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ALTERNATIVE THEORIES OF WAGES IN LESS DEVELOPED COUNTRIES:

AN EMPIRICAL TEST

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ALTERNATIVE THEORIES OF WAGES IN LESS DEVELOPED COUNTRIES:

AN EMPIRICAL TEST[1]

This paper develops a methodology of distinguishing between different
theories of industrial wage determination in less developed countries and
presents the results of applying this methodology to manufacturing industry
in Colombia. The concentration of this paper is on "economic" theories of
wage determination, rather than social and political theories. All of the
theories considered here attempt to explain why, in many countries, the
real wages of industrial workers have continued to rise despite the in-
creasing level of urban unemployment. At a microeconomic level, these
theories have attempted to explain why individual firms do not reduce their
wages when there is large-scale unemployment. The phenomenon that these
theories have been developed to explain is of central importance to large
areas of development economics, such as income distribution,[2] unemployment,[3]
choice of technique and project evaluation.[4] It is, therefore, interesting
to discover which of the theories are consistent with the available data.

All of the theories have been considered to some extent by other re-
searchers. However, no satisfactory empirical tests have been devised.

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[1]This paper is based on my Ph.D. dissertation for Yale University. The
latter benefited from comments by Gary S. Fields, James L. McCabe, Gustav
Ranis, and Lloyd G. Reynolds.

[2]A particularly good exposition of this point is provided by Kuznets, S.,
"Economic Growth and Income Inequality," American Economic Review, 45, March
1955. A review of recent literature on this point is Cline, W. R., "Distribu-
tion and Development: A Survey of the Literature," Journal of Development
Economics, 1, February 1975.

[3]The seminal article in this field is Harris, J. and Todaro, M., "Migra-
tion, Unemployment and Development: A Two-Sector Analysis," American Economic
Review, 60, March 1970. A survey of the literature is contained in Bairoch, P.,
Urban Unemployment in Developing Countries, International Labour Office, Geneva,
1973.

[4]Little, I.M.D. and Mirrlees, J. A., Project Appraisal and Planning for
Developing Countries, pp. 45-47, Heineman, London, 1974.

There are two reasons for this state of affairs. First, all the theories have been developed to explain one phenomenon--the failure of the real wage to fall in the face of widespread unemployment--and they naturally give similar predictions about the relationship between wages and unemployment. Second, the theories have typically been developed in terms of unobservable variables, such as cost of turnover, and so do not lend themselves directly to empirical testing.

The approach taken in this study is designed to get around these difficulties. Instead of testing the theories' predictions about the relationship between wages and unemployment, it was decided to test the theories by developing their predictions about inter-firm wage differentials, and, in particular, the wage differences between firms in the same industry. These predictions were then used in an attempt to explain the wage differentials between firms of different sizes in the same industry. The results of this test, which was conducted for eighteen two-digit manufacturing industries in Colombia, are reported in Section 4.

As well as reformulating the theories to explain inter-firm wage differentials, it was necessary to reformulate them in terms of observable variables such as the relative quantities of labor, intermediate goods and capital used in production. Such reformulations required the use of assumptions as to the way in which factor intensities affect the motives for firms to pay high wages. The most important assumption is that firm size, in itself, is not a reason for paying higher wages. Thus, a larger firm may pay higher wages if it is more capital-intensive or if it is more profitable than a smaller firm, but not if the only difference between it and the smaller firm is its size. Therefore, this study is attempting to explain the differences in wages between firms of different sizes in terms of variables other than size.

Without this restriction, the exercise could well become tautological in the absence of data which directly ties the motives for paying high wages to the size of the firm. The possibility of obtaining such data is considered in Section 5.

For the purposes of exposition, the various theories will be divided into two groups: the "cost-minimizing" theories and the "profit-sharing" theory. The cost-minimizing theories will be considered in Section 1 and the profit-sharing theory will be analyzed in Section 2. Section 3 will consider the basis for distinguishing empirically between the two groups of theories and Section 4 will report on the application of the test to Colombian data.

1. The Cost-Minimizing Theories

The three theories considered in this section are grouped together because they all explain the payment of high wages in terms of increasing the efficiency of production by improving the skill mix of the labor force (the skill theory), by increasing the efficiency of the existing labor force (the efficiency wage theory), or by reducing the rate of labor turnover (the labor turnover theory).

