

The Theory and Experience of Economic Development

Essays in Honor of Sir W. Arthur Lewis

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London

GEORGE ALLEN & UNWIN

Boston

Sydney

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George Allen & Unwin (Publishers) Ltd,
40 Museum Street, London WC1A 1LU, UK

George Allen & Unwin (Publishers) Ltd,
Park Lane, Hemel Hempstead, Herts HP2 4TE, UK

Allen & Unwin, Inc.,
9 Winchester Terrace, Winchester, Mass. 01890, USA

George Allen & Unwin Australia Pty Ltd,
8 Napier Street, North Sydney, NSW 2060, Australia

First published in 1982

British Library Cataloguing in Publication Data

The Theory and experience of economic development.

1. Lewis, *Sir W. Arthur* 2. Economic
development – Addresses, essays, lectures
I. Gersovitz, Mark II. Lewis, *Sir W. Arthur*
330.9 HD82

ISBN 0-04-330323-4

Library of Congress Cataloging in Publication Data

Main entry under title:

The Theory and experience of economic development.

1. Economic development – Addresses, essays, lectures.
2. Economics – Addresses, essays, lectures. I. Gersovitz,
Mark. II. Lewis, W. Arthur,
(William Arthur), 1915–
HD82.T47 338.9 82-3910
ISBN 0-04-330323-4 AACR2

Set in 10 on 12 point Times by Pintail Studios Ltd, Ringwood, Hampshire
and printed in Great Britain by Mackays of Chatham

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Alternative Theories of Wage Determination and Unemployment: the Efficiency Wage Model

JOSEPH E. STIGLITZ

Introduction

Wages in different sectors (different locations, industries, or firms) have been observed to differ markedly from one another. This may be because the quality of labor in the different sectors differs; but it may also be the case that a worker of a given quality who happens to obtain a job in one sector (firm) will obtain a higher wage than a similar individual who obtains a job in another sector. In conventional competitive equilibrium theory, such a situation could not persist; the fact that it does requires explanation and its consequences – in particular, the unemployment to which it gives rise – need to be taken into account in any analysis of policy. That is the purpose of this chapter.

I focus my discussion on the wage differentials existing between urban and rural sectors in a less developed economy, partly because this provides a setting in which these wage differentials and their consequences are so evident. But it should be apparent that most of what I say is, with minor modifications, applicable to labor markets in developed economies as well.

The basic argument of this chapter is that it pays firms to pay higher wages, because higher wages, up to a point, lead to lower labor costs; the 'optimal' wage may differ in different sectors, leading different sectors to pay different wages.¹ Although the alternative theories presented have this much in common, they differ in the explanation of why higher wages lead to lower labor costs: at least three views suggest themselves:

- (1) higher wages lead to lower quit rates;²
- (2) higher wages lead to greater productivity on the job;
- (3) higher wages lead the firm to obtain a higher-quality labor force.

For convenience, I shall refer to the first as the 'labor-turnover model' (or hypothesis), the second as the 'efficiency wage-productivity model' and the third as the 'efficiency wage-quality' model.

It is important to distinguish among these alternative reasons, because the effect of various governmental policies (for instance, wage subsidies) may depend critically on what determines the level of wages. In particular, I showed in Stiglitz (1974c) that earlier discussions in the development literature may have led to seriously misleading conclusions concerning the desirability of wage subsidies and the relationship between the urban wage and the shadow price of labor. These earlier studies contended that because there was unemployment in the urban sector ('surplus labor'), the opportunity cost of hiring an additional worker was zero.³ They ignored the effect of the policy on the wages paid in the urban sector and on the induced migration from the rural to the urban sector and the consequent unemployment. In the simplest model I showed that, if the unemployment rate remained unchanged, then the opportunity cost of hiring laborers was precisely the urban wage. The desirability of various governmental policies depended critically on what effect they had on the unemployment rate; this in turn was determined by the urban-rural wage differential. Whether, for instance, a wage subsidy raises the urban wage (thus increasing the unemployment rate) depends critically on whether the wage subsidy is 'shifted' in the sense that some part of the benefits accrue to the workers in the form of higher real wages; and whether the wage subsidy is shifted depends critically on one's theory of the determination of wages and the form which the wage subsidy takes. For example, for the labor-turnover model, I showed that an *ad valorem* wage subsidy is partially shifted, leading to higher unemployment rates. The shadow price of labor is, however, just equal to the urban wage. The results presented here are equally destructive of much of the folklore of development economics, but differ markedly from those of the 'labor turnover model':

- (1) In the efficiency wage-productivity model, an *ad valorem* wage subsidy leaves the wage unaffected, and the optimal wage subsidy is $1/(1 + \xi)$, where ξ is the elasticity of labor supply to the urban sector.
- (2) In the efficiency wage-productivity model, the opportunity cost of a laborer employed by the government is equal to $w_u \xi / (1 + \xi)$, where w_u is the urban wage. If, as is conventionally postulated, there is a very elastic supply of laborers from the rural sector to the urban sector (as there would be if the urban sector is very small), then the optimal *ad valorem* subsidy is small and the opportunity cost is approximately equal to the urban wage.
- (3) If the government directly controlled the manufacturing sector, it would pay exactly the same wage as the market economy does, but would hire more laborers.
- (4) A technical improvement which, at each level of wages increases the productivity of a worker, could not only lead to greater unemployment, but also lower national output.
- (5) In the efficiency wage model with capital mobile between the sectors, the shadow price of labor is less than the urban wage. Similarly, the impos-

ition of a wage subsidy lowers the unemployment rate and raises net national income. These results should be contrasted with those obtained in the labor-turnover model, where we established that a wage subsidy would increase the unemployment rate.

- (6) In the efficiency–quality model, the wage paid in the market economy is too high; if the productivity of the marginal migrant exceeds that of the average migrant, the level of employment is too low, but in the converse case, the level of employment is too high. To correct these distortions, requires a specific wage *tax* combined with an *ad valorem* wage subsidy.
- (7) In the efficiency–quality model, the opportunity cost of hiring an additional worker may be either greater, or less, than the urban wage.
- (8) Although the opportunity cost of the government's hiring additional laborers exceeds that conventionally assumed in the literature, the distributional implications are less significant. Consequently, the effect on investment is smaller. For instance, in the case of an infinitely elastic labor supply schedule to the urban sector, additional urban employment may have no effect at all on aggregate consumption.

Whether one believes the precise assumptions employed in the models presented here, they do cast considerable doubt on the widespread presumption that shadow prices for labor are considerably less than the urban wage and that as a consequence wage subsidies are desirable.

The Efficiency Wage–Productivity Model

The Basic Model

It is often argued that the efficiency of a worker is an increasing function of the wage he receives;⁴ we let $\lambda(w)$ represent the efficiency of a worker receiving a wage w , and we assume that λ has the shape depicted in Figure 6.1: initially there are increasing returns to increasing the wage, but eventually diminishing returns sets in.

