NOTE

Wage Determination in Labor-Managed Firms under Market-Oriented Reforms: Estimates of Static and Dynamic Models¹

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In this paper we present a framework for analyzing the wide wage dispersion observed in a suddenly decentralized socialist system with workers' control. We model a process through which workers may appropriate capital rents as income and, using Yugoslav data from the 1960s and 1970s, we estimate a dynamic approximation to an earnings equation and an equation derived directly from a dynamic model. Our principal finding is that the appropriation of capital rents by workers does not account for the wide interindustry earnings differentials observed in the relatively free market, Yugoslav environment of the 1960s and 1970s. *J. Comp. Econom.*, September 1993, 17(3), pp. 687-700. London Business School, Sussex Place, London NW1 4SA; and University of Pittsburgh, Pittsburgh, Pennsylvania 15260. © 1993 Academic Press, Inc.

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1. INTRODUCTION

When the Yugoslav firms were suddenly allowed to operate in a relatively free market environment in the 1960s, extremely large interfirm and interin-

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dustry wage differentials emerged.² These differentials were found to persist even when skill, region, and job characteristics were taken into account.³ The major debate about the determinants of these differentials has never been fully resolved, but at present the phenomenon is naturally gaining particular significance.

Our goal in this paper is to (i) present a framework for analyzing wage determination in a suddenly decentralized socialist system with workers' control and (ii) apply the model to the Yugoslav data from the 1960s and early 1970s. The approach is of broader relevance because significant employee control and ownership as well as capital market imperfections seem a likely outcome of the reform process in much of Central and Eastern Europe. We extend the previous models in this area (see, e.g., Vanek and Jovicic (1975), Estrin and Svejnar (1985), and Estrin et al. (1988)) and we estimate a dynamic approximation to an earnings equation as well as an equation derived directly from a full dynamic model of the labor-managed firm.

The existing literature offers two explanations of the large wage dispersion. The first school of thought, referred to as the labor school, suggests that wage differentials derive from product and labor market imperfections that are transmitted to earnings through workers' bargaining power. The second group of observers, referred to as the capital school, sees income dispersion as stemming from rents attributable to capital market imperfections. Although in principle the labor and capital school hypotheses are not mutually exclusive, they have normally been treated as such and virtually no rigorous attempt has been made to evaluate their relative importance in explaining the observed wage dispersion.⁴

The paper is structured as follows: in Section 2 we develop a general formulation of the enterprise optimization problem, given earlier rationing of capital, and we provide estimates of the reduced form and various approximations to the system as a whole. However, the approach follows the mainstream applied literature in that it remains ad hoc with respect to dynamic

² By wages we refer to the Yugoslav term personal income per worker.

³ See, e.g., Wachtel (1972), Dirlam and Plummer (1973), World Bank (1975), Estrin (1981, 1984), and Lydall (1984). In the mid-1960s, the ratio of Yugoslav industrial wages from highest to lowest between firms within an industry typically exceeded 400%, and that between firms across all industries sometimes exceeded 1000%. Some 15% of Yugoslav firms paid average wages outside the range of 50–200% of the industrial mean, that is, outside a ratio from top to bottom of 4:1 (see Estrin, 1981).

⁴ Hence the formal models of Wachtel (1972, 1973) and Estrin (1984) focus exclusively on the labor school approach, while the more ad hoc research in the capital school tradition has either failed to test for, or has failed to isolate, any significant determinants of wages other than capital rents; see, e.g., Vanek and Jovicic (1975), Rivera-Batiz (1980), and Stallerts (1981). Moreover, in order to be consistent with the earlier literature, our recent work on this topic (Estrin et al., 1988) has treated the issue within a rather restrictive framework.

adjustment. In Section 3 we present a formal intertemporal specification of the problem, derive the dynamic estimation equation explicitly from intertemporal optimization, and provide an empirical illustration. We conclude that in an appropriately specified choice theoretic framework the capital school hypothesis is not supported empirically.

2. A STATIC FRAMEWORK FOR WAGE DETERMINATION

2.a. Labor and Capital Schools Compared

We now discuss the theory of wage determination in a labor-managed economy such as that of Yugoslavia.⁵ The labor-management literature, e.g., Ward (1958), Vanek (1970), Ireland and Law (1982), and Bonin and Putterman (1987), focuses almost exclusively on issues of comparative static adjustment and efficiency. Applied work on wage determination in this context has relied on ad hoc postulated functional relationships (see, e.g., Vanek and Jovicic (1975)), which leads one to question the robustness of the findings (see Estrin et al. (1988)).

