Inside the black box: compensation structures of efficient Yugoslavian firms

Klinedinst, Mark
University of Southern Mississippi

09. January 1991

Inside the Black Box: Compensation Structures of Efficient Yugoslavian Firms

Mark Klinedinst*

December, 1989
(A later version of this paper was published in Economic Analysis, 1991, Vol. 25, No. 4, pp. 363- 383.)

*University of Southern Mississippi

I would like to thank Janez Prasnikar for making the data available and for graciously going over details. I would like to also thank Jaroslav Vanek, Jan Svejnar, Tim Mount, Charles Rock and seminar participants at Cornell University who commented on earlier drafts of this paper.

Section I: Introduction

The main purpose of the research discussed in this paper has been to try to understand the main determinants of labor productivity within a firm from the perspective of the worker through a model and econometric application. Understanding why workers do the best they can or "just make time" is at the heart of the issue.

Yugoslavian labor managed firms are often thought to have an advantage in their use of potential labor compared to more autocratically structured firms. A general understanding of what makes labor more productive may elucidate the practitioners' understandings and enable the analysis of proposed changes in firm structure in capitalist and etatist countries (such as profit-sharing plans) to rest on a firmer theoretical foundation. In this paper a model for analyzing worker effort is developed and then applied to an analysis of 105 Yugoslavian firms. As a result of this investigation an interesting pattern was discovered between efficient Yugoslavian firms and their compensation structures.

The productivity of workers in western industrialized nations has been the subject of numerous empirical studies, usually on an aggregate level. Most analyses of the U.S. have had little luck in explaining the slowdown in the growth of productivity in the 1970's. As Edward Denison put it, "what happened is, to be blunt, a mystery" (E.F. Denison, 1979, p.4). The studies that have resulted in poor explanatory power have had one thing in common: they have consistently neglected the inner structure of the firm. This neglect of the structure of the workplace follows the tradition of taking the firm's structure as a given, and hence views the dynamics of growth as solely due to resources such as capital, labor quality, energy, etc. In a review of these methods, Richard R. Nelson pointed out that

> "the neoclassical theory of the firm contains two strong presumptions. The first is that 'technological knowledge'

is the basic determinant of the input-output possibilities available to the firm. The second is that management's 'choice' among clearly defined options determines what a firm does. The implicit image is of a firm as a machine, with some human parts, with management controlling the action by making choices which are implemented through direct command, perhaps mediated by a tight hierarchical structure" (R.R. Nelson, 1981, p.1037).

This view of the firm as a machine with the workers relegated to the role of an appendage is consistent with early 20th century Taylorism.

Some current theoretical work in macro and micro economics has begun to focus on the competitive advantages that may result from profit-sharing, codetermination, etc. Concurrent with this new emphasis in economics, many organizational behaviorists and management scientists place great importance on properly gauging and, when possible, promoting the workers' job satisfaction. These practitioners recognize that the workers' attitudes towards their jobs can be at least as important as any technological input in affecting productivity. Even "Business Week" acclaimed the quality of worklife emphasis as the "new industrial relations" (May, 1980). For organizational behaviorists and some managers there lately, then, has come about a "rediscovery of workers as a significant variable in production equations...both management and labor have begun to search for more effective ways to utilize individual capabilities and to reach previously untapped potential" (S.A. Levitan and C.M. Johnson, 1982, p. 213). Economists, though, for the most part, have not yet recognized this "untapped potential" of workers and consequently have continued to treat labor as an input that is unaffected by various work settings. When economists have attempted to gauge the effect of various work settings on productivity, they have been primarily concerned with three problems: the union, "extraction" attempts by management, and how the development of labor participation schemes affect labor productivity.

Although pointing out different channels for worker attitudes to be assessed and acted upon within a union workplace, the studies concerned with the union effect fail to make explicit how and why these attributes affect an individual's effort to supply greater work effort (e.g., C. Brown and J. Medoff, 1978; K. Clark, 1980; R.Ehrenberg,1982).

"Radical" economists (such as S. Bowles, M. I. Naples, etc.) who have examined the effects of various methods capitalist firms use to extract a greater amount of worker effort have shown that these extraction techniques (bureaucratic controls, unemployment, etc.) can be powerful explanatory variables in productivity changes, but again they have included them in models in an ad hoc manner. This ad hoc inclusion of variables, again, is the result of not tying these variables to a well-defined model of human effort.

The third type of productivity studies that also include important aspects of the social nature of work are studies that analyze the productivity effects of participation. Studies by Jan Svejnar, Derek Jones, Saul Estrin, etc., have helped show what kinds of structures and behaviors are conducive to creating and sustaining cooperatives in a market economy. These studies suggest that a great deal of the viability of cooperatives in a competitive environment is due to their comparative advantage in labor productivity, consequently giving statistical support to cooperators' intuition and to theoretical arguments developed by Jaroslav Vanek, Branko Horvat, and others. Many of these studies, however, recognize their ad hoc inclusion of variables that depict participatory structures and behavior, but so far no adequate linkage has been employed that ties these variables to a comprehensive theory of effort that would point to the source of the productivity advantage cooperatives enjoy.

Present and past studies on productivity generally neglected the importance of the inner structure of the firm; or when researchers have taken this into consideration, they have not shown precisely how the variables that they have chosen to reflect this essentially social structure might affect worker effort. Often it is the case that firm attributes found to be of importance in one study are neglected in another; however, it is also common in many empirical studies that the detail necessary for a comprehensive study is unavailable. The data set used here includes not only measures of capital, potential labor, firm income, etc., but it also has many other variables that are necessary for an accounting of labor supply, such as total labor compensation, skill levels of employees, hours of training within the firm, etc.