The skill theory will be considered first. The fundamental idea behind this theory is that the employment of more highly skilled workers increases the efficiency of a firm's production methods. It is for this reason that more highly skilled workers can command higher wages. If we now concentrate our attention on a particular profit-maximizing firm, the firm will choose its skill mix in such a way that the efficiency gain from improving the skill mix slightly is exactly counter-balanced by the wage cost of the improvement. If the production function of the firm in terms of each type

of labor and non-labor input were known, it would be possible to apply calculus to this problem and derive the optimal skill mix, and the optimal wage structure.

If this theory were the only theory that could explain wage differentials, one would expect to observe a correlation between the average wages paid by firms and the skill level of their workforces. However, the observation of such a correlation in a world where there are several different possible causes of wage differentials is not proof of the operation of the skill theory. It is quite possible that wages are high in a firm for some reason unrelated to skill requirements (perhaps a strong trade union) but that the firm still uses its high wages to attract more highly skilled workers. In order to be sure that high wages are due to high skill require-ments, it is necessary to develop a theory that explains why different firms choose different skill levels and test whether this theory is consistent with the data. Such a model was outlined in the previous paragraph. However, its requirement of a detailed production function in terms of different skills is beyond the data availability of any less developed country.

A simpler approach is required and this can be achieved by noting that any particular firm with a given capital stock, K, given quantities of intermediate goods, I, a given number of workers, L, and a given average wage, W, will have an optimal wage structure which will be determined by such factors as the technical importance of different skills and the state of the labor markets for these different skills. Furthermore, if the firm adopts this optimal wage structure, a certain amount of output will be produced. We thus have a production function:

$$Y = F (K, I, L, W) \qquad (1\text{-}1)$$

where: Y is output,

K is capital stock,

L is the number of (heterogeneous) workers,

I is intermediate goods,

W is the average wage.

There are two points that must be made about this production function.
First, because the average wage is used instead of the whole wage structure,
it is assumed that a considerable amount of optimization has already taken
place in order to obtain the optimal wage structure. This is, in fact,
not particularly unusual as ordinary production functions involve some degree
of optimization by excluding technically inefficient input combinations.
The second point is that this production function, and the optimization that
has taken place behind it, is not simply a technical relationship: it also
depends on the state of the various labor markets.

Although certain general results can be obtained from the general form
of the production function (1-1), useful empirical predictions can only be
obtained if assumptions are made about the way in which wages (and thus
skill) affect the production function. It is assumed that the effect of an
increase in skill is similar to factor-augmenting technical change. In
other words, an increase in wages has an effect identical to an increase in
the quantity of factors. For example, an increase in wages might result in
the employment of more careful workers who would waste less intermediate
goods, thus having the same effect as an increase in the quantity of inter-
mediate goods. Under this assumption the production function can be written:

$$Y = F (AK, BL, CI) \qquad\qquad (1-2)$$

where A, B, C are functions of W.

It is also necessary to make an assumption about the form of $A(W)$, $B(W)$ and $C(W)$. The assumption is that there is some wage, $\bar{W}$, at which all are zero and that each is of constant elasticity in $(W - \bar{W})$.[5] Thus:

$$\frac{dA}{dW} \frac{(W-\bar{W})}{A} = a, \quad \frac{dB}{dW} \frac{(W-\bar{W})}{B} = b, \quad \frac{dC}{dW} \frac{(W-\bar{W})}{C} = c \qquad (1\text{-}3)$$

The development of this production function makes it possible to formulate a specific model of firm behavior. Let us consider a firm which produces a single output according to the production function (1-2). Let us also suppose that this firm faces a downward sloping demand curve and so has some control over the price of its product:

$$P = P(Y) \qquad (1\text{-}4)$$

where: P is the price of output.

We shall also assume that the firm can buy its intermediate goods at a constant price, q, but that the cost of capital (including interest costs) varies with the amount of capital employed:

$$P_K = P_K(K) \qquad (1\text{-}5)$$

The firm's problem of maximizing total profits is thus to maximize:

$$R = PY - WL - qI - P_K K \qquad (1\text{-}6)$$

The first order conditions are:

$$\frac{\partial R}{\partial L} = \frac{dP}{dY} \frac{\partial Y}{\partial L} Y + P \frac{\partial Y}{\partial L} - W = 0$$

$$\frac{\partial R}{\partial I} = \frac{dP}{dY} \frac{\partial Y}{\partial I} Y + P \frac{\partial Y}{\partial I} - q = 0$$

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[5]This assumption is made so that the final equation for estimation, equation (1-7), is linear.

