has only a second-order effect on output. In essence this arises because the expected wage and hence the expected output (net of unemployment) is the same in the two sectors in equilibrium. Dickens and Lang (1988) argue that if a worker could be costlessly shifted from employment in the low-wage sector to employment in the high-wage sector, this would be desirable since firms would be no worse off given that the marginal profit on a worker is zero and the worker would be strictly better off. In the standard queue unemployment models, the case of costless transfer makes little sense. All the benefits from expanding employment in the high-wage sector will be dissipated by increased unemployment in that sector.[2]

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[2]Bulow and Summers claim that in the waiting time model there are benefits to expanding employment in the high-wage sector. The difference between their analysis and ours is that we compare equilibria while they include the benefits that arise out of the transition. Workers who are waiting for high-wage employment are made strictly better off by an expansion of the high-wage sector, and thus receive a one-time benefit. Given the reality that we start from a distortionary tax base so that the costs of financing the expansion of employment are finite and that the benefits are of strictly limited duration, this one time benefit from expanding high-wage employment provides a very weak basis for advocating industrial and other activist policies.

Because there is unemployment in both sectors in our model, it is possible that expanding employment in one sector will reduce the unemployment rate in both sectors and bring down the aggregate unemployment rate. To see under what circumstances this is possible, we begin by elaborating our model slightly.

Let p be the probability that a worker applies to a high-wage firm and 1-p the probability that he applies to a low-wage firm. Let α be the fraction of firms which enter the high-wage sector and $1-\alpha$ the fraction that enter the low-wage sector. Then

$$(10)\quad q_h = p/(\alpha bN), \qquad q_l = (1-p)/((1-\alpha)bN).$$

The employment and filled job rates for each of the sectors are:

$$(11)\quad EM_h = \alpha b(1-e^{-p/(\alpha b)})/p, \qquad EM_l = (1-\alpha)b(1-e^{-(1-p)/((1-\alpha)b)})/(1-p)$$

$$(12)\quad F_h = 1-e^{-p/(\alpha b)}, \qquad F_l = 1-e^{-(1-p)/((1-\alpha)b)}.$$

Labor market equilibrium, of course, requires that expected earnings be equal in the two sectors.

To complete the model we need to model entry into the two sectors. This will turn out to be the essential part of the model which determines whether subsidizing high-wage or low-wage employment is desirable. We begin by assuming that there is a fixed entry cost in the low-wage sector but that entry costs rise as the number of entrants in the high-wage sector increases. We assume that output prices in the two sectors are fixed. This is equivalent to assuming that there is a unique equilibrium filled job rate in the low-wage sector. In the high-wage sector, we assume that the structure of entry costs

is such that the filled job rate which firms require in order to enter the sector is given by

(13) $F_h = \gamma_1 + \gamma_2 ab$.

Note that together with the labor market equilibrium condition, (11) and (12) imply that

(14) $\ln (1-F_h)/F_h = (w_h/w_l) \ln (1-F_l)/F_l$.

Suppose now that government adopts a balanced-budget tax policy in which it subsidizes entry into or employment in the high-wage sector and taxes it in the low-wage sector. Then the filled-job rate firms require to enter the low-wage sector will rise. By equation (14) the filled-job rate must also rise in the high wage sector. Since the unemployment rate is positively related to the filled-job rate, the unemployment rate also rises in both sectors. We have already seen that when the unemployment rate within each sector is unaffected by the increased high-wage employment, the effect on aggregate output is zero.[3] In this case since the unemployment rate in both sectors rises, the output effect is negative.

What happens is that the decline in employment opportunities in the low-wage sector shifts workers into the high-wage sector to a greater extent than the subsidy creates employment opportunities. Thus not only do we shift workers from the low unemployment to the high unemployment sector, but we increase the unemployment within each sector, thereby increasing overall unemployment.

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[3]It is easy to see that if unemployment increases in both sectors, average output falls. The output of the average person is $p\bar{E}M_h w_h + (1-p)EM_l w_l$. Since equilibrium requires $EM_h w_h = EM_l w_l$, changes in the proportion of workers applying to each sector have no effect on output. However, a higher unemployment rate means a lower EM_h and EM_l. So average output decline.