The next section of this paper will develop the model that will then be applied to the data, which is described in the third section of the paper. The fourth section will discuss the empirical results. The policy implications from both the theory and empirical results will then be addressed in the fifth section.

Section II: The Model

A contribution of this empirical study is the application of hierarchic preferences to the analysis of the firm. An hierarchic preference function allows the diverse aspects of the firm to affect effort in a manner consistent with theoretical and practical developments in utility theory.

In order to explicitly account for these diverse firm aspects' effect on worker effort and performance this study will use an effort function (i.e., a utility function or a de-alienation function). The function used here is fairly general. It nests within it more typical homothetic functions, but if all parameters are non-zero the function will have the important property of not being homothetic. The property of non-homotheticity is important in that most empirical work has found that expansion paths or income consumption curves are not linear, and hence are hierarchic in nature.

Briefly, a hierarchic preference function is characterized by an ordered "switching" of consumption bundles as income increases. As income increases, purchases of some goods level off or in the case of inferior goods even decline, while at the same time purchases of goods formerly rejected increase. In recent years the use of hierarchic preferences in theoretical work has atrophied, for the most part, to the brief acknowledgement of the differing demand elasticities for necessities and luxuries. In empirical work, however, hierarchic preferences are often used implicitly in the estimation of commodity demand functions. If hierarchic functions are indeed fair models of preferences, it is not surprising that in empirical work logarithmic forms of the Engels curves have proved so successful (see Jackson, 1984).

The analysis of the firm in economic studies that attempt to capture some aspects of the firm's structure presently include them as either simple dummy variables (e.g., unionized firm or not) or simply add them in production functions as additive or multiplicative terms (e.g., Brown and Medoff, 1978; Clark, 1980; Ehrenberg,1982),

$$\text{e.g.,} \quad Q=AK^{b}(L_{non-union}+cL_{union})^{a}. \qquad [1]$$

The inclusion of these variables in this manner can be justified on several grounds. The most powerful justification is that labor, like capital services, must be measured by some accounting of capacity utilized.

In other words, effective labor input to a firm is not necessarily equal to the potential labor input. The effort of workers will influence very profoundly the extent with which they utilize their abilities. Effective labor, then, is a result not only of potential labor, but also of effort. That is:

$$\text{Effective Labor} = (\text{Effort})*(\text{Potential Labor}). \qquad [2]$$

Zero effort may be seen as equivalent to having a strike. A highly motivated workforce may be able to use a large part of its potential; therefore, in this case the effort variable would be large.

If we let this motivational variable equal an hierarchic preference function and using a tractable function that captures the salient features of hierarchic preferences, we get:

$$\text{Effort} = U(\text{workplace}) = X^{A}Y^{B}e^{(D/X)} \qquad [3]$$

where A, B, AX-2D > O.

This function has the desirable properties usually expected of utility functions and a few more. The composite variables X and Y correspond to "goods" that fill the lower level and higher level preferences respectively. According to most economists and analysts of behavior, an hierarchic conception of effort has several different levels , but most all theorists would agree that at least two levels exist, and many would consider as the most basic partition a division of "goods" into two levels (e.g., "necessities" and "luxuries;" "negative" and "positive" incentives; etc.).

The broad nature of "goods" in each level creates both a benefit and a problem in analyzing effort. The benefit from these broad levels is that most data sets on firms have variables that are contained within these levels. Even if only a few of the variables necessary for a complete description of each level are available, the likely covariance of these variables will allow the few to act as adequate proxies for those variables for which no data is available.

The problem with using such broad levels to characterize human effort is to determine the "dividing line" between these two levels and to know which variables most adequately define the degree of fulfillment of each level. To deal with this problem reference must be made to economic and behavioral theory as well as to the actual institutional setting in which the data was collected.

Section III: Description of the Data and the Estimating Equations

The data used here, whose collection was directed by Janez Prasnikar of the University of Ljubljana, was collected from 105 industrial firms over the years from 1975 to 1979. These 105 firms represent approximately five percent of Yugoslavian industrial firms. The firms were randomly selected in proportion to the number of firms in each region of the country (eight regions: six republics and two autonomous provinces) and in proportion to the number of firms within each of the nine industrial classifications.

This data set is rich in detail. There are numerous variables that capture the characteristics of the firm and the workers that are often not available in other studies. The simple production function analysis of the firm that many studies conduct need far fewer variables due to the remnants of the servo-mechanistic or "Tayloresque" view of the firm. The hierarchic preference theory's emphasis on effective labor as a very important determinant of a firm's behavior will here utilize the detailed description of labor in these 105 firms.

The variables selected to act as proxies for the levels of the effort function were chosen with both theoretical guidance and from the results of a survey of 1,922 workers in these firms (Prasnikar, 1984). Average personal income was chosen to represent X, or level one of the effort function. This choice is consistent with the wide use of average personal income in theoretical models of labor managed firms which use average personal income as the prime variable of firm maximization. Average personal income was also listed in the survey mentioned as the primary goal of the workers. Three other variables were also tried individually and together with personal income (i.e., collective consumption on housing, new workers per year, and the capital labor ratio), but were found to be insignificant.

Collective consumption was ranked second in this survey. Although this survey did not break down collective consumption into two parts as was done here, collective consumption without housing expenditures captures not only a large part of total collective consumption, but it is also consistent with the public goods connotation that is part of the concept sought for in the second level of the effort function. Hence, collective consumption without housing expenditures per worker was used here as a proxy for level two, i.e., Y. Similar to level one, seven other variables were tried individually and together with collective consumption (e.g., training hours, low to high income ratio, etc.), but again they were found to be of secondary importance in nearly all specifications.