There are several alternative explanations of why efficiency (productivity) should increase with the wage; in very poor LDCs, nutritional considerations are probably dominant, but in more developed economies, morale and incentive effects are undoubtedly important.⁵

Firms pay a wage which minimizes labor costs per efficiency unit,⁶ that is,

$$\min_{\{w\}} w/\lambda(w).$$

This implies that

$$\lambda'(w^*) = \lambda(w^*)/w^*. \quad (6.1)$$

The solution to equation 6.1 is referred to as the *efficiency wage* (see

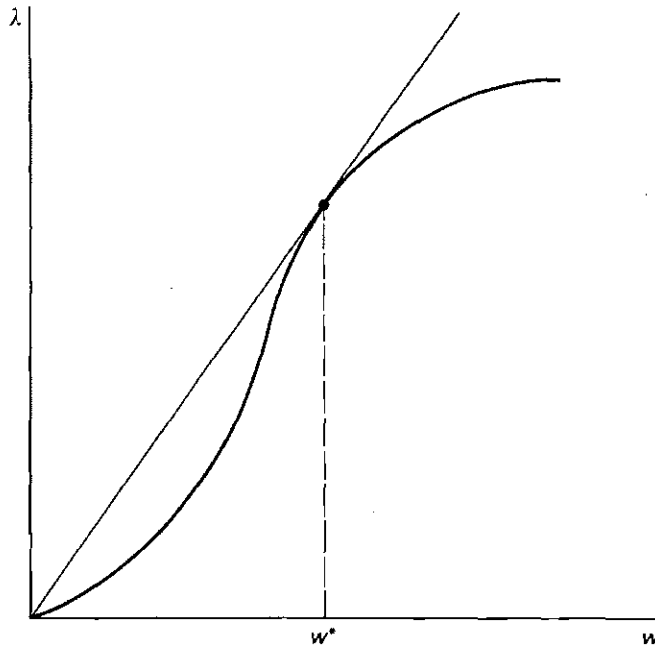


Figure 6.1 *Efficiency wage.*

Figure 6.1). Efficiency wage considerations may be important in both the rural and urban sectors; but there is no reason that the efficiency–wage function should be the same in the two sectors (since the nature of the work performed is so different, as are the environmental factors which affect the effect of wages on productivity). Thus, the wages paid in the two sectors may differ markedly. Here, we simplify by assuming that efficiency is independent of the wage in the rural sector.⁷

Let Q_u and Q_r be output in the urban and rural sectors, respectively; output in each sector is a function of the labor inputs,

$$Q_u = F(\lambda(w)L_u), \quad F' > 0 \quad F'' \leq 0 \quad (6.2)$$

and

$$Q_r = G(L_r) \quad G' > 0 \quad G'' \leq 0 \quad (6.3)$$

where L_u and L_r are employment in the urban and rural sectors, so $\lambda(w)L_u$ is the effective labor supply in urban employment.

We assume that the country in question is a small country, trading both urban and rural output at international prices; we normalize our units so the price of each is unity.⁸

The wage in the rural sector is just equal to (the value of) its marginal product,⁹

$$w_r = G'(L_r) \quad (6.4)$$

and similarly, in the urban sector,

$$w_u = \lambda(w)F'(\lambda(w)L_u). \quad (6.5)$$

But as we noted earlier, the urban wage is just the efficiency wage

$$w_u = w^*. \quad (6.6)$$

Finally, we must describe how labor becomes allocated between the urban and rural sectors. We let \bar{L} be the total labor supply, N_u the total number of job-seekers in the urban sector and U the unemployment rate; then

$$L_r + N_u = \bar{L} \quad (6.7)$$

and

$$1 - U = L_u/N_u. \quad (6.8)$$

Under a variety of assumptions concerning the hiring behavior of firms and migration decisions of individuals, it can be shown that migration equilibrium requires that the expected wage in the urban sector equals the wage in the rural sector. The expected wage is just equal to the nominal wage times the probability of being hired, L_u/N_u ¹⁰:

$$w_u^e = (1 - U)w_u = \frac{L_u w_u}{N_u} = w_r. \quad (6.9)$$

We can now describe the equilibrium. Given the efficiency wage w^* , equation 6.5 determines the demand for labor in the urban sector L_u^* :

$$L_u^* = \frac{1}{\lambda(w^*)} F'^{-1}(w^*/\lambda(w^*)). \quad (6.10)$$

Substituting equations 6.4 and 6.7 into 6.9, we obtain

$$G'(\bar{L} - N_u)N_u = w^*L_u^* \quad (6.11)$$

which can be solved uniquely for N_u (or equivalently L_r).

Comparative Statics

In this section we consider briefly the effect of a number of changes in the parameters of the model on the equilibrium. First, note that an increase in the

labor supply \bar{L} has no effect on the urban wage, but does lead both to a lower rural wage (if there is diminishing returns to labor), and a higher unemployment rate. Secondly, an increase in the capital stock in the urban sector, which would lead to an increase in urban employment, will lead to a lower level of unemployment, a lower unemployment rate and a higher rural wage. Similarly, a change which leads to higher agricultural productivity, and a higher wage in the rural sector, will lower the unemployment rate but still leave the urban wage and urban employment unchanged.

Consider now what happens if the efficiency wage-productivity relationship should change. Labor could become more efficient at every wage rate (say, as a result of better schooling or a labor-augmenting technical innovation), but the efficiency wage could be increased; this would lead to an increase in the unemployment rate. Let us decompose a (small) change in the wage-productivity relationship into a change in the productivity, keeping the efficiency wage fixed, and a change in the efficiency wage, keeping productivity fixed.

Differentiating equation 6.5 with respect to λ , holding w^* fixed, we obtain

$$\left. \frac{\lambda}{L_u} \frac{\partial L_u}{\partial \lambda} \right|_{w^*} = \eta_u - 1 \quad (6.12)$$

where $\eta_u = -F'/F''\lambda L_u$ = the elasticity of demand for labor in the urban sector. Thus, an increase in productivity leads to a decrease or increase in demand for labor as the elasticity of demand is less than or greater than unity.

The effect of this on *unemployment* can be directly calculated from equation 6.11, which we rewrite for convenience as

$$xG'(\bar{L} - L_u x) = w^* \quad (6.13)$$

where $x = 1/(1 - U)$. Then

$$\begin{aligned} \frac{\partial \ln x}{\partial \ln L_u} &= \frac{x^2 G''}{G' - x L_u G''} \frac{L_u}{x} \\ &= -1/[(L_r \eta_r / N_u) + 1] = -\frac{1}{1 + \xi} \end{aligned} \quad (6.14)$$

(using equation 6.9) where $\eta_r = -G'/G''L_r$ = elasticity of demand for labor in the rural sector and $\xi = d \ln N_u / d \ln w_u^e$ = elasticity of supply of laborers to the urban sector. Thus, the unemployment rate is increased or decreased depending on whether urban employment is increased or decreased, in other words, depending on whether the elasticity of demand for labor is greater or less than unity. For a Cobb-Douglas production function $\eta_u > 1$, so a technical improvement always leads to increased employment, a higher unemployment rate and a larger number of unemployed individuals.

As a result of the increased unemployment rate, a technical change could actually make the economy worse off. Let Q be total national output:

$$Q = Q_u + Q_r \quad (6.15)$$

Then, recalling that $Q_r = G(\bar{L} - L_u x)$

$$\begin{aligned} \left. \frac{\partial Q}{\partial \lambda} \right|_{w^*} &= F' L_u + \left(F' \lambda - \frac{G'}{1-U} \right) \frac{dL_u}{d\lambda} - G' L_u \frac{dx}{d\lambda} \\ &= \frac{w_u L_u}{\lambda} \left(1 + \frac{\eta_u - 1}{1 + \xi} \right) > 0 \end{aligned} \quad (6.16)$$

where we have made use of the migration equilibrium condition (so $F' \lambda = G' / (1 - U)$) and equations 6.12 and 6.14. At a fixed wage, technical change increases national output.