$$\frac{\partial R}{\partial K} = \frac{dP}{dY}\frac{\partial Y}{\partial K} Y + P \frac{\partial Y}{\partial K} - (P_K + K \frac{dP_K}{dK}) = 0$$

$$\frac{\partial R}{\partial W} = \frac{dP}{dY}\frac{\partial Y}{\partial W} Y + P \frac{\partial Y}{\partial W} - L = 0$$

but from (1-2):

$$\frac{\partial Y}{\partial W} = \frac{\partial Y}{\partial K}\frac{K}{A}\frac{dA}{dW} + \frac{\partial Y}{\partial L}\frac{L}{B}\frac{dB}{dW} + \frac{\partial Y}{\partial I}\frac{I}{C}\frac{dC}{dW}$$

Substituting this and the first three first-order conditions into the last condition, we obtain:

$$(P_K + K \frac{dP_K}{dK}) \frac{K}{A}\frac{dA}{dW} + W \frac{L}{B}\frac{dB}{dW} + q \frac{I}{C}\frac{dC}{dW} = L$$

This can be rewritten with the help of (1-3) to give:

$$(P_K + K \frac{dP_K}{dK}) K \frac{a}{W-\bar{W}} + W L \frac{b}{W-\bar{W}} + q I \frac{c}{W-\bar{W}} = L$$

This can be rewritten:

$$W = [\bar{W} + a (P_K + K \frac{dP_K}{dK}) K/L + c q I/L]/(1-b) \qquad (1-7)$$

Equation (1-7) constitutes a formulation of our skill theory in which wages are a function of value of capital per man (valued at marginal cost) and value of intermediates per man.

This result is not hard to understand intuitively. It is simply saying that, <u>ceteris paribus</u>, a firm will have an incentive to pay higher wages and employ a more highly skilled workforce if this will increase the efficiency of its capital (if a is positive) or its intermediate goods (if c is positive).[6] Moreover, this incentive will be greater if the value of

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[6] Firms will have a greater incentive to pay high wages, <u>ceteris paribus</u>, if b is larger but a positive b (common to all firms) cannot explain inter-firm differentials.

capital per man or value of intermediates per man is greater.

It should be noted that value of capital per man and value of inter-mediates per man are not exogenous. Rather, they are determined simul-taneously with the wage rate in a system of simultaneous equations that include equation (1-7). Thus, Section 4 will use a simultaneous equation estimation procedure.

This result rests heavily on the assumption that wages have a factor-augmenting effect on productivity. Essentially, it is saying that the only reason why firms in any one industry should pick different skill mixes is their differences in factor intensities. Thus, this assumption rules out the possibility that larger firms need more highly skilled workers simply because they are large. As pointed out in the introduction, this assumption is essential to the results of this study.

Having considered the skill theory in some detail, it is now possible to consider the efficiency wage theory. The essential idea is that the pay-ment of higher wages increases the efficiency of the workers either because it improves their diet and thus their strength or because a well paid man tends to be more interested in his job and is prepared to put in more effort. This theory has recently been analyzed by Stiglitz.[7]

A thorough test of whether this theory could explain wage differentials between firms would require detailed data on the effect of wages on workers' effort and the relative importance of effort in each firm's production methods. No such data are available and so we must be content with testing whether the firms' behavior is consistent with a situation where the payment of higher

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[7]Stiglitz, J. E., "Alternative Theories of Wage Determination in LDCs, II: The Efficiency Wage Model," Cowles Foundation Discussion Paper No. 357.

wages increases productivity, and thus where the wage rate is an argument in the production function. However, this formulation of the efficiency wage theory is identical to the formulation of the skill theory presented above. Therefore, if the same assumptions are made about the way in which wages affect productivity, the efficiency wage theory will give the same predictions about the relationship between wages and capital-intensity and intermediate-intensity:

$$W = [\bar{W} + a \ (P_K + K \frac{dP_K}{dK}) \ K/L + c \ q \ I/L]/(1-b) \qquad (1-7)$$

It can also be seen that, given the restrictions on data availability, the labor turnover theory gives the same predictions as the skill theory. The idea behind the labor turnover theory is that a firm will incur costs as a result of workers leaving to take up employment elsewhere. For example, there are costs of search, hiring and training, and production might well be disrupted to a certain extent. In such a situation, a firm might be prepared to raise its wages in order to reduce turnover. This behavior could lead to wage differentials between firms if some firms had larger costs than others. This theory has also been analyzed by Stiglitz.[8]

A test of whether this theory can explain the wage differentials between firms would require data on the differences in turnover costs and on the responsiveness of turnover rates to changes in wages. No such data are available and so we are back, once again, to a situation where all we can

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[8]Stiglitz, J. E., "Alternative Theories of Wage Determination and Unemployment in LDCs: The Labor Turnover Model," Quarterly Journal of Economics, 88, May 1974.

say is that the payment of higher wages increases efficiency and thus,
under the assumption that the effect of wages is factor augmenting, that
firms should set their wages according to equation (1-7).