The firms used here average about 1,350 employees and range in size from 35 to 19,287. They have an average marketshare of approximately forty-one percent. The top twenty-five observations, ranked according to labor productivity (i.e., Q/L), are smaller firms in terms of employees than the bottom twenty-five; i.e., 771 versus 1,015 respectively (see Table 2). As expected, the high productivity firms have a higher rate of capacity utilization and also greater marketshare. There is a striking difference between the means for collective consumption expenditures per worker (i.e., Y). The value here for the top observations is approximately 70 times as great as for the bottom.

The dependent variable used in the estimation was value added (deflated, see Table 1 and the appendix for a description of the variables used). The measure of capital services used was capital valued at purchase value (deflated) corrected for actual capacity utilized. The variable used to measure potential labor, "L," was the number of hours worked corrected for the skill and education levels of the workers.

Taking the specification of effective labor in equation two, i.e.,

$$\text{Effective Labor}=(\text{Effort})*(\text{Potential Labor}) \qquad [2]$$

and replacing the normally used labor variable (usually just skill corrected labor), we get the following firm production function:

$$Q = F(\text{capital, effective labor}). \quad [4]$$

More specifically, in the case of a Cobb-Douglas production function, the production function would be the following:

$$Q = cK^b(\text{effective labor})^a.$$
[5]

Since potential labor is equivalent to the commonly used skill corrected labor, potential labor here is the standard "L." Substituting in for the hierarchic effort function and the standard labor variable gives the following specification:

$$Q = cK^b[(X^A Y^B e^{(D/X)})L]^a \quad [6]$$

or

$$Q = cK^b(X^{aA} Y^{aB} e^{(aD/X)})L^a. \quad [7]$$

The two other major functional forms used were the transcendental function and the constant elasticity of substitution function. Similar to the Cobb-Douglas case above, these two production functions were estimated with the effort function having an embodied effect on labor. The use of all three forms gives a certain amount of robustness to the results.

Since all of the specifications alluded to above have their advantages and their drawbacks all forms were estimated. All the variables that have so far been discussed could be argued to be choice variables of the firms within a given year. If firms determine their inputs according to the amount of output they expect to sell (among other things) then it could be also argued that there would be no simultaneity bias (A. Zellner, J. Kmenta, and J. Dreze, 1966).

Given the above two arguments, regressions were run for all the above models with and without instrumental variables. Instruments used for all variables were the same. Instruments used include: firm marketshare and firm marketshare squared; a dummy variable indicating joint ventures with foreign firms; the percentage change of Yugoslavian industrial prices; the value of Yugoslavian imports; time; and, following MaCurdy and Pencaval (1986) firm-specific dummies interacted with time and time squared.

Besides the three basic functional forms given above in which both truncated (i.e., one variable for each level as well as the use of first principal components) and complete representations (i.e., the use of all twelve variables mentioned earlier) of the effort function were estimated. All the regressions mentioned above were run with ordinary least squares and instrumental variables as well as with and without marketshare; a time trend; and regional, industry, region and industry, industry specific coefficients for labor and capital,and firm specific dummies.

In order to impose the least number of restrictions on the estimates, the labor and capital coefficients were allowed to be industry specific, as well as allowing for firm and time specific effects as mentioned above. Letting Q = output, Z = matrix of input and structural/policy variables, the firm fixed effects model may be written as

$$\ln Q = [I_N \otimes j_T \quad j_N \otimes (I_{T-1} \; 0')' \; Z] \, [\lambda \gamma \mu]' + \varepsilon \qquad [8]$$

where N = 105, T=5, $Q'=(Q'_1, Q'_2, . . ., Q'_{105})$, $Q_i = (Q_{i1}, Q_{i2}, . . ., Q_{i5})'$, $j_T = (1,1, . . ., 1)'$ and is of dimension T x 1. ε is defined in the same manner as Q. Lambda here represents the vector of firm-specific intercepts. Gamma is a vector of time-specific effects. Mu is a vector representing coefficients for labor, capital, and the effort variables (X and Y) in the matrix Z.

In order to get the most efficient estimates about the population parameters for all of Yugoslavian industry and not for just these 105 firms, a random effects model was also tested. The random effects model may be written as

$$\ln Q = [j_N \otimes (I_{T-1}\ 0')'\ Z]\ [\gamma\ \mu]' + \zeta \otimes j_T + \varepsilon \qquad [9]$$

where $\zeta = (\zeta_1, \zeta_2, \ldots, \zeta_N)'$.

Since in equation [9] time-specific effects are assumed fixed (there are only five years), the residual here with random firm effects becomes $v_{it} = \zeta_i + \varepsilon_{it}$. The presence of ζ_i causes correlation among observations of the same cross-sectional group, hence EGLS (estimated generalized least squares) must be used. Taylor (1980) has shown this two-step procedure to be more efficient than the fixed effect covariance model even if T = 2 and N - (number of right hand side variables) ≥ 10, a condition which is comfortably met here.

Section IV: The Results

The empirical results give tentative support to the hypotheses developed earlier. The results give evidence that average personal income (i.e., X) and collective consumption per worker without housing expenditures (i.e., Y) seem to have a particularly strong effect on worker effort and firm efficiency.