The effect of a change in the efficiency wage w^* , keeping $\lambda(w)$ constant (at the efficiency wage), is more easily analyzed. Again, differentiating 6.5, we obtain

$$\left. \frac{w^*}{L_u} \frac{\partial L_u}{\partial w^*} \right|_{\lambda} = -\eta_u \quad (6.17)$$

and from equation 6.13

$$\frac{w^*}{1/1-U} \frac{d(1/1-U)}{dw^*} = \frac{\partial \ln x}{\partial \ln L_u} \frac{\partial \ln L_u}{\partial \ln w^*} + \frac{\partial \ln x}{\partial \ln w^*} = \frac{\xi + \eta_u}{1 + \xi} > 0. \quad (6.18)$$

As a result

$$\left. \frac{dQ}{dw^*} \right|_{\lambda^*} = \left(F' \lambda - \frac{G'}{1-U} \right) \frac{\partial L_u}{\partial w^*} - G' L_u x \frac{d \ln x}{dw^*} = -L_u \frac{\xi + \eta_u}{\xi + 1} < 0 \quad (6.19)$$

an increase in the efficiency wage leads to a lowering of national income.

A technical change will always lead to a lowering of labor costs, that is, of $w^*/\lambda(w^*)$, but may be associated with either a lower or a higher efficiency wage. Thus, any particular technical change may be associated with either an increase or decrease in unemployment, unemployment rate and national output.

Second-Best Optimality

We now compare the market equilibrium, already depicted, with the equilibrium which would emerge were the government to control the wage rate

and urban unemployment; we assume, however, that the government cannot control migration, and it is for this reason that we call the equilibrium a second-best optimum. We assume also that the government is interested in maximizing national income, that is,

$$\max_{\{L_u, N_u, w\}} Q = F(\lambda(w)L_u) + G(\bar{L} - N_u)$$

subject to the migration constraint, that

$$N_u G'(\bar{L} - N_u) = L_u w. \quad (6.20)$$

Straightforward calculations yield the result that

$$\lambda'(w^0) = \lambda(w^0)/w^0$$

and

$$F'\lambda = \frac{w^0 \xi}{1 + \xi}.$$

The government would, in fact, pay the efficiency wage – the same wage that the private market pays – but it would hire laborers up to the point where the marginal product of labor equals the urban wage times $\xi/(1 + \xi)$. *If the elasticity of labor supply to the urban sector is very large, then the market economy is approximately a second-best optimum.*

Calculation of Opportunity Cost of Labor

What is the consequence of the government hiring one additional laborer (in a situation where it does not directly control urban employment in the private sector)? Let L_g be government employment. The only modification to the model already presented is that we now write the migration equilibrium condition as

$$(L_u + L_g)w^* = G'(\bar{L} - N_u)N_u$$

where it is now understood the L_u refers to employment in the private urban sector. Since government employment will leave unaffected L_u and w^* , we have

$$\frac{dN_u}{dL_g} = \frac{w^*}{-G''N_u + G'} = \frac{w^*\xi}{G'(1 + \xi)} = \frac{\xi}{(1 - U)(1 + \xi)}$$

so that the opportunity cost of hiring one additional laborer is

$$-\frac{dQ}{dL_g} = \frac{w^*\xi}{(1 - U)(1 + \xi)} = \frac{w_u \xi}{1 + \xi}.$$

Again, if the elasticity of labor supply to the urban sector is large, then the opportunity cost is approximately the urban wage.

Ad Valorem Wage Subsidy

The equilibrium described in the section on second-best optimality can be attained in a private-market economy by the imposition of an *ad valorem* wage subsidy. An *ad valorem* wage subsidy leaves the wage rate unaffected, since

$$\min \frac{w}{\lambda(w)}$$

has exactly the same solution as

$$\min(1 - \tau) \frac{w}{\lambda(w)}$$

where τ is the *ad valorem* subsidy. The subsidy does lead firms to hire more workers:

$$\lambda F' = w_u(1 - \tau)$$

from which we immediately infer that

$$1 - \tau = \frac{\xi}{1 + \xi}$$

or

$$\tau = \frac{1}{1 + \xi}.$$

The Efficiency–Wage Quality Model

Firms often claim that they pay high wages as a means of recruiting a higher-quality labor force.¹¹ In a world of perfect information, firms would be unconcerned about the quality of labor: an individual who was twice as productive would receive twice the wage and there would be no gain to the firm. But with imperfect information, this is no longer true. However, the social returns from a firm in the urban sector obtaining a higher-quality labor force are very different from the private return; the social returns (the increase in national output) only arise from the sorting out of individuals according to

comparative advantage, that is, in having workers who have a comparative advantage in urban employment working in the urban sector. If there is imperfect information, wages may not accurately reflect opportunity costs of the marginal individual hired in the urban sector. The firm is only concerned with the relation between the wages it pays and the quality of labor it obtains, not with opportunity costs and comparative advantage. As a result, the market economy is likely not to be efficient.

The model¹² we analyze in this section is very similar to that presented in the previous section, except now the quality (productivity) of those employed in the urban sector depends on the mix of those applying for jobs. For the i th firm, this depends on the wage it offers w_i ; the wage offered by other firms \bar{w} and the total number of job-seekers N_u :

$$\lambda_i = \lambda(w_i, \bar{w}, N_u). \quad (6.21)$$

For a given value of N_u and \bar{w} , λ_i is assumed to have the shape of Figure 6.1. The important assumption of the analysis is that any firm cannot identify who is more productive, who is less productive: all that it knows is the *average* quality mix of those who apply for a job (or who accept a job) paying a wage w . On the other hand,

$$\frac{\partial \lambda_i}{\partial \bar{w}} < 0.$$

If other *urban* firms increase their wage, relative to the given firm, the workers it succeeds in recruiting will be less productive.

Each firm is sufficiently small that it ignores its effects on N_u and \bar{w} and hence, just as in the previous section, chooses its wage to

$$\min_{\{w\}} w/\lambda \quad (6.22)$$

so

$$\lambda_{w_i}(w_i, \bar{w}, N_u) = \lambda_i/w_i. \quad (6.23)$$

In equilibrium, of course, if all urban firms have the same λ_i function and pay the same wage,¹³

$$w_i = \bar{w}.$$

For simplicity, we write

$$\bar{\lambda}(w, N_u) \equiv \lambda_i(w, w, N_u)$$

where we write

$$\bar{\lambda}_w = \partial\lambda_i/\partial w_i$$

and

$$\bar{\lambda}_w^* = \frac{\partial\lambda_i}{\partial w_i} + \frac{\partial\lambda_i}{\partial \bar{w}}$$

Where there is no ambiguity, we drop the subscripts on w_u . Equilibrium in this economy is, thus, fully described by the three following equations.

(a) Firms choose a wage to minimize labor costs:

$$\bar{\lambda}_w(w_u, N_u) = \bar{\lambda}(w_u, N_u)/w_u \quad (6.24)$$

(b) Firms hire workers to the point where the wage equals the value of the marginal product:

$$\bar{\lambda}(w_u, N_u)F'[\bar{\lambda}(w_u, N_u)L_u] = w_u \quad (6.25)$$

(c) Workers migrate to equate the expected urban wage to the rural wage:

$$w_r N_u = w_u L_u \quad (6.26)$$

Here w_r is the (rural) wage of the *marginal* migrant. We assume, in other words, that the marginal migrant assumes that he has a chance of obtaining employment equal to the average applicant; this is consistent with our hypothesis that the firm is unable to differentiate among those workers who apply to it.