This section has produced two conclusions. First, that the theories
cannot be distinguished from each other with the available data. Second,
that the wage setting behavior predicted by the theories can, under certain
assumptions, be represented by equation (1-7). It is this equation which
will form the basis of the test between these cost-minimizing theories and
the profit-sharing theory which will be discussed in the next section.
It is worth noting at this point that these theories, as formulated here,
can only explain wage differentials between firms in one industry and not
wage differentials between industries. The reason for this is that equation
(1-7) was derived on the assumption of a fixed production function.

Finally, it might be thought that the theories could be differentiated
by the association of skill with wages if the skill theory is true, or
the association of low turnover rates with high wages if the turnover theory
is correct. However, one example will show that this view is unfounded.
If a firm pays high wages to reduce turnover, it will have more skilled
workers applying for jobs and will end up with a workforce of a higher skill
content than other firms, even if skill is a relatively unimportant factor
in productivity. In order to find out which theories apply in each case, it
would be necessary to have detailed information about the technologies of a
sort that is not available.

2. <u>The Profit-Sharing Theory</u>

The theories considered in Section 1 gave similar predictions to each
other because of their great similarity: they all justified the payment of

high wages in terms of it increasing efficiency and thus reducing cost. The theory considered in this section is quite different: it explains the payment of high wages in terms of the firms sharing their profits with their workers.

There are several reasons why a firm might share its profits with the workers. For example, the managers might feel some moral obligation to ensure that workers had an "adequate" standard of living. However, this section will consider only one possible explanation: that firms share their profits because they are forced to by trade unions.

The idea that a firm's profitability affects the wages it pays is very common in the literature on the effects of unions on wage negotiations.[9] The basis for this idea is that the loss to a firm from a strike is very largely composed of lost profits. Thus, ceteris paribus, a more profitable firm would be prepared to pay higher wages in order to prevent a strike.

The difficulty arises because other factors enter into the determination of wages. Such factors include the strength of the union, the losses to the union members resulting from a strike and the relative skills of the negotia-tors. Unfortunately, there are no measures of these factors and so, in order to carry out any empirical tests, it must be assumed that they are constant across firms in the same industry. This assumption is again crucial to pre-vent us from simply concluding that wages are higher in larger firms because unions are stronger. Without an independent measure of union strength, such a conclusion would be equivalent to saying that large firms pay high wages because they are large.

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[9]One example is the recent article: Johnston, J., "A Model of Wage Determination Under Bilateral Monopoly," Economic Journal, 82, September 1972.

There are two particular aspects of this assumption that are doubtful. First, it is often thought that larger firms are in a stronger position because they are less likely to go bankrupt. However, this factor also reduces the loss to the union because the strikers' jobs are more secure. Second, union membership is greater in larger firms than smaller firms. However, it is not necessarily true that greater membership implies greater strength. Also, the fact that workers in smaller firms are lower paid means that the workers might make up in determination what they lack in numbers.

In order to formulate a model based on the idea of unions forcing firms to share profits, let us start by considering what would happen if the union always went on strike in an attempt to persuade the firm to raise its wages. Let us also assume that the union will be able to keep its members out on strike for a longer period if the wage offer is lower. Thus we have the relationship:

$$S = S(W) \qquad . \qquad (2\text{-}1)$$

where S is the proportion of days that will be lost through strikes,

W is the wage.

For simplicity, we will assume that $(1-S(W))$ is of a similar form to $A(W)$, $B(W)$ and $C(W)$:

$$-\frac{dS}{dW}\frac{W-\bar{W}}{1-S(W)} = s \qquad (2\text{-}2)$$

Before applying this idea to a monopolistically competitive firm, it is worth emphasizing that the $S(W)$ function is not a probability function, as its equivalent is in Johnston's Model, but it is the maximum length of strike that the workers will ensure for any particular wage offer. It will be

pointed out below that this strike need not always take place.