The dominant approach in the empirical literature is that of the capital school, which seeks to explain Yugoslav earnings differentials in terms of capital immobility and pricing. The relevant features of the Yugoslav environment in this framework are capital shortages and the fact that enterprises are not required to pay the full opportunity cost for capital previously allocated to them by planners. The capital allocation process is therefore seen to generate monopoly rents which, in a decentralized system of workers' self-management, are appropriated by the labor force as personal income. It is argued that these differentials can be eliminated in the short term by appropriate capital pricing policies and in the longer run by the efficient allocation of capital.

Labor school theorists take a broader and more systemic approach to the determinants of wage differentials under decentralized labor-management. Their point of departure is the endogeneity of worker earnings in such a system and the peculiar operation of labor markets, and in particular labor immobilities associated with the fact that workers-insiders, appropriate the enterprise surplus as income and control the admission of new worker-members. Unlike in capitalism, where one can expect competitive forces to equalize the wages paid to a common labor type, differentials will not be

⁵ The large literature on wage determination in capitalist economies in the absence and presence of trade unions (see, e.g., Parsley (1980) and Lewis (1963, 1986)) has not generated models for firms in which the labor force participates in the decision-making process and the objectives of workers are at least partially maximized by the firm (see, e.g., Steinherr (1977), Svejnar (1982a,b, 1986), MaCurdy and Pencavel (1986), Brown and Ashenfelter (1986), and Ben-Ner and Estrin (1991)).

eliminated in the short run under labor-management because workers control labor recruitment. The narrowing of differentials and efficient transfer of labor between uses must rely on enterprise entry and exit, which the evidence suggests has been minimal in Yugoslavia over the studied period (see Sacks (1972), Prasnikar and Svejnar (1988), and Estrin and Petrin (1991)). In the light of their analysis, labor school theorists favor the encouragement of labor mobility, antitrust legislation, the reduction of entry barriers, and positive measures to stimulate enterprise entry into profitable areas.

The capital and labor schools therefore appear to offer different ways of modeling the wage determination process, estimating explanatory equations, interpreting the findings, and deriving implications for policy. However, it can be seen that the two are not in principle inconsistent, and indeed both rely on the fact that under labor-management, workers appropriate the residual surplus. We therefore develop a formulation of the problem which embeds both views.

2.b. Models

Our starting point is the standard analysis of labor-managed firms in which the firm pursues workers' objectives.⁶ Assuming for simplicity that the labor force, L , is homogeneous, workers maximize income per head, y , which is given by

$$y = \tilde{w} + \frac{\pi}{L}, \quad (1)$$

where $\tilde{w}$ denotes a wage and π denotes profits, equaling revenue, R , minus notional labor cost, $\tilde{w}L$, minus capital costs, rK .⁷

$$\pi = R - \tilde{w}L - rK. \quad (2)$$

Substituting (2) into (1) and rearranging terms yields the usual maximand for the labor-managed firm,

$$y = \frac{R - rK}{L}. \quad (3)$$

In operationalizing (3) we specify the revenue function as

$$R = R(p, \xi, L, K, A), \quad (4)$$

where A represents productive efficiency, p is product price, and ξ is the inverse of the elasticity of product demand.⁸ The function is formulated in

⁶ The model can be extended to the case where workers appropriate only part of the surplus (i.e., where insiders have incomplete power). See, e.g., Svejnar (1982a, 1986).

⁷ See Vanek (1970), Meade (1972), and Dreze (1985) for extensions of the homogeneous labor assumption. Note that in this framework, "wage" $\tilde{w}$ represents merely an accounting convention, with workers actually receiving earnings y .

⁸ For analytical convenience we assume that $R = p(1 - \xi)Q$.

this way to maintain the assumption of imperfect competition, which has been the dominant product market structure in Yugoslavia. The case of perfect competition is encompassed in Eq. (4).⁹

Conventional analysis proceeds by maximizing (3) with respect to L and K , subject to (4). The first-order conditions to this problem generate input demand equations which, when substituted into Eq. (3), yield an earnings equation as a function of product demand, productive efficiency, and input costs (see Estrin and Svejnar (1985)). However, this approach takes no account of the possibility of capital rationing.