Equations 6.24–6.26 are three equations in the three unknowns, w_u , L_u and N_u . We depict the solution diagrammatically in Figure 6.2. Differentiating equation 6.24, and using the second-order condition we see that¹⁴

$$\frac{d\ln w_u}{d\ln N_u} = \left(\frac{\bar{\lambda}_{N_u} N_u}{\bar{\lambda}} - \frac{\bar{\lambda}_{w N_u} N_u}{\bar{\lambda}_w} \right) / \left(\frac{\partial^2 \lambda_i / \partial w_i^2 + \partial^2 \lambda_i / \partial \bar{w} \partial w_i}{\bar{\lambda}_w} + \frac{1}{\bar{\lambda}} \frac{\partial \lambda_i}{\partial \bar{w}} \right) w_u < 0 \quad (6.27)$$

provided

$$\bar{\lambda}_{w N_u} \leq 0 \quad (6.28)$$

and

$$\bar{\lambda}_{N_u} \geq 0 \quad (6.29)$$

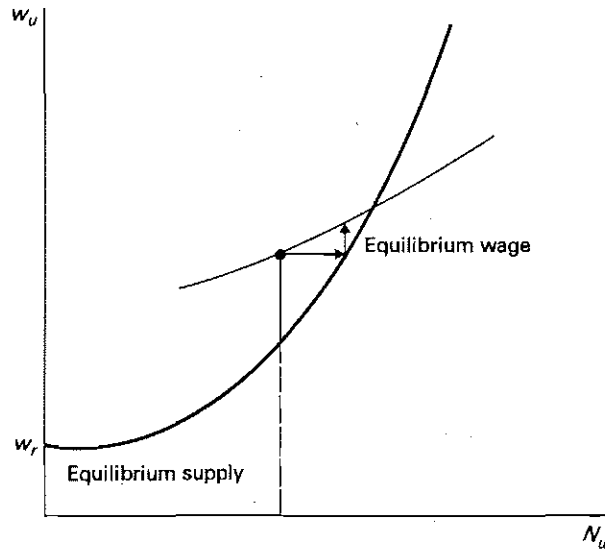


Figure 6.2 *Equilibrium in the efficiency-wage quality model.*

that is, increased urban migration not only increases average productivity in the urban sector (since the most marginal workers are those who migrate first) but also reduces the marginal return to increasing the wage. (Later, we shall present a simple model which satisfies inequalities 6.28 and 6.29.) If inequalities 6.28 and 6.29 are satisfied, as N_u increases, the equilibrium wage rises.

On the other hand, from 6.25 and 6.26,¹⁵ assuming for simplicity that w_r is constant,

$$\frac{d \ln N_u}{d \ln w_u} = \frac{(1 - 1/\eta_u)(1 - \bar{\lambda}_{w_u}^* w_u / \bar{\lambda})}{(1 - 1/\eta_u) \bar{\lambda}_{N_u} N_u / \bar{\lambda} - 1/\eta_u} \quad (6.30)$$

At w_u^* (the solution to 6.24), the numerator has the sign of $1 - 1/\eta_u$. (Since $\lambda_{w_u}^* = \frac{\partial \lambda_i}{\partial w_i} + \frac{\partial \lambda_i}{\partial \bar{w}}$ and $\frac{\partial \lambda_i}{\partial w_i} = \lambda/w$; from 6.28, $\frac{\partial \lambda_i}{\partial \bar{w}} < 0$.) The sign of the denominator is ambiguous. If a firm hires an additional worker, it induces migration and, under our assumptions, this increases the average productivity of those applying for jobs. Hiring an additional worker reduces the value of the marginal product of labor, but the indirect effect may partially offset this. Equations 6.25 and 6.26 together can be thought of as the supply function of laborers to the urban sector; given each value of w_u , it represents the equilibrium allocation of laborers between the urban and rural sector. As we increase w_u from a low level, we increase the productivity of workers in the urban sector by more than the wage increment, so that the cost of an effective labor unit is reduced. Thus, provided the elasticity of demand for labor is

greater than unity, the number of individuals hired in the urban sector increases; moreover, the increase in w_u increases the unemployment rate, so total urban population increases even more rapidly. The equilibrium is depicted in Figure 6.2. The natural dynamics implies that, for stability, the equilibrium wage equation is flatter than the equilibrium labor-supply function to the urban sector.

Second-Best Optimality

The market equilibrium differs from what the government would have done both in the number of workers hired, and in the wages paid. We assume, as before, that the government wishes to maximize national income. Since some of the workers who apply for jobs and obtain them are infra-marginal, the opportunity cost of labor will, in general, be less than the wage. We let $\bar{B}(N_u)$ represent the mean opportunity cost of those applying for an urban job when there are N_u urban job-seekers. Clearly, individuals will not apply unless the urban expected wage exceeds the rural wage, so

$$\bar{B}(N_u) \lesseqgtr w_u^e = w_r \quad (6.31)$$

as the marginal migrant's opportunity cost is greater or less than that of infra-marginal migrants. Moreover, as we raise the urban wage and induce more migration, we induce more productive workers to migrate from the rural sector. Thus

$$\bar{B}'(N_u) > 0. \quad (6.32)$$

Maximizing net national output then entails

$$\max_{(L_u, N_u, w_u)} F(\bar{\lambda}(w_u, N_u)L_u) - \bar{B}(N_u)N_u \quad (6.33)$$

subject to the constraint that

$$N_u w_r = L_u w_u \quad (6.34)$$

The first-order conditions yield

$$\frac{w_r F' \bar{\lambda}}{w_u} - (\bar{B} + \bar{B}' N_u) + L_u F' \left(\bar{\lambda}_{N_u} + \bar{\lambda} \frac{w_r'}{w_r} \right) = 0 \quad (6.35)$$

$$L_u F' \left(\bar{\lambda}_w^* - \frac{\bar{\lambda}}{w_u} \right) = 0. \quad (6.36)$$

To see more clearly the contrast between the market equilibrium and the

second-best optimum, we rewrite 6.35 and 6.36 as

$$F'\bar{\lambda}/w_u = \frac{(\bar{B} + \bar{B}'N_u)/w_r}{1 + \bar{\lambda}_{N_u}N_u/\bar{\lambda} + w'_rN_u/w_r} \quad (6.37)$$

$$\frac{\bar{\lambda}_w^*}{\bar{\lambda}} w_u = 1. \quad (6.38)$$

There are three important differences between the market and the second-best optimum:

- (1) The market takes the cost of labor in the urban sector as w_u ; the government recognizes that this is an overstatement of the opportunity cost of workers hired.
- (2) The market ignores the fact that as it hires more workers, it induces more migration, and this tends to increase the average quality of those applying to itself and all other firms and increases the *average* opportunity cost of the migration.
- (3) In the market economy, each firm takes the wages of other firms as given; thus, the quality of workers it obtains depends in part on its wage relative to the wages paid by other urban firms. The government, on the other hand, is concerned with the effect of the general level of urban wages on the quality of the work force. Thus, in determining the optimal wage, in the symmetric case, the government sets

$$\frac{\partial \lambda_i}{\partial w_i} + \frac{\partial \lambda_i}{\partial \bar{w}} = \lambda_i/w \quad (6.39)$$

while the firm sets

$$\frac{\partial \lambda_i}{\partial w_i} = \lambda_i/w. \quad (6.40)$$

From equation 6.38, it is thus clear that, at any given level of N_u , the market sets the wage too high, except in the limiting case where $\partial \lambda_i / \partial \bar{w} = 0$. There is some presumption, moreover, that at each level of wages, the market hires too few workers. Since the opportunity cost is less than the wage, the numerator of the left-hand side of 6.37 is less than (or equal to) unity, provided B' is not too large; moreover, the denominator is greater than unity, because migration raises both w_r and λ . Under our assumptions, increasing the number of job-seekers increases their average quality and increases the rural wage. It is clear, of course, that it is possible that there may be excessive employment in the urban sector, if for instance the initial migrants are those who are most skilled

in the urban sector. This would be the case, if those who had the lower rural wages were the most skilled in the urban sector (an unlikely situation); or if those for whom the effective costs of migration were the lowest, were those most adapted to urban life and therefore had the highest productivity in the urban sector.