The observations ranked according to labor productivity show average personal income for the top twenty-five observations is almost twice that of the bottom twenty-five and collective consumption expenditures, i.e., Y, are many times higher for the efficient firms than for the less efficient. This finding between these two groups that there is a smaller difference in average personal income than collective consumption expenditures gives support to the hypothesis developed earlier that there are likely to be clearly superior goods, or firm characteristics, and that specifically collective consumption expenditures were hypothesized to be superior goods.

The translog and CES production functions both nest the Cobb-Douglas function, but they are non-nested vis a' vis themselves. The translog estimates are not reported here due to the near perfect multicollinearity (due to the larger variable set that is used with the effort function included, some cases they were actually computed to be perfectly collinear). That left comparison of the CES and Cobb-Douglas specifications. The CES estimations in all but one case (no effort function variables included with instrumental variables) had a higher sum of square errors than the Cobb-Douglas regressions. This can be explained, I believe, because of inaccuracies in the iterative procedure for nonlinear least squares with the CES formulation. However, the overall conclusion was that results from the CES model could not be used.

Since the translog specifications and the CES regressions were excluded from consideration for model selection, that left the remaining Cobb-Douglas regressions that were computed with a broad range of functional forms and procedures. The range of functional forms and procedures used include random firm effects, fixed firm effects, instrumental variables, principal components (of the original twelve variables considered for the effort function), industry specific labor and capital coefficients, etc.

The question of simultaneity was addressed by running models with and without instrumental variables. The test statistic developed by Wu (1973) and extended by Kiviet (1985) was used. The results of this test were ambiguous[1]. Given the theoretical expectation of possibly small simultaneity bias, the

[1] For example the F value computed for the model with firm dummies was 2.28 versus a critical F of 3.02 with 5 and 410 degrees of freedom and a significance level of 0.01 and the F value computed with only industry dummies was 4.46 versus a critical value of 3.17 with 5 and 506 degrees of freedom and a significance level of 0.01.

ambiguous test results, the high possibility of a type one error (Kiviet, 1985), and the very basic result that there is very little difference in the parameter estimates between the two models (i.e., OLS and IV), my choice here will be for the more parsimonious OLS models.

The random effects model although typically more efficient than the fixed effects models may suffer from bias due to omitted variables whose effects are summarized in the fixed effect parameters and are correlated with other independent variables. An example of this in production function studies is differing managerial ability. This type of bias due to the omission of variables (that may be unmeasurable) is not a problem if firm-specific effects are modeled. The existence of this bias was tested with the chi-square test developed by Hausman and Taylor (1981)[1] . This test indicated there is significant bias when the random effects model is used versus the fixed effects model (i.e., the chi-square computed was 53.89 versus the critical value for the 1 percent significance level at 26 degrees of freedom of 45.6).

The model with fixed firm effects, i.e., equation two in table 3, was also compared with F tests against the remaining equations of table two. Specifications 3-5, which are nested within specification 2, all were found inferior. When considering the time, region, and industry dummies appended to the Cobb-Douglas function in specifications 3-5, according to F tests industry specific intercepts were the most powerful

---

[1] The specification test is from Hausman and Taylor (1981).

$$\chi 2 = (b - B)'(M1-M2)^{-1}(b-B)$$

where $M1=\sigma_{\varepsilon}^{2}[X'(I_N \otimes D_T)X]^{-1}$, $M2 = (X'\Psi^{-1}X)^{-1}$,

D_T is the parsing matrix $I_T - j_T j'_T/T$, Ψ is the covariance matrix,

and the vectors b and B represent the parameter estimates from the fixed effects and error components models respectively.

explanatory dummy set. This lack of power of the regional and time dummy sets is reflected in the lack of precision with which most of these dummies are estimated. This lack of precision is shown most glaringly in the regional dummies which are often negative, this is counterintuitive to what would be expected since relatively underdeveloped Kosovo is the base. Although measurement of these effects is not measured with much accuracy, they were left in the model due to the results of the F tests and to help ensure the unbiasedness of the effort function parameters.

The labor and capital coefficients when taken together show the expected result of slightly decreasing returns to scale in equations 4 and 5. In the equations with industry specific labor and capital coefficients, those coefficients which have relatively high t-scores also typically show slightly decreasing returns as well. Looking at equation 4, if these same parameters are considered cost share parameters, the results are at some variance from what is usually expected. The coefficient on labor, here effective labor, is estimated to be .84 and the capital coefficient of approximately .12 indicates that when effective labor is considered rather than just potential labor, the elasticity of output with respect to labor increases at the same time as it decreases for capital.

Since the regression without any effort function variables is nested within the regression using X and Y, it would be expected, as was found, that the sum of squared errors of this estimation would be greater. Which regression is more powerful was tested again with the F test. As is obvious by the difference in the sum of squared errors for these two equations, the results of this test were strongly in favor of the full model that used X and Y (the F value computed was 156.53 versus a critical value of 3.78 with 3 and 500 degrees of freedom and a significance level of 0.01).

This dramatically increased explanatory power of the model when effective labor is modeled rather than just potential labor showed up in a broad number of specifications. Table 4 shows this extraordinary drop in error across specifications.

The above results indicate that there is evidence that the effort function specification gives a better fit in analyses of the firm than the traditional "black box" interpretation that does not consider the inner workings of the firm as important. The comparison of the effort function specification here with models that do include variables that attempt to gauge the inner workings of the firm must rest mainly on the precision of the coefficient on the extra term the effort function specification would add to these models, i.e., the parameter "D," or delta. (A real test is actually more involved since some of the variables used were suggested by the effort function theory, etc.) The parameter D, although measured with some precision by the top models, is not measured with much precision in others.