To embed the capital school hypothesis, we formalize Yugoslav experience at the time of the 1965 reforms as follows. We assume that during the time period $[-\psi, 0]$ investment at the enterprise level is centrally controlled. At time 0, planners relinquish control and investment decisions are decentralized to the enterprise level, with funds being available for borrowing via a commercial banking system although significant capital rationing remains. The new independent labor-managed or participatory firms inherit an initial capital stock, FK ,

$$FK = \sum_{t=-\psi}^0 I_t(1 - \delta)^{-t}, \quad (5)$$

where I_t denotes investment in year t and δ is the rate of depreciation. The cost of this capital to the firms is denoted $\bar{r}$, a variable that many adherents of the capital school regard as zero. When the market-oriented reforms are introduced, investment funds are henceforth allocated to the firms at some positive cost r , and the assumption is that even if $\bar{r} > 0$, $r > \bar{r}$. It is not, however, assumed that r necessarily represents a market clearing price for capital.

During the market-oriented period $t > 0$, the firm uses capital stock K_t , with part $\bar{K}_t = FK(1 - \delta)^t$ —the discounted inheritance from the planners, costing $\bar{r}\bar{K}_t$, and being free if $\bar{r} = 0$ —and the part accumulated since the onset of the reform, $\hat{K}_t = K_t - \bar{K}_t$, costing $r\hat{K}_t$. If the marginal product of capital is R_{K_t} , the enterprise earns a capital rent in year t ,

$$P_t = (R_{K_t} - \bar{r})\bar{K}_t + (R_{K_t} - r_t)\hat{K}_t, \quad (6)$$

where $(R_{K_t} - \bar{r})\bar{K}_t$ and $(R_{K_t} - r_t)\hat{K}_t$ are rents on the capital accumulated in the prereform and reform periods, respectively. If worker-insiders have positive power, these rents can be distributed to the workers as income. Earnings can therefore be expected to be an increasing function of $\bar{K}_t$, and possibly $\hat{K}_t$, and to be inversely associated with $\bar{r}$ and r .¹⁰

⁹ This obtains when $\xi = 0$.

¹⁰ However, this only holds if $K > \bar{K}$. Suppose that at $t = 0$ the firm inherits more capital than it would choose for itself; i.e., $\bar{K}_0 > K_0^*$, where K^* is the desired capital stock. Incremental units of

In the absence of adjustment costs, in the years $t > 0$, the enterprise therefore maximizes

$$y = \frac{R(\xi, A, p, L, K) - \bar{r}\bar{K} - r\hat{K}}{L} \quad (7)$$

which, in the range $K > \bar{K}$ ($\hat{K} > 0$), yields first-order conditions

$$R_L = \frac{R - \bar{r}\bar{K} - r\hat{K}}{L} = y \quad (8)$$

and

$$R_K \geq r. \quad (9)$$

In Eqs. (8) and (9), R_i is the partial derivative of revenue with respect to input i , and the inequality $R_K \geq r$ reflects the fact that capital may still be rationed in the reform period. The two first-order conditions can in principle be solved for the reduced form input demand equations

$$L^* = L^*(r, \bar{r}, \bar{K}, \hat{K}, A, p, \xi) \quad (10)$$

$$K^* = K^*(r, \bar{r}, \bar{K}, \hat{K}, A, p, \xi), \quad (11)$$

where $*$ denotes the desired value of a given variable and $\hat{K}$ is present since capital was still rationed in the reform period. Workers' income is the maximand and hence cannot enter the input demand functions in the conventional way. Combining (7), (10), and (11) allows us to express earnings as an indirect function of the exogenous variables,

$$y^* = \frac{R(p, \xi, A, \bar{K}, \hat{K}, L^*(\cdot), K^*(\cdot), r, \bar{r}) - \bar{r}\bar{K} - r\hat{K}}{L^*(\cdot)} \quad (12)$$

$$= y(p, \xi, A, \bar{K}, \hat{K}, \bar{r}, r). \quad (13)$$

Comparative statics of Eq. (13) reveal that average earnings will be an increasing function of product price, technical efficiency, and of both pre- and post-reform capital stocks, although the coefficients on the latter two will be different if $r \neq \bar{r}$. Earnings will also be inversely related to the pre- and post-reform cost of capital.