It should be evident that had we reversed our assumptions about the relation between the number of firms entering the sector and the cost of entering so that the cost was unaffected by entry in the high-wage sector and equation (13) applied in the low-wage sector, unemployment within each sector would have decreased and welfare increased as a result of the tax/subsidy program. The effect on aggregate unemployment is ambiguous since the policy continues to shift workers to the high-unemployment sector.

In general it is clear that the welfare effects will depend on the elasticity of entry with respect to the tax/subsidy. Without strong priors about how this elasticity varies among sectors, we can make no strong statements about the desirability or lack thereof of subsidizing high-wage employment. Also, other modifications of the model such as worker heterogeneity in aversion to unemployment can lead to different results. Our results should nevertheless sound a note of caution regarding the desirability of policies designed to "capture worker rents."

IV. Heterogeneous Workers

The two-sector model with homogeneous workers is largely uninformative regarding who will be unemployed. The evidence (Clark and Summers, 1979) suggests that much of job search ends with employment in "bad" jobs (short-term jobs) when it does not end in labor force withdrawal.[4] The homogeneous worker model in which employment is concentrated among those seeking high-wage employment is not consistent with the descriptive literature on segmented labor markets. There the emphasis was on the unemployment of disadvantaged workers "confined" to the low-wage sector. To investigate this question, we

[4]Some would say that the evidence suggests that job-seekers are disproportionately bad workers. This distinction is not important for our argument.

need to develop the model for the case where workers are heterogeneous. As will be seen, the results of the model are substantially modified by this change.

To model this formally, we assume that there are two types of workers, both with productivity v. The number of workers of each type (N_1 and N_2) is assumed to be large. Firms pay an entrance fee of d if they wish to advertise for a worker. They can hire only one worker. Firms announce the wage they will pay if they hire a worker. They can observe worker type but cannot condition the wage on the type. Workers observe the wage and apply to a single firm. If more than one worker applies to the firm, the firm chooses randomly among the type 1 workers, and, if there are no type 1 applicants, among the type 2 workers. Thus firms have lexicographical preferences. Equivalently, it is a partial tie-breaking rule. They maximize profits, but for equal profits, they prefer type 1 workers. This is similar to the situation which would arise if there were an infinitesimal productivity difference between the two types, but simplifies the mathematics. Blanchard and Diamond (1990) assume a similar lexicographical preference for workers with shorter unemployment durations. However, because their wage-setting assumptions are quite different, they reach conclusions which differ significantly from ours.

We again consider only the case where all workers of a given type have identical strategies. As in the homogeneous worker models, these strategies are probabilities of applying to firms. Let z_1 and z_2 be the expected number of applicants of type 1 and type 2 at the firm. Given the large number of workers and firms, each firm acts as if its behavior does not affect the behavior of other firms. Similarly workers disregard the effect of their behavior on other workers.

Under these circumstances, firms maximize their profits which are given by

$$\pi = (1 - e^{-(z_1 + z_2)})(v - w) - d \tag{17}$$

subject to

$$(1-e^{-z_1})w/z_1 \leq k_1 \tag{18}$$

and

$$e^{-z_1}(1-e^{-z_2})w/z_2 \leq k_2 \tag{19}$$

and

$$z_1 \geq 0,\ z_2 \geq 0 \tag{20}$$

where k_1 and k_2 are the expected wages for type 1 and type 2 workers if they apply to other firms. Equation (18) is the condition that type 1 workers will apply until their expected wage in the firm is the same as elsewhere. Equation (19) is the equivalent expression for type 2 workers. The additional term reflects the fact that firms will always hire type 1 workers in preference to type 2 workers. Although they are also equilibrium conditions, equations (18) and (19) summarize the strategies of type 1 and type 2 workers in a manner analogous to equation (2).