It is assumed that a strike prevents any production but that capital costs must continue despite a strike. Thus the problem of maximizing profits can be stated as:

$$\text{maximize } R = (PY - q\,I - WL)\,(1 - S(W)) - P_K K$$

One of the first-order conditions for this maximization problem is:

$$\frac{\partial R}{\partial W} = -L(1 - S(W)) - (PY - q\,I - WL)\,\frac{dS}{dW} = 0$$

This can be rewritten using (2-2) as:

$$L = (PY - q\,I - WL)\,\frac{s}{W-\bar{W}}$$

This, in turn, becomes:

$$W = \bar{W} + s\,(PY/L - q\,I/L - W) \tag{2-3}$$

This condition states that wages depend on the profit per man made by the firm and formalizes the intuitive argument at the beginning of this section. Note that the fact that capital costs must continue to be borne during strikes means that the appropriate profit concept is total profits, without deduction of capital costs.

It is important to note that, if strictly interpreted, this model predicts that unions will strike an amount $S(W^*)$, where W^* is the optimal wage from the point of view of the firm. However, by definition of W^*, such a strike will not induce the firm to raise wages. Thus, if viewed over a period of several years, the unions will keep on striking without ever winning--a rather peculiar situation. It seems more reasonable to assume that unions will learn what W^* should be in any year and will only

use their strike power if the firm ceases to recognize the power of the unions and pays less than W*. This would be in keeping with the view that strikes only arise because the firm does not recognize the power of the unions or vice versa. Thus the function S(W) does not represent the actual strikes that take place; instead it represents the potential striking ability of the unions.

Finally, to facilitate comparison with the results of the previous section, equation (2-3) can be rewritten:

$$W = [\bar{W} + s \ (PY/L - q \ I/L)] \ / \ (1 + s) \qquad (2-4)$$

3. The Two Types of Theory

Sections 1 and 2 introduced two types of theory: the cost-minimizing theories and the profit-sharing theory. The purpose of this section is to consider how to distinguish between them. This can be done by estimating a combined equation:

$$W = a_0 + a_1 \ (PY/L - q \ I/L) + a_2 \ q \ I/L + a_3 \ (P_K + K \ \frac{dP_K}{dK})K/L \qquad (3-1)$$

If this equation were estimated and if the value of a_1 were significantly positive, it could be concluded that the profit-sharing theory was in operation. Similarly, if either a_2 or a_3 were significantly positive, it could be concluded that the cost-minimizing theories were in operation. It should be noted that it is quite possible for both groups of theories to operate at the same time.

There is, however, one difficulty with this method of distinguishing between the theories. It is that there is a very strong connection between costs of production and value added, and thus that the difference between

equations (1-7) and (2-4) is not as great as might appear at first sight. This is not hard to see intuitively: a large part of profits is made as a result of the "mark-up" that is the difference between marginal cost and price. This mark-up is usually proportioned to marginal costs and so an increase in costs will produce an increase in profits. Therefore, it is hard to discover whether an increase in costs has increased wages directly, as a result of the cost-minimizing theories, or indirectly via an increase in profits and the operation of the profit-sharing theory.

This problem is one of identification and can only be dealt with by considering the other equations in the system. These equations are the factor demand equations which determine the quantities of factors used and thus value added per man, value of intermediates per man and value of capital per man. These equations are:

$$EP \frac{\partial Y}{\partial K} - (P_K + K \frac{dP_K}{dK}) = 0 \qquad (3-2)$$

$$EP \frac{\partial Y}{\partial L} - W \qquad = 0 \qquad (3-3)$$

$$EP \frac{\partial Y}{\partial I} - q \qquad = 0 \qquad (3-4)$$

where: $E = 1 + \frac{dP}{dY} \frac{Y}{P}$

E represents a measure of monopoly power, with a lower value of E corresponding to greater monopoly power. It is reasonable to assume that the degree of monopoly is greater for larger firms and so dummy variables for each firm size category will be used to represent monopoly power in the empirical work of Section 4. Thus, there are three exogenous variables: monopoly power, price of intermediate goods and supply of capital.[10] This equals the number

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[10]The problems associated with measuring this variable are considered in the next section. Note that the supply of capital is not a given quantity but is a function, $P_K(K)$, which will be shifted by such factors as the cost of capital goods and the credit-worthiness of the firm.

of right-hand side variables in equation (3-1) and so this equation satisfies the order condition for identification.

The order condition is not, of course, sufficient and it is worth giving brief consideration to the rank condition. If the production function were homogeneous to degree r, Euler's theorem can be applied to equations (3-2) to (3-4) to give the relationship:

$$rEPY/L = (P_K + K \frac{dP_K}{dK})K/L + q \ I/L + W \tag{3-5}$$

If E is neglected, equation (3-5) would be observationally equivalent to (3-1) and so the rank condition would have been violated, because equation (3-1) could be expressed as a combination of equations (3-2) to (3-4). However, the existence of E as an observable variable prevents this observational equivalence and saves the identification of equation (3-1).