To obtain more precise results, we need to make explicit assumptions about the characteristics of the population. Assume a fraction $H(b)$ have a rural productivity coefficient less than b . Thus, if the least productive workers migrate,¹⁶ rural output when a fraction $H(\hat{b})$ of the population has migrated is

$$Q_r = G \left(\left(\int_{\hat{b}}^{\infty} bh(b) db \right) L \right) \quad (6.41)$$

where $h = H'$, and

$$\bar{L}H(\hat{b}) = N_u. \quad (6.42)$$

The wage of the marginal worker is

$$w_r = G' \mid \hat{b}. \quad (6.43)$$

For the subsequent discussion, we shall assume G' is constant, and we choose our units so it equals unity. (The more general case is a straightforward extension.) Thus,

$$B(N_u) = \int_0^{\hat{b}} bh(b) db / H(\hat{b}). \quad (6.44)$$

Straightforward calculations¹⁷ establish that

$$B + B'N_u = w_r. \quad (6.45)$$

Although the opportunity cost of the set of workers hired by any firm is less than the wage paid, the opportunity cost of the *marginal* individual induced to migrate to the urban sector is the rural wage. Thus, under these conditions, the market always leads to underemployment in the urban sector. The precise calculation of the magnitude of the bias depends on the specification of the λ_i function.

The derivation of the λ_i function is fairly complicated. We illustrate it with a simple example. Let us postulate that the productivity of a worker at the i th firm depends both on his general ability at urban jobs, and how well-matched his specific abilities are to the requirements of the job. The latter, in turn, depends on the size of the applicant pool, among which the firm has to choose. For simplicity, let us assume that individuals can only apply to one job, are risk-neutral, know the wages offered by the firm before they apply, but do not

know how well their skills match the requirements of the firm until after they apply. The queues at each firm will then adjust, so that the expected wage from applying to each firm is identical:

$$w_i^e = \frac{L_i}{N_i} w_i \quad (6.46)$$

where L_i is the number of jobs offered by the firm, N_i the number of applicants at the i th firm. The average *general* ability of those applying at all firms is the same. If the individual with productivity b in the rural sector has a general ability of a in the urban sector, the average general ability of those applying in the urban sector is just

$$A(N_u) = \int_0^{\hat{b}} a(b)h(b)db/H. \quad (6.47)$$

For simplicity, let us assume that we can represent total ability as simply the product of general ability and specific ability. Specific ability depends on the size of the applicant pool (per job). Since

$$w_i^e = w_j^e \quad (6.48)$$

from 6.46, this implies that specific ability is just a function of w_i/w_r , where w_r is the rural wage of the *marginal* migrant, that is,

$$w_r = \hat{b}.$$

We, thus, write

$$\lambda_i = A(N_u)\phi(w_i/\hat{b}). \quad (6.49)$$

It is immediate that the market will, for each value of N_u , set the correct wage. However,¹⁸

$$F'\lambda \gtrless w_u \quad \text{as } A \gtrless a \quad (6.50)$$

that is, as the average ability of those applying is greater or less than the marginal ability. If productivity in the urban and rural sectors are positively correlated, then since the marginal migrant's productivity in the rural sector exceeds that of the average, so too in the urban; thus, the marginal return to hiring workers in the urban sector exceeds the average return. On the other hand, if the marginal migrant's productivity is less than that of the average, just the converse holds.

Note that because the level of employment changes, the actual wage paid in the second-best optimum will differ from that in the market solution; in

particular, in our example, if productivities are positively correlated, then the optimal wage will exceed the market wage. The market rate of unemployment will, however, be optimal.

On the other hand, with an additive specification of the productivity function

$$\lambda_i = A + \phi$$

if urban and rural productivities are positively correlated, the market unemployment rate can easily be shown to be too high.

Although in this simple example, the market wage, for each level of employment, is optimal, it is easy to modify the productivity function to show that, in general, it will be too high. Assume, for instance, that workers apply to several firms. The number of applicants (per job) at each firm will still be a function of the wage paid. Now, however, some of the individuals who are found to have the specific skills that are well suited for the given firm will also receive offers from other firms. Thus, the fraction of offers which the firm makes which are accepted will be a function of the wage it offers, relative to the wages offered by other firms. (If different workers have different evaluations of the nonpecuniary characteristics of the firm, this function will be a smooth one; by raising its wages slightly over that of its competitors, it will not, in fact, induce all workers to accept its offers.) Thus, if

$$g(w_i/\bar{w})$$

is the percentage of offers accepted, we can write the productivity function as

$$A\phi[(w_i/b)g(w_i/\bar{w})].$$

Now, firms believe that increasing the wage has two effects: it increases the length of the queue and it increases the probability of acceptance; but the latter gain is only at the expense of other firms. The government (in the symmetric equilibrium) takes $w_i = \bar{w}$.

Government Policies

It is clear from equations 6.37 and 6.38 that to induce firms to behave optimally, the government must use both *ad valorem* and specific wage taxes/subsidies. In particular, to induce firms to lower the wage, it imposes a specific wage subsidy and then, to induce firms to hire more workers, it provides an *ad valorem* wage subsidy (the latter, as before, leaves the wage paid unchanged).

The shadow price of labor may be calculated (using 6.33) by noting that (from 6.34)

$$L_u = \frac{N_u w_r}{w_u} - L_g. \quad (6.51)$$

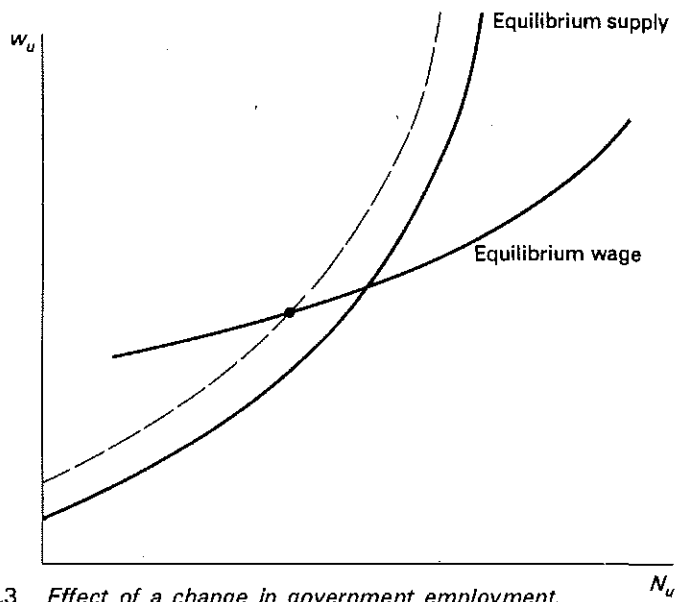


Figure 6.3 Effect of a change in government employment.

Differentiating $F - \bar{B}N_u$ and using 6.34 and 6.51 we obtain

$$-\frac{d(F - \bar{B}N_u)}{dL_g} = w_u + F'\lambda_u \frac{d(w_r/w_u)}{dL_g} + F' \frac{d\bar{\lambda}}{dL_g}.$$

If w_r/w_u remained unchanged (so the unemployment rate was unaltered), and if the mean productivity of those hired in the urban sector were unchanged, then the shadow wage would just equal the urban wage.