Claim: There is a sub-game perfect equilibrium with symmetric strategies by all workers of a given type in which some firms offer the optimal wage for the case where there are only type 1 workers and others offer a wage equal to k_1. Only type 1 workers apply to the high-wage firms, and only type 2 workers apply to low-wage firms. The ratio of type 2 workers to low-wage firms is given by

$$z_2 = -\log(1 - d/(v-k_1)). \tag{21}$$

The ratio of type 1 workers to high-wage firms is given by (9).

Proof: We first show that if firms follow the strategies stated above, the workers' strategies constitute an equilibrium of the sub-game. If a type 1 worker deviates and applies to a low-wage job, he receives k_1 with certainty which is equal to his expected wage if he applies to a high-wage job. There is thus no incentive to deviate. A type 2 worker's expected wage is

$$(22) \qquad k_1 (1-e^{-z_2})/z_2 = k_1 d/[(v-k_1)(\log(1-d/(v-k_1)))]$$

where we have used (21) to derive the right-hand-side of the equality.

A type 2 worker who deviates receives

$$(23) \qquad e^{-z_1} w_1 = -k_1^2 \log(k_1/v)/(v-k_1)$$

where we have used (3) and (9).

To see that (22) exceeds (23), note that if (23) were greater than (22), we would have

$$(24) \qquad \log(1-d/(v-k_1))\ k_1\ \log(k_1/v) > d.$$

But the left-hand-side of (24) is less than

$$(25) \qquad d\ (k_1/(v-k_1))\ \log(v/k_1) = d\ \log(v/k_1)/((v/k_1-1)) < d.$$

So deviation will not be optimal for type 2 workers.

We now show that it will not be optimal for firms to deviate from their equilibrium strategies. Both high-wage and low-wage firms make zero expected profit. From section 2, it is obvious that it will not be profitable to offer any other wage which attracts only typel or only type 2 workers. Therefore we

need only show that any wage which attracts both types of workers is not profitable.

Suppose the wage was set so that z_1 and z_2 were both positive. Denote the expected number of applicants by x_1 and x_2. We show that $x_1 + x_2 < z_2$ so that the offer cannot be profitable. Since equations (18) and (19) hold with equality

$$(26) \qquad (1-e^{-z_2})(1-e^{-x_1})/(z_2x_1) = e^{-x_1}(1-e^{-x_2})/x_2.$$

The left-hand-side of (26) is declining in z_2. Therefore a sufficient condition for the offer to be profitable is

$$(27) \qquad (1-e^{-(x_1+x_2)})(1-e^{-x_1})/(x_1(x_1+x_2)) > e^{-x_1}(1-e^{-x_2})/x_2.$$

Rearranging terms gives

$$(28) \qquad (1-e^{-x_2})/x_2 < e^{x_1}(1-e^{-(x_1+x_2)})(1-e^{-x_1})/(x_1(x_1+x_2)) = R.$$

At $x_1 = 0$, (28) holds with equality. The remainder of this part of the proof is a tedious exercise in showing that the derivative of the right-hand-side with respect to $x_1 > 0$.

Taking derivatives gives

$$(29) \quad dR/dx_1 = \{(1-e^{-(x_1+x_2)})/(x_1(x_1+x_2))\}\{(1-e^{-x_1})(2e^{x_1}-e^{x_1}/x_1 - e^{x_1}/(x_1+x_2))+1\}.$$

This will be positive iff the term in square brackets is positive. To determine whether this is positive, note that it is increasing in x_2; we need therefore only verify that

$$(30) \qquad 2e^{x_1}(x_1-1)(1-e^{-x_1})/x_1 + 1 > 0.$$

The left hand side (excluding the + 1) is most negative when $x_1 = 0$ in which case expression (30) holds with equality. For positive x_1, the inequality holds. Therefore inequality (28) holds, and the alternative offer will not be profitable.