This discussion of identification has shown how important monopoly power is in distinguishing between the two groups of theories and so it is essential to understand how the difference arises. It is simply that if a firm pays high wages in order to increase efficiency (to cost minimize) this motive is entirely unaffected by the market power it can exert in the product market, because the firm would pay no more than the market wage for a given type of worker. Thus changes in market power do not produce changes in the optimal wage. The situation is quite different with the profit-sharing theories: market power is an important determinant of profits and thus wages.

This discussion also provides the rationale for estimating equation (3-1) across firms of different sizes, which could be expected to have different degrees of monopoly power.

Finally, it is worth noting that if we dropped the assumption that

firm size, in itself, were not a reason for paying high wages, the identification of equation (3-1) would fail. This is because monopoly power is being measured by firm size. Thus, the inclusion of firm size in the wage determination equation (3-1) would make the equation observationally equivalent with equation (3-5). In such a situation, it would be impossible to tell whether the association between wages and profitability is due to profit-sharing or to the fact that firms which pay higher wages employ less labor and thus obtain higher profitability per man.[11]

4. The Empirical Evidence from Colombia

The aim of this section is to outline the results of estimating equation (3-1), using data from Colombian manufacturing industry. Equation (3-1) was estimated for each of eighteen two-digit manufacturing industries using data for four firm size categories[12] in each of five years, 1963-1967 (giving twenty observations in all).

The use of a time series of cross-sections can produce problems of both serial correlation and heteroscedasticity.[13] However, Nerlove's procedure revealed that in this case only heteroscedasticity was present and the variables were transformed to eliminate it. Two-stage least squares was applied to these transformed data in order to obtain consistent estimates of a_0, a_1, a_2 and a_3.

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[11]However, if we are prepared to assume that the direct influence of firm size per se is small, we can attribute most of the association to profit-sharing.

[12]These categories are: 5-24 employees, 25-99 employees, 100-199 employees, 200 employees and more.

[13]This is explained in Nerlove, M., "Further Evidence on the Estimation of Dynamic Economic Relations from a Time Series of Cross Sections," Econometrica, 39, March 1971.

Two-stage least squares requires data on the exogenous variables as well as the variables in equation (3-1). It has already been stated that dummy variables for each size category are used to represent the degree of monopoly, E. Size is also an important determinant of the cost of capital because it affects the terms on which a firm can borrow money, and thus the position of the $P_K(K)$ function. The other exogenous variable to represent shifts in the cost of capital function, $P_K(K)$, was the price index of electrical machinery,[14] which was taken as the price of capital goods. Finally, a separate index of intermediate prices for each industry, constructed with the help of an input-output table,[15] was used to indicate the supply conditions of intermediate goods.

This means that the econometric work reported below is based on the assumption that the endogenous variables value added per man, value of intermediates per man and value of capital per man were determined by the following equations, which can be regarded as linearized solutions of equations (3-2) to (3-4):

$$(PY/L - q\,I/L) = b_0 + b_1D_1 + b_2D_2 + b_3D_3 + b_4W + b_5q + b_6P_E$$

$$q\,I/L = c_0 + c_1D_1 + c_2D_2 + c_3D_3 + c_4W + c_5q + c_6P_E$$

$$(P_K + K\frac{dP_K}{dK})K/L = d_0 + d_1D_1 + d_2D_2 + d_3D_3 + d_4W + d_5q + d_6P_E$$

where: D_1, D_2, D_3 are dummy variables representing differences in E across firm size categories. Thus:

D_1 = 1 for size category of 25-99 employees, D_1 = 0 otherwise.

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[14] Unless otherwise stated, all data are from Departamento Administrativo Nacional de Estadística, Boletin Mensual de Estadística, March 1970.

[15] United Nations, Economic Commission for Latin America, Economic Development of Colombia (1956), p. 296. The raw materials prices were obtained from International Bank for Reconstruction and Development, Economic Growth of Colombia, p. 484.

D_2 = 1 for size category of 100-199 employees, D_2 = 0 otherwise.

D_3 = 1 for size category of 200 employees and more, D_3 = 0 otherwise.

q is the price index of intermediate goods.

P_E is the price index of electrical machinery.

As far as the endogenous variables were concerned, the data on average wages, value added per man and value of intermediates per man were easily computed from data on total wages, total value added, total value of output and total employment for each size category of each industry. However, the cost of capital per man was much more difficult to derive and it is the problems associated with this variable that constitute the main qualification to the empirical results. There are two problems. First the cost of capital includes interest costs which are unobservable and could be expected to vary between firms, because larger firms can usually borrow money more easily. Second, there are no data for the value of capital, only of installed electrical capacity.