Turning to Figure 6.3 we note that a change in L_g leaves unaffected the equilibrium-wage curve (equation 6.24) but shifts the equilibrium labor-supply function. At a given level of N_u , if the elasticity of demand for labor exceeds unity, an increase in L_g necessitates an increase in w_u for 6.25 to hold. As a result, the equilibrium level of N_u and the equilibrium level of w_u fall. However, if the efficiency wage is not very sensitive to N_u , then the unemployment rate falls. Moreover, the decrease in N_u leads to a decrease in $\bar{\lambda}$. Hence, there would appear to be some presumption that the shadow wage is less than the urban wage, although perhaps not significantly so. Moreover, if the elasticity of demand for labor is less than unity, precisely the same arguments lead to the conclusion that the shadow price of labor exceeds the urban wage.

Capital Mobility

The basic principle of second-best economics – that a distortion in one market has important ramifications in other markets – is sufficiently widely known

that it should come as no surprise that it is in general desirable to impose taxes and/or subsidies on capital in the different sectors. Moreover, the shifts in the allocation of capital induced by, say, the government's hiring one more worker in the urban sector, have secondary effects on the allocation of labor which may be sufficiently large to affect the shadow price of labor in a significant way. The detailed calculations of the shadow prices and optimal taxes and subsidies are elaborate, so we only illustrate the methodology for the case of the efficiency-productivity wage model.

Equilibrium

We assume a constant return to scale production function in the urban sector¹⁹

$$Q_u = Y^u(K_u, L_u) = L_u y_u(k_u) \quad (6.52)$$

where K_u is capital employed in the urban sector, and

$$k_u = \frac{K_u}{L_u} \quad (6.53)$$

is the capital intensity.

As before, firms in the urban sector pay the efficiency wage w^* . Hence,

$$w^* = w_u = y_u(k_u) - k_u y'_u(k_u) \quad (6.54)$$

which can be solved for the equilibrium capital-labor ratio k_u^* ; this in turn immediately determines the rate of return on capital ρ ,

$$\rho^* = y'_u(k_u^*). \quad (6.55)$$

Since output in the rural sector is a function of labor, capital and land, it is not reasonable to assume a constant returns to scale production function in labor and capital; since land is assumed fixed, we can write

$$Q_r = Y^r(K_r, L_r) \quad (6.56)$$

where K_r is capital in the rural sector.

Equilibrium requires the following.

(a) Equality of rate of return on capital:

$$Y'_K = \rho^*. \quad (6.57)$$

(b) Rural wage equal expected urban wage:

$$Y'_L = \left(\frac{L_u + L_g}{N_u} \right) w^*. \quad (6.58)$$

(c) Capital and labor be allocated either to the rural or urban sectors:

$$K_r + K_u = \bar{K} \quad (6.59)$$

$$L_r + N_u = \bar{L}. \quad (6.60)$$

The equilibrium may now be easily described. First, we make use of the fact that the capital-labor ratio in the urban sector is given to rewrite equation 6.59 to read

$$K_r = \bar{K} - L_u k_u^*. \quad (6.61)$$

Then 6.58 may be thought of as defining the supply of labor to the urban sector as a function of urban employment

$$\left. \frac{d \ln N_u}{d \ln L_u} \right|_{w^*} = \frac{1 + m K_u / K_r - L_g / (L_u + L_g)}{1 + \varepsilon N_u / L_r} \quad (6.62)$$

where

$$\varepsilon = - \frac{Y_{LL}^r L_r}{Y_L^r}$$

and

$$m = \frac{Y_{KL}^r K_r}{Y_L^r}.$$

As urban employment increases, labor is drawn out of the rural sector.

On the other hand, equation 6.57 defines (with 6.61) pairs of values of rural employment and urban employment for which the capital market is in equilibrium. As urban employment increases capital is drawn out of the rural sector, raising the return on the remaining capital; for equilibration, some labor must migrate from the rural sector:

$$\left. \frac{d \ln N_u}{d \ln L_u} \right|_{p=p^*} = - \frac{Y_{KK}^r K_u}{Y_{KL}^r N_u}. \quad (6.63)$$

For a Cobb-Douglas production function with shares of labor and capital of β_L and β_K ,

$$\left. \frac{d \ln N_u}{d \ln L_u} \right|_{w^*} = \frac{1 + \beta_K K_u / K_r - L_g / (L_u + L_g)}{1 + (1 - \beta_L) N_u / L_r}$$

while

$$\left. \frac{d \ln N_u}{d \ln L_u} \right|_{p^*} = \frac{1 - \beta_K}{\beta_L} \frac{L_r}{N_u} \frac{K_u}{K_r} > 1, \quad \text{provided } \frac{K_u}{N_u} > \frac{K_r}{L_r}$$

The intersection of the two curves defined by equations 6.57 and 6.58, both of which are upward-sloping, is an equilibrium (see Figure 6.4). There is some presumption that the capital-market clearing curve 6.57 is steeper than the labor-market equilibrium curve. For the Cobb–Douglas case with $L_g = 0$, this requires that

$$\frac{(1 - \beta_K) K_u / K_r}{\beta_L N_u / L_r} > \frac{1 + \beta_K K_u / K_r}{1 + (1 - \beta_L) N_u / L_r}$$

or

$$(1 - \beta_K) \frac{K_u}{K_r} + (1 - \beta_K - \beta_L) \frac{K_u}{K_r} \frac{N_u}{L_r} > \beta_L \frac{N_u}{L_r}$$

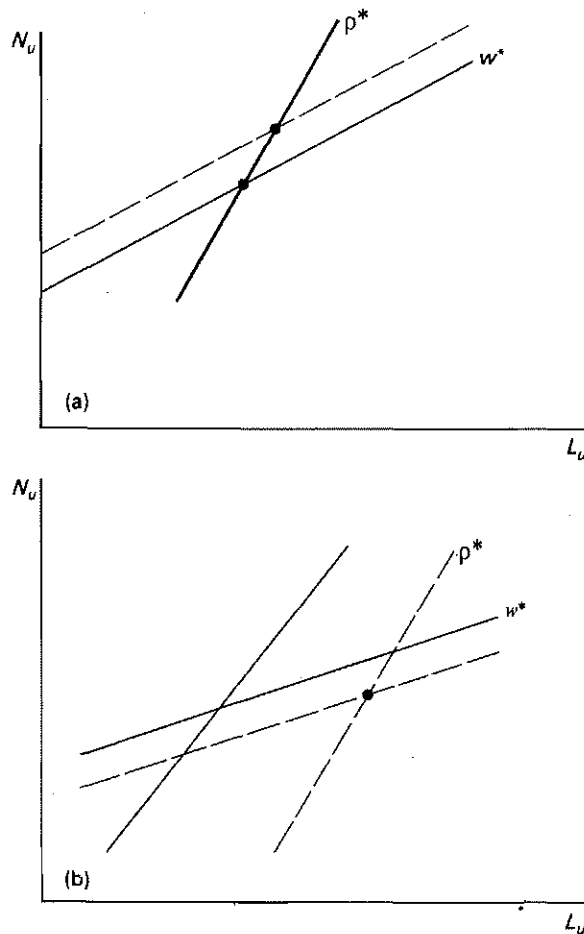


Figure 6.4 *Equilibrium with capital mobility. (a) Effect of increased government employment. (b) Effect of wage subsidies.*

If the urban sector is relatively capital-intensive and the equilibrium unemployment rate is not too high, so

$$\frac{K_u}{K_r} > \frac{N_u}{L_r} = \frac{L_u}{(1-U)L_r}$$

this inequality will clearly be satisfied. This, we assume; the assumption is important in determining the relationship between urban wages and shadow prices.