$\bar{K}$ still raise earnings provided $R_{Kt} > \bar{r}$, but the firm will optimize (3) subject to a capital constraint ($\bar{K}$) and therefore hire relatively more workers than in the unconstrained case in order to spread the fixed cost burden more widely. As the excess capital depreciates away through time, the additional workers are shed until the firm reaches an unconstrained equilibrium. If the excess of inherited over desired capital is sufficiently large, so that $R_{Kt} < \bar{r}$, incremental units of $\bar{K}$ actually decrease earnings. While this special case is not ruled out by our formulation, we would expect, for most plausible values of K^* , $\bar{K}$, R_{Kt} , and $\bar{r}$, that monopoly rentals from inherited capital are positive.

2.c. Data

In applying the model, we use annual data for 19 Yugoslav industries during the 1965–1972 period. The choice of time period is guided primarily by institutional factors. The Yugoslavs introduced market self-management with a series of major reforms in 1965 (see Milenkovich (1971)), which fixes $t = 0$ at 1965 and hence makes FK be the capital stock in 1964. The system began to change with constitutional amendments in 1971 and strong pressures that were exerted to reduce income differentials. This has led firms to disguise the profit element of workers' incomes. Thus, although the residual surplus continued to vary among firms and be appropriated by the workers as incomes, this was no longer systematically recorded in official data. Measurement problems were also exacerbated by changes in the legal definition of the enterprise, which led to major data inconsistencies in the pre- and post-1972 periods (see Estrin (1984)). Our estimation period hence ends in 1972.

2.d. The Empirical Formulation and Estimates

Equation (13) implies immediate adjustment of the endogenous variables to their desired levels. However, a more realistic assumption is that lags exist in the adjustment of both capital and labor to their equilibrium values because of adjustment costs. In this section we take the usual ad hoc approach to the underlying dynamic relationships, by assuming a lag structure for each input demand equation,

$$L_t^* = D_1(l)L_t + u_{1t} \quad (14)$$

$$K_t^* = D_2(l)K_t + u_{2t} \quad (15)$$

as well as for

$$y_t^* = D_3(l)y_t + u_{3t}, \quad (16)$$

where $D_i(l)$ ($i = 1, 2, 3$) are lag operators and the error terms u_{it} are assumed to have zero mean and constant variance and to be serially uncorrelated. In the next section, we approach the issue of dynamics by explicitly specifying the underlying intertemporal model in order to derive directly the lag structure for the system.

Combining Eqs. (10) and (11) with (14) and (15), and time subscripting yields nonlinear labor and capital demand functions,

$$L_t^* = L_t^*(p_t, \xi_t, r_t, \bar{r}, \bar{K}, \hat{K}, A_t, D_1(l)L_t) \quad (17)$$

$$K_t^* = K_t^*(p_t, \xi_t, r_t, \bar{r}, \bar{K}, \hat{K}, A_t, D_2(l)K_t). \quad (18)$$

Similarly, combining (16) with (13) yields the nonlinear expression for worker incomes,

$$y_t^* = y_t(p_t, \xi_t, r_t, \bar{r}, \bar{K}, \hat{K}, A_t, D_1(l)L_t, D_2(l)K_t, D_3(l)y_t). \quad (19)$$

We approximate Eq. (19) by a log-linear specification. Product price is specified via an index of industrial prices with a base in 1964, and the elasticity of demand is permitted to vary over time, being proxied by a time-specific fixed effect. Since prices are endogenous in this imperfectly competitive environment, they are instrumented.¹¹ In the absence of any reliable measure of capital costs in the planning period, we estimate the log-linear approximation of Eq. (19) under the extreme capital school hypothesis, $\bar{r} = 0$.¹² An important aspect of the problem is the fact that the Yugoslav authorities controlled capital markets very tightly in the postreform period, fixing interest rates at all times except for one change in 1968. The fixing of interest rates was of course the main source of capital rentals after 1965 and it gave rise to the capital school argument. Given the absence of variation in r between industries, the real interest rate effects must be subsumed in the year specific fixed effects. The rationed element of capital, $\bar{K}$, equals capital in 1964 depreciated by the time- and industry-varying rates of amortization. All value variables are specified in real terms. Dynamics enter via $D_1(l)$, $D_2(l)$, and $D_3(l)$. Given that the data are annual and cover only 8 years, $D_i(l)$ s are specified as 1-year lags. In order to commence with the most general econometric form (see Hendry and Mizon (1978)), we also permit 1-year lags on the price and interest rate variables in our initial estimates.¹³

The industry-level nature of the data set induces heteroskedasticity, which leads to inconsistent covariance matrix estimates and faulty inferences from the use of conventional statistical hypothesis tests. We overcome this problem by using the covariance matrix estimator proposed by White (1980). This estimator is consistent in the presence of heteroskedasticity but does not rely on any formal model of its structure. The standard errors reported in Table 1 have all been computed on the basis of the estimates proposed by White (1980), Theorem 1. Finally, since Eq. (19) is a reduced form, it is estimated by ordinary least squares.