The first difficulty cannot be solved and so interest costs are not included in the cost of capital used in estimating equation (3-1). This exclusion of interest costs constitutes an omitted variable specification error. It seems reasonable to assume that a more profitable firm will, ceteris paribus, pay lower rates of interest while a more capital-intensive firm will, ceteris paribus, pay higher rates of interest. Thus, this specification error should bias the estimated value of a_1 downward and the estimated value of a_3 upward.

As far as the second difficulty is concerned, the physical measure of capital (installed electrical capacity) was transformed into a value measure by multiplying it by the price index for electrical machinery. This is only

satisfactory for representing machinery value if one unit of electrical
capacity costs the same for all types of machines, a condition that is
made more likely by the fact that each regression involves data from only
one two-digit industry. Unfortunately, there is no way of assessing whether
this condition is met or of predicting the likely results of such a specifi-
cation error.

Finally it was necessary to deflate all the variables (apart from the
size dummies) by an index of average urban wages. The reason for this is
that each firm sets its wages relative to the average level of wages and
so an increase in the average level will increase the wages paid by any
particular firm. This index was constructed by assuming that national
income per head[16] represented an index of average earnings. Such an index
must be a weighted average of an index of agricultural earnings and an
index of urban wages (which is what we must compute), the weights being
the proportion of the workforce in each sector. As an index of agricultural
earnings was available and the proportion of the workforce in agriculture
(47.2%) was known,[17] it was possible to work back to an index of urban
wages. This procedure is clearly not perfect, not least because national
income per head is not a particularly good index of average earnings, but
it is the best available.

The results of estimating equation (3-1) with these data are given in
Table One, t-statistics are given in parentheses. There are three tests
that must be applied to these results.

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[16] Obtained from United Nations, Statistical Yearbook.

[17] Both are given in International Labour Office, Yearbook of Labour
Statistics.

Table One

Coefficients of Equation (3-1) for Each Industry
Estimated Across Firm Size Categories Within Each Industry

| | Estimated Coefficients | | |
| | Value Added Per Man a_1 | Value of Intermediates Per Man a_2 | Value of Capital Per Man a_3 |
Industry			
Food	0.224 (3.12)	-0.025 (-2.43)	0.101 (1.31)
Beverages	0.092 (2.30)	0.080 (1.01)	0.007 (0.08)
Tobacco	0.374 (1.63)	-0.973 (-1.32)	0.338 (0.68)
Clothing	0.143 (1.26)	-0.061 (-3.08)	0.098 (1.89)
Textiles	0.267 (2.61)	0.042 (0.21)	0.203 (0.39)
Wood	0.411 (9.08)	-0.073 (-1.02)	0.058 (2.71)
Furniture	0.312 (6.92)	0.280 (3.62)	0.053 (0.89)
Paper	0.099 (0.92)	0.084 (1.83)	0.016 (1.60)
Printing	0.526 (3.46)	-0.165 (-1.02)	0.233 (1.51)
Leather	-0.223 (-0.57)	0.255 (1.88)	0.102 (0.84)
Rubber	0.160 (2.34)	0.299 (3.03)	0.006 (2.50)
Chemicals	0.287 (7.06)	-0.064 (-0.48)	0.016 (0.78)
Petroleum Products	0.219 (3.42)	-0.004 (-0.15)	0.015 (2.13)
Non-Metallic Minerals	0.380 (4.24)	-0.029 (-0.85)	0.020 (1.03)
Basic Metals	0.094 (1.25)	0.041 (1.24)	-0.024 (-0.63)
Metal Products	0.420 (3.08)	0.026 (0.22)	-0.024 (-0.50)
Non-Electrical Machinery	0.320 (0.88)	0.370 (1.03)	-0.058 (-0.72)
Transport Equipment	0.360 (0.96)	0.264 (1.62)	-0.190 (-0.65)

Notes: (1) Value of intercept, a_0, is not reported as it has no economic significance; (2) R^2 is not reported as this is Two-Stage Least Squares.