Shadow Wages Rates

We now calculate the effect of an increase in government employment on private output; we assume that the government does not divert directly any capital from the private sector, but that its hiring decision will have an effect on capital allocation. Since capital has the same (value of) marginal productivity in both sectors, the reallocation of capital will not have any direct effect on national output; but it will induce, in turn, migration. The higher level of government employment will imply that, for each value of L_u , there is a larger number of urban residents. Thus, in Figure 6.4, the labor-market curve shifts up. Thus, both the level of urban employment and the number of urban job-seekers increases. In the appendix to this chapter, we show that none the less the unemployment rate decreases:

$$\frac{dU}{dL_g} < 0.$$

It is immediate that

$$\begin{aligned} -\frac{d(Q_u + Q_r)}{dL_g} &= \frac{Y_L^r}{1-U} - \left\{ Y_L^u - \frac{Y_L^r}{1-U} \right\} \frac{dL_u}{dL_g} \\ &\quad - (Y_K^u - Y_K^r) \frac{dK_u}{dL_g} + Y_L^r \frac{N_u}{1-U} \frac{dU}{dL_g} \\ &= w_u \left(1 + N_u \frac{dU}{dL_g} \right) < w_u \end{aligned}$$

The opportunity cost is less than the urban wage.

Optimal Wage Subsidies

As we noted earlier, an *ad valorem* wage subsidy has no effect on the wage paid to workers in the urban sector; its only effect in this model is to reduce the capital intensity:

$$y(k_u^*) - ky'(k_u^*) = (1 - \tau)w^*.$$

Hence, the choice of an optimal *ad valorem* subsidy is equivalent to the choice of an optimal value of k_u^* .

Let us rewrite equations 6.57 and 6.58 as

$$Y'_K(\bar{K} - k_u L_u, \bar{L} - N_u) = \rho^* \quad (6.64)$$

$$N_u Y'_L(\bar{K} - k_u L_u, \bar{L} - N_u) = w^* L_u \quad (6.65)$$

For each value of N_u , equation 6.64 can be solved uniquely for $k_u L_u$. Hence, a decrease in k_u increases L_u . Similarly, at a fixed value of N_u , a decrease in k_u increases the LHS of equation 6.65, so that right-hand side is less than the left-hand side. An increase in L_u to the point where $k_u L_u$ is unchanged leaves Y'_L unchanged, but now the RHS exceeds the LHS. Hence, both curves are shifted to the right, but the capital-market curve more than the labor-market curve. This implies that L_u is increased. N_u is increased, but it always does so less than L_u . Hence, unemployment is reduced

$$\frac{dU}{dk_u} > 0.$$

(See the appendix to this chapter.) Hence:

$$\begin{aligned} \frac{d(Q_u + Q_r)}{d\tau} \Big|_{\tau=0} &= (Y'_K - Y'_K) \frac{dK_u}{d\tau} + \left(Y'_L - \frac{Y'_L}{1-U} \right) \frac{dL_u}{d\tau} \Big|_{U=U} - Y'_L L_u \frac{dx}{d\tau} \\ &= -Y'_L L_u \frac{dx}{d\tau} > 0. \end{aligned}$$

A wage subsidy increases national income.

Aggregate Savings, the Distribution of Income and Labor Migration

The traditional development literature has focused on the effect of employment on the distribution of income and, hence, on the level of aggregate savings; even if the opportunity cost of labor were zero, it has been argued, the shadow price of labor is positive. Whatever is paid out in wages is consumed, and therefore not available for investment. Thus, an increase in employment lowers savings and, since the shadow price of savings exceeds that of consumption, the shadow price of labor exceeds its direct opportunity costs. But in the labor-migration model we have formulated, hiring one additional worker has absolutely no effect on the total income of workers, provided the rural wage

does not change. For total wages are equal to rural wages plus urban wages:

$$W = w_r L_r + w_u L_u$$

but expected urban wages equal rural wages,

$$\frac{w_u L_u}{N_u} = w_r$$

Substituting, we obtain

$$W = w_r(L_r + N_u) = w_r \bar{L}.$$

The only effect on consumption of hiring more workers arises through the effect on rural wages. Thus, not only has the traditional model underestimated the opportunity cost of labor, it has overestimated the importance of employment for aggregate savings. Obviously, if there is an increase in government employment, financed by a tax on private-sector profits, then there may be an important effect on investment and saving.

Extensions, Modifications and Alternatives

The models formulated in this chapter are highly idealized: yet most of the results appear to be quite robust. Among the extensions we have investigated are: (a) disaggregating the urban sector, allowing for the existence of a 'murky' urban sector, into which those in the urban sector who do not succeed in obtaining employment go (shoeshine boys and newspaper vendors); (b) disaggregating the labor market to allow for different skill levels; (c) disaggregating the rural sector to allow for rural manufacturing; (d) taking into account the evaluation of the nonpecuniary benefits (or costs) of urban versus rural living. None of these seems to have a serious effect on our analysis. The effect of the murky sector on shadow prices is negligible; the shadow price of skilled labor is even more likely to exceed its wage than for unskilled labor (even when the marginal skilled person is hired at an unskilled job). Allowing for rural manufacturing and taking into account amenity values, may have an effect on the elasticity of supply of labor from the rural to the urban sector (the former likely increasing it; the latter likely decreasing it), but leaves the analysis otherwise unaffected.

There are at least two other models of wage determination in LDCs which should briefly be mentioned. One of them is a variant of the models developed here – that where the wage affects productivity through morale effects (see Stiglitz, 1973b). Although the descriptive properties of such a model are similar to those analyzed here, its analysis is more complicated for two reasons: first, it

is likely that the effort supplied by an individual is a function of his wage relative to the whole wage distribution and, thus, even when all firms are identical, there may be a whole wage distribution (not just a single urban wage); second, if the wage the individual receives relative to other wages affects productivity, it presumably also affects welfare and this needs explicitly to be taken into account. An individualistic welfare analysis of the kind employed here is not possible.

The other model is a variant of the Cambridge savings model, implicitly employed in much of the development literature. Assume investment \bar{I} is fixed; a fraction s_π of profits (and none of wages) is saved; and the capital market in the urban sector is separate from that in the rural sector. Then, for savings to equal investment,

$$\bar{I} = s_\pi(F(L_u) - w_u L_u)$$

and, if firms are profit-maximizers,

$$F'(L_u) = w_u.$$

Thus, the savings equals investment condition and the wage equals marginal productivity condition jointly determine the urban wage and employment, independently of the rural wage:

$$\bar{I}^*/s_\pi = F(L_u^*) - F'(L_u^*)L_u^*,$$

$$w_u = F'(L_u^*).$$

If the equilibrium urban wage exceeds the rural wage, there is induced migration and unemployment. This model, although plausible in several respects, has one most implausible implication: the reason for the excessively high wage is insufficient investment (an excess of savings), which is contrary to what is usually assumed to be the case in most LDCs. Hence, if the government hires additional laborers in the urban sector, financed by a profits tax, the wage *falls*, unemployment is reduced and, indeed, the opportunity cost can be shown to be negative.