It is surprising that large wage differentials can result from small productivity differentials when wages are determined endogenously. The reason is that even if there is only an infinitesimal difference in productivity, firms will always prefer the higher productivity worker if they cannot offer them different wages. High-wage firms will attract large numbers of type 1 workers. Consequently, type 2 workers who apply there will have a low probability of getting a job. To attract type 2 workers, firms would like to commit to hiring them rather than type 1 workers if both types of workers apply. In the absence of such commitments, firms can set a wage that does not attract type 1 workers. Thus an equilibrium arises in which type 1 workers apply to high-wage firms and type 2 workers apply to low-wage firms.

Thus in this example both wages and employment rates are higher for the type 1 workers. It is worth noting that from cross-section data on wages and employment alone, the model is indistinguishable from a standard human capital model with heterogeneous jobs and workers. In a standard hedonic model, wages could be regressed on some measure of worker type such as education, and we would observe a positive return to education. If no measures of worker type were available, we could regress wages on measures of job type. The return to job type would be interpreted as a compensating differential or as a proxy for unobserved worker skill.

Aside from the finite wage differential between the two types of workers, the equilibrium has the interesting feature that vacancy rates are high in

low-wage firms and that the unemployment rate for type 1 workers is higher. Consequently, this model goes only part way towards generating the type of segmentation described in labor market segmentation literature. Equally productive workers have different wages, and those confined to the low-wage sector are worse off. Vacancies are higher in the low-wage sector than in the high-wage sector. However, in contrast with the literature, the model suggests lower not higher unemployment rates for the disadvantaged group.[5]

This last result can be reversed if we are willing to drop the assumption that the two groups are only infinitesimally different in productivity. When type 2 workers are less productive than type 1 workers, equilibria may exist where both types apply to high-wage jobs and only type 2 workers apply to low-wage jobs or where only type 1 workers apply to high-wage jobs and both apply to low-wage jobs.[6] In this case it is easy to generate examples in which the equilibrium corresponds to the descriptive literature. We present two such examples.

First, suppose that type 1 workers produce 2 and type 2 workers produce 1.65. The cost to firms of entering the market is .94. Then the high-wage sector pays .82. Only type 1's apply. They have an employment rate of .5.

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[5]When wages are exogenous, it is easily shown that the concentration of unemployment among applicants to high-wage jobs can be reversed when workers are heterogeneous. Consider the following example. There are two high-wage jobs and three low-wage jobs. Similarly there are two type 1 and three type 2 workers. High-wage jobs pay 2 while low-wage jobs pay 1. It is readily verified than the following is an equilibrium — both type 1 workers apply to the high-wage jobs and all three low-wage workers apply to the low-wage jobs. The employment rate for high-wage applicants is .75 which is higher than the 19/27 (.70) employment rate for low-wage applicants.

[6]Obviously there are some parameter values for which the separating equilibrium will be the unique sub-game perfect equilibrium. There are also parameter values for which there is a unique wage, but these can only arise if type 1 workers and type 2 workers are present in just the right ratio for the given value of d. We conjecture that there are no sub-game perfect equilibria in which both types apply to both types of jobs.

The low-wage sector pays .49. Type 1 workers have an employment rate in this sector of .84 while type 2 workers have an employment rate of .46. Obviously, type 2 workers have a higher overall unemployment rate than do type 1 workers. Moreover, at least to type 1 workers, low-wage jobs seem plentiful. This is reflected in the different vacancy rates — 28% in the low-wage sector and 20% in the high-wage sector. It is worth noting that the wage penalty exceeds the productivity difference. Type 1 workers are less than 25% more productive but their expected wage is almost twice that of type 2 workers.[7]

In our second example, type 2 workers apply to both types of jobs. Type 1 workers continue to have productivity equal to 2 but type 2 workers have productivity equal to 1.60. The parameter d is set equal to 1.19. In this case there is an equilibrium in which high-wage firms pay .5. Type 1 workers have an employment rate of .82 while type 2 workers have an employment rate of .22 in this sector. The wage in the low-wage sector is .32 and the employment rate is .35 for type 2 workers. Thus relative to the high-wage sector, jobs seem plentiful for type 2 workers although, reflecting low vacancy rates (.07 in the low-wage sector and .04 in the high-wage sector), they are not plentiful in an absolute sense. Again both the wage differential between the two sectors and the expected wage differential between the two types of workers are large relative to the productivity differential.