The first test is to discover whether the profit-sharing theory is in operation and consists of testing whether a_1 is positive. Table One shows that the estimated value of a_1 is positive for all but one industry and the application of a one-tailed 5% test to the t-statistics reveals that the estimated value of a_1 is significantly positive in eleven industries: Food, Beverages, Textiles, Wood, Furniture, Printing, Rubber, Chemicals, Petroleum Products, Non-Metallic Minerals and Metal Products. These tests, combined with the fact that the estimated values of a_1 would be expected to be biased downward, show that the profit-sharing theories are in operation in Colombia. Also, the size of the coefficients (typically above 0.2) shows that quite a high proportion (over a quarter) of profits are shared with the workers. Thus the profit-sharing that is observed is also economically significant.

The second test is to discover whether the cost-minimizing theories are in operation by seeing whether a_2 is positive. Table One shows that a_2 is sometimes positive but not always. The application of a 5% one-tailed test on the t-statistics reveals that the values of a_2 are significantly positive in three industries: Furniture, Paper and Rubber.

The third test is also to discover whether the cost-minimizing theories are in operation, this time by seeing whether a_3 is positive. Table One shows that the estimated values of a_3 are positive in all but four industries. The application of a one-tailed 5% test reveals that a_3 is significantly positive in four industries: Clothing, Wood, Rubber and Petroleum Products. However, it should be noted that the specification error tends to bias a_3 away from zero and so the evidence is not conclusive.

The second and third tests together provide evidence of the operation of the cost-minimizing theories in six industries: Clothing, Wood, Furniture,

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Paper, Rubber and Petroleum Products. It is worth noting that there was also evidence of profit-sharing in all of these industries apart from Clothing and Paper. This underlines the fact that there is nothing to prevent both sets of theories from operating in the same industry at the same time.

It should also be noted that the fact that the cost-minimizing theories have not been observed in many of the industries does not imply that factors such as skill are unimportant in explaining wage differentials. We have only been testing their explanatory power over intra-industry wage differentials and so they will not show up in industries in which there are only small differences between firms in capital-intensity and intermediate-intensity, or in which the capital-augmenting and intermediate-augmenting effects of wages are small. Skill, at least, might well be a more powerful explanation of inter-industry wage differentials.

5. Conclusions

This study can be divided into two parts, theoretical and empirical. The theoretical part argued that there was a group of theories, the cost-minimizing theories, that could not be distinguished from each other with the available data. However, a test was developed which could distinguish between the cost-minimizing theories as a group and the profit-sharing theory. The empirical part of the study then applied this test to data from Colombian manufacturing industry, in an attempt to explain why larger firms within each industry tend to pay considerably higher wages than small firms. The main result was that both the profit-sharing theories and the cost-minimizing theories had a role to play in explaining this phenomenon. However, profit-sharing on an appreciable scale appeared to be involved in more industries than was the operation of the cost-minimizing theories.

These results are subject to several qualifications. Most of these qualifications apply only to this particular example of empirical work[18] and do not constitute criticisms of the basic methodology. However, there is one qualification that applies to the whole methodology. It is the need to assume that firm size, in itself, is not a reason for paying higher wages. In the context of the cost-minimizing theory, this was an assumption that firm size does affect the relationship between wages and productivity. In the context of the profit-sharing theory, this was an assumption that firm size does not affect the balance of bargaining power. The essential nature of this assumption is demonstrated by the fact that it is essential to achieve the identification of the wage equation (3-1). Thus, without definite confirmation of this assumption, our empirical conclusion is simply that the wage differentials between firms of different size is consistent with the simultaneous operation of both the cost-minimizing theories and the profit-sharing theory but that it is also consistent with the hypothesis that large firms pay more because of some feature (such as higher unionization) which is not captured by differences in value added per man, value of intermediates per man or cost of capital per man.

One way of testing the validity of the assumption that firm size does not affect the relationship between wages and productivity would be to directly estimate the effects of wages on productivity by estimating the production function (1-1):

$$Y = F(K,L,I,W) \qquad (1-1)$$

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[18] The main qualifications in this category are the small-sample bias of two-stage least squares and the specification errors that result from an inability to observe the cost of capital.

Such an estimation would also be of great value because it would give direct estimates of the elasticities of factor productivities. These values could then be compared with the values obtained from estimating equation (3-1). However, this type of estimation was impossible in this study because it would require a considerable amount of data on individual firms and this is not available.

Data of similar detail would also be necessary to test whether firm size affects the balance of bargaining power in wage negotiations. However, it would be very interesting to test this assumption as soon as data does become available. In this connection it is worth pointing out that even if firm size does have some direct effect on wages, it would not necessarily destroy the results of this study. The question would then become one of how much of the wage differentials can be explained by firm size alone and how much by the theories considered here. The advent of such data would not destroy the methodology here; it would simply remove the necessity of assuming that firm size does not directly affect wages.