The parameters alpha and beta of the effort function were rather precisely estimated to be positive as expected across a wide range of model specifications. These two parameters and the parameter delta together determine whether the effort function estimated is consistent with an hierarchical effort function. The models selected as best according to statistical criteria from a wide variety of specifications all estimated an effort function (evaluated around the mean of the data) that is consistent with an hierarchical conception of effort.

Section V: Policy Implications

The empirical application of an hierarchical preference function to the productivity problem did seem to garner at least tentative support. This being the case, what are the implications for a firm if members of that firm are motivated by an hierarchic preferences as developed earlier in this paper? The concept of an ordered change in observed behavior inherent in the hierarchic effort function theory makes part of this question relatively easy to answer. The hierarchical leveling of preferences implies that a firm that is attuned to these needs and how they change will probably be a more efficient firm. This is because as the firm moved out the analogue to the income consumption curve the workers' effort, or welfare, would be greater and hence also their productivity. This increase in productivity would result in a more efficient firm that would have greater market viability. It is in describing these needs and how they change that makes the above question harder to answer.

The empirical investigations undertaken here point out X and Y, (i.e., average personal income and collective consumption without housing per worker) are the most powerful attributes of each of the two levels of the hierarchic preference function. As mentioned earlier,this result is also consistent with the rankings that the survey of 1,922 workers in these firms revealed (Prasnikar, 1984). Average personal income, as discussed earlier, has long been considered the primary maximand of workers in a labor-managed firm. The results, however, also suggest that the higher level firm attributes are also important. If the hierarchic preference model is true, it is also true then that average personal income is the primary maximand for the labor-managed firm only part of the time. The hierarchical preference function implies that once average personal income has reached a certain level the higher level goods, here characterized by collective consumption expenditures, become important incentives for the firm. Hence average personal income is the primary maximand only part of the time. The firm that spends an ever-increasing portion of its disposable income on collective consumption as its disposable income rises would be the more efficient firm. This supposition seems to be born out by not only the regressions estimated, but also by a comparison of collective consumption expenditures (i.e., Y) by the top versus the bottom twenty-five observations ranked according to labor productivity. The collective consumption expenditures per person for the top twenty-five observations were almost seventy times as great as those at the bottom (i.e., 9,250 dinars versus 134).

Using the estimated production function from equation two in the results section, there are a number of interesting policy implications that surface from an analysis of the partials of output with respect to X and Y. These partials were computed using the overall means for the variables involved, for the mean values of the top twenty-five observations, and for the mean values of the bottom twenty-five observations. The top firms, as might be suspected, seem to be splitting their income between X and Y in a manner that maximizes the effort function, as evidenced by the ratio of partials (i.e., Q_X/Q_Y equaling approximately one). An analysis of the partials using the means from both the bottom firms and all firms indicates that firms are putting too much emphasis on personal income relative to collective consumption expenditures (i.e., Y). The return to the firm from increasing collective consumption expenditures is estimated here to be greater than twice as rewarding as extra money spent on personal income. This result suggests that expenditures on collective consumption may be a vastly overlooked "asset," not a cost, that the average and below average firms should not do without.

A problem in the interpretation of these results is whether the effort function estimated here is actually a revelation of the workers' preferences or an observation of government "moral suasion" and customs. The two different interpretations are difficult to disentangle. Since regional governments often discourage firms from paying personal incomes that are well above the regional average, the firms may for this reason imitate an hierarchical effort function by distributing increased firm income in increasingly higher percentages on the less visible expenditures of collective consumption. This could be interpreted as indirect support for the hierarchic effort function since the workers of the firm (as political "actors") should have input in the determination of regional policy, but this behavior would not then be a revelation of the preferences of any one particular firm. To attempt to disentangle these competing interpretations, plots of Y on X, collective consumption and average personal income respectively, were performed for each region with Y on the vertical axis. If regional government suasion is really effective then at high levels of personal income the observations on collective consumption should increase dramatically. Graphically this dramatic rise in collective consumption expenditures should cause a line fit to the scattergram of these points to approach a vertical asymptote where the regional limit on personal incomes is reached. A visual inspection of these plots does show a dramatic rise in collective consumption expenditures as personal income increases, but there does not appear to be any definite asymptote.

The two variables found here to represent the effort function (from twelve variables originally), i.e., average personal income and collective consumption without housing per worker, were both monetary variables. Although both variables here are monetary variables I believe the interpretation of Y, i.e., collective consumption expenditures, implies a much richer pattern than implied by the oft-heard refrain that workers are "just after the money." Collective consumption expenditures in Yugoslavian firms are spent on such diverse items as; training within the firm, the organization of day care, vacation houses, lunches, culture in the firm (e.g., music and actors for celebrations), sports, holiday pay, etc. Although some of these items seem like typical fringe benefits, there is still an aspect here that is different. The focus of some of these expenditures on trying to support a broad range of workers' concerns in the workplace could give credence to interpreting some of these expenditures as workers' decisions to support an "internal supporting structure." A structure for looking not just at how workers are doing individually, but also how they are functioning together. The importance of supporting structures (e.g., financial institutions, government regulatory bodies, indicative planning agencies, etc.) have been widely discussed in an attempt to keep markets viable. Thus, similar to these relatively large scale schemes, the success of firms here that spend a relatively higher percentage of their income on collective consumption expenditures seems due in part to the success of a supporting structure inside the firm.