V. Capitalist Exploitation: Splitting the Working Class

One of the recurring themes in Marxist labor economics is that capitalists use various devices to create false distinctions and thus disunity among workers (Bowles, 1985; Roemer, 1979). By generating a hierarchy within

[7]The average wage received by type 1 workers cannot be calculated without assumptions about the relative number of the two types of workers.

the ranks of the working class, capitalists prevent workers from recognizing their common interests. In addition, if the "favored" workers recognize that they are being exploited, they may nevertheless be reluctant to challenge employers or the distinctions out of fear of losing their favored status. One such distinction discussed in the Marxist literature is race (Reich, 1981).

The major difficulty with arguments of this type is that it is often difficult to demonstrate that the division helps capitalists or hurts workers. If firms "buy off" workers from organizing, it is probable that they are helping some workers and hurting others. The workers who are "bought off" must be better off than they expect to be if they resist capitalist exploitation. Thus upward-sloping wage profiles may be a mechanism for ensuring the cooperation of senior workers (Stone, 1975) and may be injurious to the positions of workers as a class and individual workers over their lifetimes. However, senior workers presumably benefit from this policy.

In particular, in most models of discrimination, it is difficult to see how capitalists benefit from the discrimination except from the long run benefit of maintaining their position. Discrimination serves primarily to transfer resources from blacks to whites, thereby buying white cooperation and forestalling worker unity.

In the model in the endogenous wage model of the previous section discrimination is advantageous to capitalists, as a class, in the short run. By dividing previously homogeneous workers such as blacks and whites, capitalists hurt both types of workers in the short run while making themselves better off. Thus dividing the work force can be advantageous even in the absence of a natural tendency towards worker unity in opposition to capitalists.

To see this suppose that blacks and whites are equally productive. In the absence of discrimination, firms would choose randomly among black and

white workers who would, in turn, have equal wages and employment probabilities. Now suppose that firms could collectively agree to give hiring preference to whites. We saw in the last section that in the long run, the equilibrium would involve blacks receiving lower wages and lower expected wages net of unemployment and would not affect the wages of whites. In the long run, free entry drives firms' profits to zero so that the discrimination harms blacks and helps neither white workers nor capitalists.

In the short run, however, before new firms can enter to take advantage of the lower wages paid to blacks, hiring black workers at the lower wage will be profitable. Of course, in the short run equilibrium the expected profit from hiring blacks at low wages and whites at high wages must be the same. Thus hiring whites must be profitable which can only be achieved by lowering their expected wage. The following theorem makes this argument more precise.

Theorem: If the number of firms is fixed at the level determined by the nondiscriminatory equilibrium, firms make positive profits in the discriminatory equilibrium. Workers who are given hiring preference receive lower wages and have a lower employment rate than in the nondiscriminatory equilibrium. Workers who are disfavored in the hiring process, receive lower wages but have a higher employment rate than in the nondiscriminatory equilibrium. Both types of workers have lower expected wages than in the nondiscriminatory equilibrium. Alternatively, if the number of firms is fixed as the number present in the discriminatory equilibrium and firms cease to discriminate, firms earn negative profits

Proof: Since profits in the two sectors must be equal, after agreeing to discriminate against blacks, firms will distribute themselves so that the

expected number of applicants is higher in the high-wage sector than in the low-wage sector and thus higher than in the nondiscriminatory equilibrium in the high-wage sector and lower than in the low-wage sector than in the nondiscriminatory equilibrium. Since the expected number of applicants and the employment rate are negatively related, it follows that the employment rate for favored workers will be lower and the employment rate for disfavored workers will be higher in the discriminatory equilibrium than in the nondiscriminatory equilibrium. Recall from section II that we can treat the expected number of applicants as a choice variable for the firm. From equation (9) choosing a lower expected number of applicants is the discriminatory equilibrium than in the nondiscriminatory equilibrium is consistent with profit maximization by high wage firms only if the expected wage net of unemployment (K) for the favored workers is lower in the discriminatory equilibrium than in the nondiscriminatory equilibrium. From (3) $dw/dK > 0$. Therefore the wage is also lower in the discriminatory equilibrium. Since the disfavored workers receive a wage equal to the expected wage of the favored workers, their wage and expected wage must be lower than in the nondiscriminatory equilibrium.