Table 1 represents five formulations of Eq. (19). Column (a) represents both the most general and best fitting formulation, with all the capital variables as well as the time-specific dummies being included. Although it has the highest R^2 and F statistics, there is rather little economics in the equation of column (a); earnings are driven primarily by previous years' earnings and time-specific fixed effects. This is as one might expect, with interindustry

¹¹ The prices are instrumented on output, time dummies, a time trend, and a constant.

¹² See Vanek and Jovicic (1975).

¹³ It should be noted, however, that from a theoretical perspective, incomes are fully determined by the actual levels of employment and capital, so that dynamics should enter via the input demand equations. We test this view among others as one of the restrictions on the general model.

TABLE 1
ESTIMATES OF LOG-LINEAR INDUSTRY EARNINGS EQUATIONS

	Dependent variable = real earnings (y_t) (values in parentheses are standard errors)				
	(a)	(b)	(c)	(d)	(e)
Intercept	1.229* (0.20)	0.563* (0.16)	0.520* (0.15)	0.559* (0.15)	0.627* (0.13)
y_{t-1}	0.945* (90.03)	0.588* (0.056)	0.603* (0.05)	0.593* (0.06)	0.582* (0.05)
L_{t-1}	-0.005 (0.008)	-0.063* (0.02)	-0.063* (0.02)	-0.064* (0.02)	-0.063* (0.02)
$\hat{K}_t$	0.003 (0.02)	0.018 (0.03)	-0.005 (0.03)	-0.007 (0.03)	—
K_{t-1}	-0.031 (0.12)	-0.234 (0.16)	0.052 (0.04)	—	-0.181 (0.16)
$\bar{K}_t$	0.028 (0.11)	0.266 (0.16)	—	0.056 (0.04)	0.231 (0.16)
p_t^a	0.075 (0.06)	0.710* (0.05)	0.679* (0.49)	0.682* (0.05)	0.695* (0.52)
p_{t-1}	-0.039 (0.04)	-0.164* (0.64)	-0.155 (0.65)	-0.156* (0.06)	-0.167* (0.06)
Year-specific fixed effects	Yes*	No	No	No	No
R^2	0.994	0.975	0.976	0.975	0.975
F	1741.9	741.3	853.0	859.6	869.8
SE	0.041	0.082	0.083	0.083	0.082

^a Instrumented as noted in footnote 14.

* Denotes statistical significance at the 99% level.

wage variations changing little from year to year and being successfully explained by annual changes submerged in the year dummies. However, it is not necessarily the best equation upon which to test the capital school hypothesis. We therefore present columns (b)–(d), in which year-specific dummies are excluded. Column (b) gives the most general formulation in this class of model, and columns (c) to (e) each exclude one of the capital variables.

This experimentation has no effect on our core result. In none of the five columns are any of the capital coefficients significant in the earnings equation. This is perhaps unsurprising in column (a), where the explanation offered is of a black box variety, but a more robust test is provided in columns (b)–(e), where instrumented prices play their expected significant role. These equations indicate that with a formal specification of the capital school model in a reduced form earnings equation, with endogeneity and fixed effects properly taken into account, there is no evidence for capital school

effects. This is in contrast to some of the previous results, i.e., Vanek and Jovicic (1972) and Estrin et al. (1988), which suggest that capital rentals are a significant factor in determining earnings. However, these earlier results are derived from partial and very restrictive models or ad hoc specifications, and they therefore cannot be regarded as reliable as results from the present, reduced form, structural model.

3. A DYNAMIC FRAMEWORK FOR WAGE DETERMINATION

3.a. Model

The static framework examined above has two potential weaknesses. First, the assumption that the wage equation could be approximated log-linearly may be too restrictive in the labor-managed context; compare Eqs. (13) and (19). Second, while the data are intertemporal, the model is static. In consequence, the dynamic structure adopted for estimation purposes, while consistent with much of the applied micro literature, is perhaps excessively simplistic.