Recently there has been a renewed interest in profit-sharing, worker ownership, etc., and its likely micro and macroeconomic benefits. Since the firms in this sample are all profit- or income-sharing firms, the results here may give some insight to other countries attempting to create similar enterprises. These results suggest that profit-sharing alone is no guarantee for increased firm efficiency. However, if these monies are spent in part on increasing support structures within the firm there may indeed be increased efficiency, and hence all the micro and macroeconomic benefits that accrue from higher productivity.

The results indicate that on the basis of these data there is support for the hypothesis that an hierarchical effort function of the workers may indeed help explain variations in firm productivity. Not all variables selected to be included in the hierarchical effort function had the predicted effect and/or were some of these effects measured with a great deal of accuracy. However, the function as a whole generally added considerable explanatory power to the analysis of firm efficiency, and some variables in the hierarchical effort function clearly dominated others in explanatory power. The two variables which were the most significant of the variables used were average personal income and collective consumption per worker (excluding housing expenditures).

These results suggest that the typical analytical maximand of average personal income in a labor managed firm is only, as expected, the firm's maximand part of the time. If personal income is at a reasonably high level, these results suggest some types of collective consumption goods become increasingly important potential incentives for enhancing productivity.

TABLE 1

SUMMARY STATISTICS OF RELEVANT VARIABLES[1]

Variables	Mean	Standard Deviation
Value Added, thousands of '75 dinars	83,658.15	17,363.11
Labor-full time equivalents	1,347.83	2,251.11
Labor-unskilled equivalents	1,734.60	2,947.10
Capital-purchase value, thousands of '75 dinars	298,426.57	1,278,614.10
Capacity Utilization	69.18	19.47
Marketshare-firm reported	40.99	28.03

[1] Calculations are made for the period 1975-79 on the 525 panel observations used in estimation

Number of Competitors	28.21	82.46
Joint Ventures with Foreign Firms	0.14	0.34
Firms, number of in sample[2]	105	
Slovenia (firms in)	20	
Croatia	27	
Vojvodina	14	
Serbia	18	
Bosnia/Herzegovina	14	
Montenegro	2	
Macedonia	7	
Kosovo	3	
Energy Industry (number of firms in)	2	
Metallurgy	5	
Processing of Non-Metals	12	
Metal Processing	29	
Chemical and Paper	11	
Wood	8	
Textile, Leather and Rubber	25	
Miscellaneous Industries	10	
X:Average Income Per Worker, thousands of '75 dinars	96.19	23.46
Y:Collective Consumption Except Housing Per Worker, thousands of '75 dinars	3.17	3.57

TABLE 2

COMPARISON OF DATA OF THE TOP TWENTY-FIVE AND BOTTOM TWENTY-FIVE OBSERVATIONS RANKED ACCORDING TO AVERAGE LABOR PRODUCTIVITY[1]

Variables	Top 25	Bottom 25
Labor Productivity	105.90	15.75
Value Added, thousands of '75 dinars	108,452.96	21,635.43
Labor-full time equivalents	771.52	1,015.52

[2] Data appearing without standard deviations are sums.

[1] Average labor productivity is here defined as Q/L. Where Q is value added deflated by industry and L is the amount of unskilled labor equivalents used in a year.

Labor-unskilled equivalents	1,034.86	1,269.31
Capital-purchase value, thousands of '75 dinars	360,746.50	83,188.27
Capacity Utilization	82.21	65.22
Marketshare-firm reported	48.72	33.52
Number of Competitors	12.40	31.44
Joint Ventures with Foreign Firms, number of in sample	6	1
Firms, number of in sample	12	16
Slovenia (firms in)	9	3
Croatia	5	5
Vojvodina	6	1
Serbia	4	3
Bosnia/Herzegovina	0	9
Montenegro	0	0
Macedonia	0	3
Kosovo	1	1
Energy Industry (number of firms in)	5	0
Metallurgy	3	1
Processing of Non-Metals	1	8
Metal Processing	2	4
Chemical and Paper	6	0
Wood	0	2
Textile, Leather and Rubber	2	9
Miscellaneous Industries	0	0
X:Average Income Per Worker, thousands of '75 dinars	135.47	67.49
Y:Collective Consumption Except Housing Per Worker, thousands of '75 dinars	9.25	0.13

TABLE 3

RESULTS

Random and Fixed Effects OLS estimates of the Cobb-Douglas Production Function Parameters for 105 Yugoslav Firms in the 1975-79 Period
(Values in Parentheses are Standard Errors)

	Random	Fixed			
	(1)	(2)	(3)	(4)	(5)
Intercept	-5.86 (1.36)	0.65E-16 (0.95E-2)	-9.66 (2.08)	-11.93 (1.86)	2.65 (0.19)
Alpha (Income per Worker)	1.80 (0.26)	1.32 (0.33)	2.42 (0.26)	2.43 (0.22)	
Beta (Collective Consumption per Worker)	0.08 (0.006)	0.07 (0.007)	0.11 (0.007)	0.10 (0.007)	
Delta	71.62 (19.50)	47.55 (23.61)	98.40 (19.40)	109.40 (18.84)	
Firm Specific Effects	Yes	Yes	No	No	No
lnL_1 (industry one)	0.96 (0.34)	0.42 (0.99)	0.69 (0.63)		
lnL_2	0.69 (0.18)	2.09 (0.90)	0.66 (0.16)		
lnL_3	0.92 (0.11)	0.67 (0.25)	1.14 (0.10)		
lnL_4	0.77 (0.05)	0.78 (0.18)	0.78 (0.04)		
lnL_5 (lnL for columns 4 and 5)	0.82 (0.09)	1.19 (0.31)	0.79 (0.07)	0.84 (0.03)	0.75 (0.03)
lnL_6	1.00 (0.10)	1.19 (0.20)	0.95 (0.08)		
lnL_7	1.04 (0.06)	0.42 (0.26)	0.91 (0.05)		
lnL_8	0.71 (0.07)	0.82 (0.36)	0.72 (0.05)		
lnL_9	1.04 (0.29)	0.98 (0.35)	1.14 (0.29)		
lnK_1	0.05 (0.19)	-0.002 (0.25)	0.29 (0.20)		
lnK_2	0.22 (0.12)	-0.10 (0.22)	0.37 (0.12)		
lnK_3	0.07 (0.07)	0.30 (0.11)	0.00 (0.55)		
lnK_4	0.17 (0.04)	0.07 (0.11)	0.17 (0.03)		