In the static model we have developed here, the discriminatory equilibrium can only arise by the conscious collective action of the capitalists. However, it is obvious that in a more dynamic model this equilibrium can be supported by appropriate strategies regarding responses to out of equilibrium moves. In particular, a firm would find it advantageous to commit to hiring black workers in preference to white workers. However, if on the next move all firms responded by not discriminating against blacks, the deviating firm would make an expected loss in future periods which might be sufficient to deter it from deviating.

Thus capitalists can use arbitrary divisions among workers to increase their own profits at the expense of all workers. It appears possible to generate this type of equilibrium without resorting to the sort of conspiracy which some people would call cooperative equilibria.

VI. Segmented Labor Markets and the Unemployment Rate

In this section we consider the implications of the segmented labor market model for the aggregate unemployment rate. We consider the case where there are a large number of different cities with free mobility of labor among the cities. In this case the expected wage for type 1 workers must be k_1 and the expected wage for type 2 workers must be k_2 in all cities. Wages and the size of the sectors may differ across the cities because of differences in the productivity of the different types of workers in the cities and because of differing entry costs.

Let the ratio of type 1 workers in low-wage jobs to type one workers in high-wage jobs be α, and the ratio of type 2 workers in low- and high-wage jobs to type 1 workers in high-wage jobs be β and γ, respectively.[8] Then the unemployment rate in the city is given by

$$(31) \qquad \overline{EM} = (EM_{1h} + \alpha EM_{11} + \beta EM_{2h} + \gamma EM_{21})/(1+\alpha+\beta+\gamma)$$

where EM_{ij} is the employment rate of workers of type i in jobs of type j.

The average wage among employed workers in the city is given by

$$(32) \qquad \bar{w} = (EM_{1h}w_h + \alpha EM_{11}w_1 + \beta EM_{2h}w_h + \gamma EM_{21}w_1)/(EM_{1h} + \alpha EM_{11} + \beta EM_{2h} + \gamma EM_{21}).$$

Substituting (32) into (31) gives

$$(33) \qquad \overline{EM} = (EM_{1h}w_h + \alpha EM_{11}w_1 + \beta EM_{2h}w_h + \gamma EM_{21}w_1)/[\bar{w}(1+\alpha+\beta+\gamma)].$$

[8] In general either α or β or both will be zero.

Recalling that the expected wage is k_1 for type 1 workers and k_2 for type two workers regardless of the sector in which they are employed gives

$$(34) \qquad \overline{EM} = (k_1(1+\alpha) + k_2(\beta+\gamma))/[\bar{w}(1+\alpha+\beta+\gamma)].$$

Somewhat surprisingly, the employment (and therefore the unemployment) rate in the city depends only on the average wage in the city and on the fraction of workers who are type 1. In the case of homogeneous workers, the average wage is a sufficient statistic for the unemployment rate. We need information on neither the relative wages in the two sectors nor their relative size. It is worth noting that this result is quite general. We have not made use of the details of our model.

If it were possible to control for α and β, then conditional on these variables, unemployment and the size of the low-wage sector would be positively correlated. Of course, it is not possible to control for α and β but these variables are related to worker heterogeneity within sectors. Using the occupational categories of Carnoy and Rumberger (1980), Orr (1991) has derived estimates of the size of the low and high-wage sectors and the degree of worker heterogeneity within sectors as well as the average wage in a cross-section of U.S. cities. He finds that the unemployment rate is positively correlated with both the average wage and the relative size of the secondary sector.[9]

VII. Segmented Labor Markets and Unemployment: An Assessment

[9]Orr's paper was not developed with our model in mind. None of his variables corresponds perfectly to our theoretical constructs, but his empirical work represents the closest approximation we could find. We are grateful to him for providing us with additional specifications not available in his paper.