We therefore proceed to extend the static framework by solving an intertemporal maximization problem for the labor-managed firm and estimating a first-order condition with the implied dynamic structure directly. We postulate that the firm maximizes the present discounted value of real income per worker over a fixed time horizon T and that it displays rational expectations in its behavior. In particular, we assume that the firm maximizes

$$\text{Max}_{\substack{I_0, \dots, I_T \\ \Delta L_0, \dots, \Delta L_T}} E \left\{ \sum_{t=0}^T \beta^t \frac{R_t(K_t, L_t) - q_t I_t - \bar{r} \bar{K}_t - C(I_t, \Delta L_t)}{L_t} \right\} \quad (20)$$

subject to

$$K_{t+1} = (1 - \delta_t)K_t + I_t \quad (21)$$

$$L_{t+1} = L_t + \Delta L_t, \quad (22)$$

where E is the expectations operator, β is the firm's discount rate, I is gross investment, q is the price of investment goods, and $C(\cdot)$ is an adjustment cost function.¹⁴

L_t and K_t ($K_t = \bar{K}_t + \hat{K}_t$) are the state variables and the nonstationary value function $V_t(K_t, L_t)$ satisfies the optimality equation

¹⁴ For an earlier literature on costs of adjusting labor in labor-managed firms, see, for example, Bonin (1984).

$$V(K_t, L_t) = \text{Max}_{I_t, \Delta L_t} \left\{ \frac{R_t(K_t, L_t) - q_t I_t - \bar{r} \bar{K}_t - C(I_t, \Delta L_t)}{L_t} + \beta E_t[V_{t+1}(K_{t+1}, L_{t+1})] \right\}. \quad (23)$$

Letting $\mu_t = \partial V_t / \partial L_t$ it follows that

$$\mu_t = \frac{L_t(R_L)_t - [R_t - q_t I_t - \bar{r} \bar{K}_t - C(I_t, \Delta L_t)]}{L_t^2} + \beta E_t(\mu_{t+1}). \quad (24)$$

From (23) it also follows that

$$\frac{\partial V_t}{\partial \Delta L_t} = - \frac{(C_{\Delta L})_t(I_t, \Delta L_t)}{L_t} + \beta E_t(\mu_{t+1}) = 0, \quad (25)$$

and hence (24) together with (25) yields

$$\mu_t = \frac{C_{\Delta L_t}(I_t, \Delta L_t)}{L_t} + \frac{L_t(R_L)_t - R_t + q_t I_t + \bar{r} \bar{K}_t + C(I_t, \Delta L_t)}{L_t^2} \quad (26)$$

Defining the rational expectations model as

$$\hat{\mu}_t = \mu_t - E_{t-1}(\mu_t) \quad (27)$$

and combining (26) with (27) yields a general estimating equation

$$\hat{\mu}_t = \frac{(C_{\Delta L})_t(I_t, \Delta L_t)}{L_t} + \frac{L_t(R_L)_t - R_t + q_t I_t + \bar{r} \bar{K}_t + C(I_t, \Delta L_t)}{L_t^2} - \frac{1}{\beta} \frac{(C_{\Delta L})_{t-1}}{L_{t-1}}, \quad (28)$$

with $\hat{\mu}_t$ being a serially uncorrelated one period forecast error of μ_t with mean zero.

To operationalize Eq. (28) in the presence of adjustment costs, we let

$$C(I_t, \Delta L_t) = \frac{1}{2} \alpha_0 I_t^2 + \frac{1}{2} \alpha_1 \Delta L_t^2 + \alpha_2 I_t \Delta L_t, \quad (29)$$

with $\alpha_0 \geq 0$ and $\alpha_1 \geq 0$. From (29), it follows that

$$(C_{\Delta L})_t(I_t, \Delta L_t) = \alpha_1 \Delta L_t + \alpha_2 I_t. \quad (30)$$

Substituting (29) into (28) and assuming that $\alpha_1 > 0$ and that the production function is of the general Cobb-Douglas form yields

$$\begin{aligned} \frac{\Delta L_t}{L_t} = & - \frac{\alpha_2}{\alpha_1} \frac{I_t L_{t+1}}{L_t^2} + \frac{(1 - \theta_L) R_t}{\alpha_1 L_t^2} - \frac{q_t I_t}{\alpha_1 L_t^2} - \frac{\bar{r} \bar{K}_t}{\alpha_1 L_t^2} - \frac{\alpha_0}{2 \alpha_1} \frac{I_t^2}{L_t^2} - \frac{1}{2} \frac{\Delta L_t^2}{L_t^2} \\ & + \frac{1}{\beta} \frac{\Delta L_{t-1}}{L_{t-1}} + \frac{\alpha_2}{\alpha_1 \beta} \frac{I_{t-1}}{L_{t-1}} + \mu_t^*, \end{aligned} \quad (31)$$

where $\mu_t^* = -\hat{\mu}_t / \alpha_1$ and θ_L is the labor elasticity of output, $(\partial Q / \partial L) / (Q / L)$.