lnK_5 (lnK for columns 4 and 5)	0.15 (0.05)	0.05 (0.11)	0.17 (0.06)	0.12 (0.02)	0.20 (0.02)
lnK_6	0.03 (0.06)	-0.23 (0.14)	0.08 (0.05)		
lnK_7	0.004 (0.04)	0.004 (0.08)	0.04 (0.03)		
lnK_8	0.20 (0.04)	0.19 (0.09)	0.19 (0.04)		
lnK_9	-0.02 (0.17)	-0.10 (0.22)	-0.04 (0.16)		
Time Dummy for 1976	-0.07 (0.03)	-0.08 (0.03)	-0.07 (0.03)	-0.09 (0.05)	-0.06 (0.05)
Time Dummy for 1977	-0.12 (0.03)	-0.10 (0.04)	-0.14 (0.03)	-0.15 (0.03)	-0.02 (0.05)
Time Dummy for 1978	-0.11 (0.03)	-0.06 (0.04)	-0.13 (0.04)	-0.15 (0.04)	0.08 (0.05)
Time Dummy for 1979	-0.09 (0.03)	-0.02 (0.05)	-0.12 (0.37)	-0.14 (0.04)	0.11 (0.05)
Industry Dummy Variables					
1-Energy			8.87 (3.36)	0.22 (0.11)	0.76 (0.14)
2-Metallurgy			-1.39 (1.14)	0.40 (0.09)	0.62 (0.13)
3-Non-Metal Processing			-0.23 (0.95)	0.22 (0.07)	0.20 (0.10)
4-Metal Processing			0.33 (0.94)	0.24 (0.07)	0.46 (0.10)
5-Chemicals & Paper			0.28 (0.97)	0.40 (0.07)	0.61 (0.10)
6-Wood			0.19 (0.96)	0.35 (0.08)	0.33 (0.11)
7-Textile, Leather & Rubber			0.92 (0.93)	0.44 (0.07)	0.34 (0.10)
8-Food and Tobacco			0.39 (0.96)	0.30 (0.08)	0.41 (0.10)
Regional Dummy Variables					
Slovenia			-0.16 (0.08)	-0.21 (0.08	0.29 (0.10)
Croatia			-0.11 (0.08)	-0.15 (0.07)	0.25 (0.10)
Vojvodina			-0.16 (0.08)	-0.19 (0.08)	0.29 (0.10)
Serbia			-0.04 (0.08)	-0.04 (0.08)	0.24 (0.10)

Bosnia/Herzegovina			-0.07 (0.08)	-0.05 (0.08)	0.12 (0.11)
Montenegro			-0.20 (0.12)	-0.27 (0.11)	0.14 (0.15)
Macedonia			-0.09 (0.09)	-0.13 (0.08)	0.01 (0.11)
N	525	525	525	525	525
Sum of Squared Errors	24.23	17.59	28.00	30.93	59.98

TABLE 4

COMPARISONS OF THE SUM OF SQUARED ERRORS
BETWEEN MODELS WITH AND WITHOUT THE EFFORT FUNCTION

Production Functions for 105 Yugoslav Firms During 1975-79 (Sum of Squared Errors are the Top Entries and the Entries in Parentheses are the Percentage Changes from First Row Entries)

	Cobb-Douglas[1]		Translog		CES[2]	
	OLS	IV	OLS	IV	OLS	IV
No Effort Variables	67.15 (0)	87.26 (0)	64.17 (0)	86.20 (0)	70.01 (0)	86.41 (0)
X, Y included	33.90 (-50)	60.61 (-31)	28.89 (-55)	34.33 (-60)	128.93 (84)	65.74 (-24)
Principal Components[3]	54.27 (-19)	75.78 (-13)	48.57 (-24)	51.83 (-40)	54.34 (-22)	45.81 (-12)
Twelve Effort Varialbes[4]	38.45 (-43)	61.88 (-30)	34.68 (-46)	72.45 (-16)	54.98 (-21)	66.64 (-23)

[1] All specifications have the basic production function variables (i.e., labor and capital) as well as industry dummy variables.
[2] Note that the CES functions and all estimations that used several effort variables (i.e., twelve and five) required the use of nonlinear least squares.
[3] First principal components of the variables in each level of the effort function were used in these regressions.
[4] The regressions here that use twelve and five effort variables simultaneously were found by appropriate selection tests to be

Five Effort Variables	47.75 (-29)	78.16 (-10)	44.24 (-31)	98.92 (15)	112.40 (61)	91.47 (6)

References

Bowles, S. "The Production Process in a Competitive Economy," American Economic Review, March 1985, 75:16-36.

Brown, C. and Medoff, J. "Trade Unions in the Production Process," Journal of Political Economy, March 1978, 86: 355- 79.