There are two types of regularities which a theory of unemployment should account for. In the first place, we are interested in the microeconomics of unemployment — who is unemployed and, in a more dynamic context, the pattern of hazard rates for exit from unemployment. In addition, we are concerned with the macroeconomics of unemployment — what accounts for intertemporal and international variation in the level and duration of unemployment.

In our view the labor market segmentation approach provides a fruitful if underdeveloped approach to accounting for these regularities. The approach remains underdeveloped, because as yet there is no agreed upon approach to segmentation. Economists who work within the labor market segmentation perspective share the view that wages do not adjust to clear the labor market, but this shared perspective allows considerable freedom to approach modelling in different ways. Because of this potential for divergence, we suspect that some economists will believe that we have not really addressed the labor market segmentation perspective. Instead, some will argue that we have developed a model of search unemployment while others will argue that we have developed an efficiency wage model. Both comments would be true, but these approaches are not inconsistent with the labor market segmentation perspective.

What our formal modelling has brought out is the ability of such modelling to generate the relation between low wages and high unemployment which was emphasized in the early literature on segmented labor markets. In most models there is little reason to expect a relation between innate productivity and unemployment. Our model improves on these models since it can generate the desired correlation, but it must be recognized that the opposite correlation can also be generated at least for sufficiently small productivity differences.

In addition, many models predict that unemployment duration and post-employment wages will be positively correlated. While our model is not dynamic and cannot therefore address this question explicitly, the one-period model suggests a more complex relation. In our example where both type 1 and type 2 workers apply to the high wage section, but only type 2 workers apply to the low-wage sectors, the shortest durations would be among the type 1 workers applying to the high-wage sector while the longest durations would be among the type 2 workers applying to this sector.

A natural way to extend the model is to make it dynamic in a manner analogous to Blanchard and Diamond (1990). If we assume that skills deteriorate with unemployment, our model, like theirs, implies negative duration dependence of unemployment. Moreover, higher aggregate unemployment rates would lower the fraction of high quality workers in the labor force and generate hysteresis in aggregate unemployment rates.

In sum, the labor market segmentation approach is a promising avenue for the investigation of unemployment at both the microeconomic and macroeconomic levels.

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TABLE 1

Factor scores

Industry	Factor 1	Factor 2
FOOD	0.56670	-0.03886
BEVERAGES	0.29004	0.20975
TOBACCO	0.24957	0.56074
TEXTILES	1.00276	-0.13598
APPAREL	1.94317	-0.25218
LEATHER	1.29356	-0.24779
FOOTWEAR	1.46189	-0.28176
WOOD PROD	0.92414	-0.25131
FURNITURES	1.00104	-0.34971
PAPER	-0.50041	0.00016
PRINT/PUBL	-0.64398	0.03131
IND CHEM	-0.56831	0.70669
OTHER CHEM	-0.26609	0.75676
REF PETROL	-1.61949	3.97735
COAL/PET PR	-0.97309	1.62394
RUBBER PROD	-0.37961	-0.24478
PLAST PROD	0.35907	0.08102
POTTERY/CHINA	0.23095	-0.06389
GLASS PROD	-0.01511	0.21659
OTHER NIN PR	-0.11155	0.08483
IRON/STEEL	-1.36486	-0.59199
N.FERROUS MET	-1.01851	-0.64635
FABR METALS	0.17669	-0.01273
MACHINERY	-0.21395	-0.15863
ELECT MACH	0.03046	0.18566
TRANSP EQUIP	-0.55172	-0.01614
SCIENTIF EQ	0.34500	-0.01370
OTHER MANUF	0.71655	-0.52841
MINING	-3.02770	-3.11332
CONSTRUCTION	-0.23618	-0.39395
TRANSP/COMM	-0.68521	-0.65663
AGRICULTURE	1.58416	-0.43664