3.b. Empirical Illustration

Equation (31) is a general estimating equation. It permits one to assess the validity of the capital school by generating an estimate of $\bar{r}$ which can be

TABLE 2
ESTIMATES OF THE UNRESTRICTED NONLINEAR DYNAMIC MODEL

$$\frac{\Delta L_t}{L_t} = -\frac{\alpha_2}{\alpha_1} \frac{I_t L_{t+1}}{L_t^2} + \frac{(1 - \theta_L) R_t}{\alpha_1 L_t^2} - \frac{1}{\alpha_1} q_t \frac{I_t}{L_t^2} - \frac{\bar{r}}{\alpha_1} \frac{\bar{K}_t}{L_t^2}$$

$$- \frac{\alpha_0}{2\alpha_1} \frac{I_t^2}{L_t^2} - \frac{1}{2} \frac{\Delta L_t^2}{L_t^2} + \frac{1}{\beta} \frac{\Delta L_{t-1}}{L_{t-1}} - \frac{\alpha_2}{\alpha_1 \beta} \frac{I_{t-1}}{L_{t-1}} + \mu_t^*$$

Parameter	Estimated coefficient	<i>t</i> statistics ^a
α_0	-0.171	0.75
α_1	-45.40	0.70
α_2	0.16	0.69
$1 - \theta_L$	-0.027	0.60
r	-0.34	0.72
β	4.69	2.89*

^a The *t* statistics are calculated using White's (1980) heteroskedasticity-consistent covariance matrix.

* Denotes statistically significant at the 99% level.

compared with r in the post-1964 period, as well as estimates of θ_L , the discount rate β , and the adjustment cost parameters α_0 , α_1 , and α_2 .

Nonlinear estimates of Eq. (31) are reported in Table 2. Instruments used were lagged change in employment, lagged investment per worker, and the industry and time dummies. The estimates were derived using starting values calculated from a linearized version of Eq. (31), with one nonlinear restriction. Other starting values included those calculated from previous drafts of the paper and other "plausible" starting points.

In practice, results were rather sensitive to starting values, which implies that the objective function is not well defined or, in other words, that it was difficult to obtain convergence to the maximum point. The equation reported in Table 2 is typical in having most coefficients insignificant and displaying some implausible signs. The cost of adjustment coefficients, which in large part motivate this framework are estimated to be insignificantly different from zero. Only the estimate of the discount rate β is found to be significant and the predicted value is implausible. Overall, the dynamic estimates are disappointing, so we attach little weight to them. The model in Eqs. (20)–(32), while theoretically a step in the right direction, must clearly await superior data to be estimated successfully.

4. CONCLUSIONS

In this paper, we have attempted to contribute to two substantive issues. The first concerns the traditional way of evaluating the impact of capital

rentals in Yugoslavia. Previous approaches, based on the assumption that the capital-labor ratio or the capital stock was exogenous, had been shown to generate biased estimates of the capital rental (see Estrin et al. (1988)). We have sought to model the rent-generating process directly, in the context of both static and dynamic models of enterprise behavior. Second, we have sought to contribute to the empirical methodology in this area. To that end, assumptions were made to derive a log-linear version of an earnings equation that theory suggested would be highly nonlinear, particularly by comparison with that of profit-maximizing firms. Dynamics were added to this equation in an ad hoc way. The results were good in econometric terms, but the underlying model could be viewed as theoretically loose. Consequently, a nonlinear model derived from a first-order condition of an intertemporal income maximization problem was also estimated. The parameters from this model had well-defined interpretations but the econometric results were unsatisfactory.

The central finding derived from the log-linear approximation is that capital rentals do not play a significant part in explaining the wide interindustry earnings variation in Yugoslavia during the period of market self-management. In future research it will be interesting to examine if a similar behavioral feature is observed in the transitional economies, e.g., Hungary and Poland, with significant worker power over the management of firms.

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