Clark, K.B. "Unionization and Productivity Micro-Econometric Evidence," Quarterly Journal of Economics, December 1980, pp. 613-39.

Denison, Edward F. Accounting for Slower Growth, Washington, D.C.: The Brookings Institution, 1979.

Ehrenberg, R.G., Sherman, D.R., and Schwartz, J.L. "Unions and Productivity in Municipal Public Libraries," mimeo., Cornell University,July, 1982.

Estrin, S. Self-Management: Economic Theory and Yugoslav Practice, Cambridge University Press, 1983.

Halter, A.N., Carter, H.O. and Hocking, J.G. "A Note on Transcendental Production Functions," Journal of Farm Economics, 1957, 39: 966-74.

Hausman, J. A., and Taylor, W. E. "Panel Data and Unobservable Individual Effects," Econometrica, 1981, 49:1377-98.

Horvat, B. Political Economy, M.E. Sharpe, 1979.

inferior relative to those that use just X and Y, hence only a small sample of their results are summarized here.

----"Yugoslav Economic Policy in the Post-War Period: Problems, Ideas, Institutional Developments," American Economic Review, 1971, 61: 69-169.

Jackson, L.F. "Hierarchic Demand and Engel Curve for Variety," Review of Economics and Statistics, February 1984, pp. 8-15.

Jones, D. and Svejnar J. Participation and Self-Managed Firms, D.C. Heath, 1982.

Kasoff, M.J. "Local Government in Yugoslavia and the Constitutional Reform of 1974," American Journal of Planning, October 1976.

Kiviet, Jan F. "Model Selection Test Procedures in a Single Linear Equation of a Dynamic Simultaneous System and Their Defects in Small Samples," Journal of Econometrics, 1985, 28:327-362.

Levitan, S.A. and Johnson, C.M. Second Thoughts on Work, Upjohn Institute for Employment Research, 1982.

MaCurdy, T. E. and Pencavel, J.H. "Testing Between Competing Models of Wage and Employment Determination in Unionised Markets," Journal of Political Economy, 1986, 94:53-59

Naples, M.I. "Industrial Conflict and Its Implications for Productivity Growth," American Economic Review, May 1981.

Nelson, R.R. "Research on Productivity Growth and Productivity Differences: Dean Ends and New Departures," Journal of Economic Literature, September 1981, 29: 1029-1064.

"The New Industrial Relations," Business Week, May 11, 1980, pp. 96-8.

Prasnikar, J. "The Yugoslav Self-Managed Enterprise and Factors of its Efficiency," Economic Analysis, 1983.

----"The Yugoslav Self-Managed Firm," Eastern European Economics, Winter, 1984.

----Svejnar, J. and Klinedinst, M. "Structural Factors and Productive Efficiency in Yugoslav Self-Managed Firms," mimeo., Cornell University, 1988.

Svejnar, J. and Jones, D. "Participation, Profit Sharing, Worker Ownership and Efficiency in Italian Producer Cooperatives," Economica, 1985.

----"Employee Participation in Management, Bargaining Power and Wages," European Economic Review, July 1982, pp. 291-303.

Taylor, W.E. "Small Sample Consideration in Estimation From Panel Data," Journal of Econometrics, 1980, 13:203-23.

Vanek, J. The Participatory Economy, Cornell University Press, 1971.

---- and Jovicic, M. "The Capital Market and Income Distribution in Yugoslavia: A Theoretical and Empirical Analysis," Quarterly Journal of Economics, 1975, vol. 89.

Wu, D. "Alternative Tests of Independence Between Stochastic Regressors and Disturbances," Econometrica, 41: 733-750.

Zellner, A., Kmenta J., and Dreze J. "Specification and Estimation of Cobb-Douglas Production Function Models," Econometrica, October 1966, 34: 784-795.

APPENDIX: Description of the Data and Variables

The data were gathered by a research team headed by Janez Prasnikar in 1980-81. The firms selected represent a five percent random sample from Yugoslavian industrial firms (WOALS) stratified by region and industry. There are a total of 735 observations in this data set, i.e., 147 firms observed over the five year period of 1975-79. 525 observations remained for use in the regressions after deleting observations with missing values.

Q = value added = total labor costs + total capital costs + surplus = revenue - material costs.

This variable, measured in thousands of 1975 dinars, was deflated using industry level price indices.

K = capital = fixed capital at historical cost (purchase value of capital).

This variable was measured in thousands of 1975 dinars. This variable was also corrected each year for reported capacity utilization; i.e., K here is equal to (capital)*(percentage of capacity utilized).

L = potential labor = number of unskilled worker equivalents = skill corrected labor given by

$$Lj = \sum_{i=1}^{8}(I_i/I_1)L_i$$

where, Lj = the number of unskilled worker equivalents in firm j. I_i = the average income of skill i in Yugoslav industry I_1 = the average income of skill one in Yugoslav industry. L_i = the number of workers in the i^{th} skill group in the firm (of eight groups).

X = The average personal income of members of the firm. 1975 dinars. X=(firm income - total capital costs - accumulation - taxes - social contributions)/(labor-full time equivalents). Where the number of full-time equivalent workers of a firm is determined by the number of hours worked.

Y = Income spent on collective consumption per worker. 1975 dinars. That portion of collective consumption spent on housing is not included here. This money is spent on such things as: lunches, holiday pay, vacation houses, day care, education courses in the firm, sports, culture in the firm (e.g., International Women's Day [March 8], parties, celebrations with music, actors, etc.).