Concluding Remarks

This chapter has formulated several alternative models of the economy which lead to wage differentials (here, between the urban and rural sectors): unemployment acts as an equilibrating mechanism. The models analyzed here are perfectly competitive; indeed, in the first model (the efficiency wage-productivity model), there is no market imperfection; in the second, there is imperfect information, but in the welfare analysis we have contrasted how

well the market economy does with the given information structure with how well a government-managed urban sector could do with precisely the same information structure. Yet the results of the models differ markedly from those of traditional competitive analysis; in particular, the market allocation lacks the usual optimality properties. Perhaps more important is the suggestion that our intuition, developed in the context of the first-best analysis of traditional competitive models, may go seriously awry in the analysis of the implications of alternative policies for dealing with unemployment. Our analysis has at least called into question the widespread presumption that in LDCs shadow wages are significantly lower than market wages for unskilled labor, and that a wage subsidy would be desirable.

Although we have focused our discussion on the implications of this class of model for LDCs, these models (particularly the efficiency wage-quality model) are equally applicable to more developed economies; there, they have important implications of macroeconomic policy and the optimality of the natural unemployment rate – questions we shall pursue elsewhere.

Appendix

We rewrite equations 6.57 and 6.58 as:

$$Y'_K[\bar{K} - k_u L_u, \bar{L} - (L_g + L_u)x] = \rho^*$$

$$xY'_L[\bar{K} - k_u L_u, \bar{L} - (L_g + L_u)x] = w^*$$

where, as before

$$x = \frac{1}{1-U}$$

Totally differentiating, we obtain

$$\begin{bmatrix} -Y'_{KK}k_u - Y'_{KL}x & -Y'_{KL}L_u \\ -xY'_{LK}k_u - Y'_{LL}x^2 & Y'_L - xY'_{LL}L_u \end{bmatrix} \begin{bmatrix} dL_u \\ dx \end{bmatrix} = \begin{bmatrix} Y'_{KK}L_u \\ Y'_{LK}L_u x \end{bmatrix} dk_u + \begin{bmatrix} Y'_{KL}x \\ Y'_{LL}x^2 \end{bmatrix} dL_g$$

so

$$\frac{dx}{dk_u} = \frac{x^2 L_u A}{AxK_u - Y'_L(Y'_{KK}k_u + Y'_{KL}x)}$$

and

$$\frac{dL_u}{dk_u} = - \frac{L_u^2 A x - Y_{KK}^r Y_L^r L_u}{A x K_u - Y_L^r (Y_{KK}^r k_u + Y_{KL}^r x)}$$

$$\frac{dx}{dL_g} = \frac{-A k_u x^2}{A x K_u - Y_L^r (Y_{KK}^r k_u + Y_{KL}^r x)} < 0$$

$$A = Y_{KK}^r Y_{LL}^r - (Y_{KL}^r)^2 > 0$$

(by concavity of the production function). Hence, in the normal case where a wage subsidy increases urban employment ($dL_u/dk_u < 0$), it also decreases the unemployment rate. Similarly, an increase in L_g decreases the unemployment rate.

Chapter 6: Notes

This chapter represents a revision and extension of part of a paper originally written while the author was a research fellow at the Institute for Development Studies, University of Nairobi (1969–71) under a grant from the Rockefeller Foundation. Subsequent work on the paper has been supported by the National Science Foundation and the Ford Foundation. The author is indebted to his colleagues at the IDS for many helpful discussions; in particular he would like to thank G. E. Johnson and L. Smith. Part of that paper appeared as Stiglitz (1974c).

- 1 It is, of course, possible to have wage dispersion even without these differences among sectors: see Stiglitz (1974b; 1976a).
- 2 See, for instance, the labor-turnover model presented in Stiglitz (1974a).
- 3 A notable exception is Harberger's (1971) paper. Many of these earlier studies also argued that since the shadow price of investment exceeded that of consumption, and since hiring an additional worker increased the level of consumption, the shadow price of labor was positive, but less than its wage. The calculated changes in consumption were seriously in error, because they too ignored the effects of the policy on wages and migration. In one limiting case, where both the rural and urban wages remained unchanged, in the simple migration model of Harris-Todaro (1970) and Stiglitz (1974b) there is no change in the aggregate level of consumption: see below.
- 4 The purpose of this section is not to argue for the validity of the wage-productivity hypothesis, but rather to consider its consequences. For a further discussion of the model see Leibenstein (1957), Stiglitz (1976b) and Mirrlees (1975).
- 5 The morale interpretation has been discussed briefly by Stiglitz (1974c). If there were no unemployment, if all firms paid the same wage and if it were costly to monitor workers, all workers would shirk. The threat of being fired would not be effective; the workers could obtain an equally good job elsewhere. See Calvo (1979) and Shapiro and Stiglitz (1982) have explored a similar model.
- 6 The firm pays this wage, provided it can obtain labor at that wage; the implications of this qualification will be apparent shortly.
- 7 Alternatively, we can assume that the wage in the rural sector exceeds the efficiency wage. If workers in the urban sector remit funds to the rural sector, at a rate which depends on the wage differential, then the efficiency wage in the urban sector will depend on the rural wage; see Stiglitz (1974c). One of the essential differences between the labor-turnover model and the efficiency-wage model is that, in the former, turnover costs are a function of relative wages. In the model presented in the next section productivity at any firm is assumed to be a function of the wages paid by all other firms. The extension of the present model to a more general specification of the productivity function is left as an exercise for the reader.

- 8 For an extension of many of the results to a closed economy, see Stiglitz (1977).
 9 The analysis can be easily extended to the case where the wage in the rural sector equals the average product; see Stiglitz (1981).
 10 The notion that the unemployment rate would serve as an equilibrating device when factor prices did not adjust was presented in an appendix to Akerlof and Stiglitz (1969). The basic equilibrium condition 6.9 was also derived there. In Stiglitz (1974c) alternative derivations of 6.9 are presented and generalizations of 6.9 are considered and developed. To keep our focus on the central issue of alternative theories of wage determination, we shall employ the basic migration-equilibrium condition 6.9 throughout this chapter.
 The application of this notion to LDCs is due to Todaro (1968) and Harris and Todaro (1970).
 11 The model presented here is closely related to that of Stiglitz (1976a).
 12 It should be obvious that the model may be considerably generalized without affecting the qualitative results; however, the form presented here is sufficiently general for developing the points we wish to raise.
 13 There may, of course, be a wage distribution; see for example, Stiglitz (1976b).
 14 The second-order condition assures that $\partial^2 \lambda_i / \partial w_i^2 < 0$. Although $\partial^2 \lambda_i / \partial w_i \partial \bar{w}$ may be positive, we assume the direct effect $\partial^2 \lambda_i / \partial w_i^2$ is larger in absolute value.
 15 Substituting 6.26 into 6.25, we obtain

$$\bar{\lambda}(w_u, N_u) F' \left(\bar{\lambda}(w_u, N_u) \frac{w_r N_u}{w_u} \right) = w_u$$

Differentiating, we obtain 6.30.

- 16 In general those who have the lowest reservation wage need not be the first to migrate, if there is any uncertainty about obtaining employment, since individuals of different abilities may have different attitudes towards risk.

$$17 \quad B' = \frac{(\hat{b} - B)h}{H} \frac{d\hat{b}}{dN_u}$$

$$w_r' = \frac{d\hat{b}}{dN_u} = \frac{1}{Lh}$$

$$18 \quad \bar{\lambda}_{N_u} = \left[\frac{(a-A)h\phi}{H} - \frac{A\phi'w_i}{\hat{b}^2} \right] \frac{d\hat{b}}{dN_u}$$

Hence the RHS of 6.37 is (using 6.38)

$$1 / \left[1 + \frac{(a-A)\phi}{A\phi} - \frac{\phi'wH}{\phi\hat{b}^2h} + \frac{H}{hb} \right] = \frac{A}{a}$$

- 19 Without loss of generality, we let $\lambda(w^*) = 1$.

Chapter 6: References

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