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Monetary Consideration in Yugoslav Industrial Production*

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This study analyzes the role of real money balances in Yugoslav industrial production. In addition to labor and capital inputs, real money balances turned out to be a significant factor of production. The production function utilized was an unconstrained Cobb-Douglas specification following earlier studies. In addition to the inclusion of both narrowly and broadly defined money measures, alternative formulations for technical change were tested. In addition to labor and capital inputs, the empirical findings suggest that Yugoslav industrial output can be explained by both real money balances and declining rate of growth in total factor productivity.

I. Introduction

The idea of real money balances as an input in the production process has not gone unnoticed.[1] The theoretical underpinnings for the inclusion of money in the production function stem from the monetary growth

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[1] Sinai and Stokes (1972) implemented an unconstrained Cobb-Douglas production specification estimated via ordinary least squares corrected for first-order autocorrelation. Niccoli (1975) suggests that real money balances serves only as a proxy for current investment within production. Prais (1975) questions the autocorrelation adjustment in Sinai and Stokes (1972) estimation. Khan and Kouri (1975) include an equation for real money balance utilizing full-information maximum likelihood estimation. Ben-Zion and Ruttan (1975) argue that money may only be a proxy for short-run fluctuations in aggregate demand through induced innovations. In turn, Sinai and Stokes (1975) refute the criticism brought fourth. Short (1979), Simos (1981), and Subrahmanyan (1980) develop structural models based on Cobb-Douglas and the more generalized translogarithmic production specifications

models of Levhari and Patinkin (1968), Johnson (1969), Friedman (1969), Stein (1970), and Nadiri (1970). The general reasoning for the inclusion of real money balances in the production function centers on the increased productivity gains derived from using money. As Sinai and Stokes (1972) point out, money used as a medium of exchange eliminates the double coincidence of wants often experienced within a barter economy. In the case of a barter economy which is implicitly assumed in typical neoclassical production functions, a fair amount of labor and capital inputs are diverted from production to that of distribution in order to fulfill the "double coincidence" of wants required in a barter economy (p. 290). Thus, by releasing capital and labor from the process of distribution to production, money provides a more efficient use of the labor and capital inputs that were alternatively used in the "search-bargain process of exchange" (Short, 1979). Moreover, Fischer (1974) suggests that real money balances may be viable within the context of a production function conditional on the particular exchange arrangements faced by a firm.[2]

Since the initial investigation by Sinai and Stokes (1972) a majority of the discussion and empirical testing has been confined to industrial countries, namely, the United States and Japan (see Sinai and Stokes, 1981). However, more recently Khan and Ahmad (1985) examine the validity of real money balances as a factor input in the production function of the manufacturing sector in Pakistan. Khan and Ahmad (1985) find that both narrowly and broadly defined real money balances exhibit a positive and statistically significant influence upon output in the Pakistan manufacturing sector. Therefore, the task of this paper is to empirically examine the role of real money balances in the production function of Yugoslav industrial output. Noting the significance of exchange arrangements faced by firms Section II will elaborate upon the unique features associated with industrial production in Yugoslavia. Section III discusses the methodology and data. The empirical results are presented in Section IV while Section V provides concluding remarks.

yielding results which support the inclusion of real money balance in the production function. Boyes and Kavanaugh (1979) conduct specification error tests concluding that any alteration of the two-factor CES production function results in misspecification error. Ngugen (1986) reexamines previous evidence casting doubts on the inclusion of real money balances.

[2] Fischer (1974) makes an interesting point pertinent to the Yugoslav case at hand, "it is expensive for the firm to be short of cash. An expected sales function

$$Y = g(X, M/P, V)$$

where Y is output, X is physical inputs, M/P real cash balances, and V is some vector of other inputs where X and M/P have positive marginal products can be incorporated into firm behavior thus making real balances a viable input into the production function" (p. 518)

II. The Relevance of Money in Yugoslav Industrial Production

In order to understand the possible inclusion of real money balances within Yugoslav industrial production one must first appreciate the uniqueness of the Yugoslav system. Gedeon (1986) points out that the Yugsolav system is a combination of social planning and worker self-management with the goal of having agreement between economic objective and investment strategy. The existence of worker-controlled enterprises along with the maintenance of production schedules constructed by social planners in turn create downward rigidities with regard to typical Keynesian adjustments in output and employment.

In order to maintain their unchanged demand for investment finance in spite of the depletion of existing lines of credit Yugoslav enterprises have tended to create their own non-bank forms of credit (Burkett, 1983; Bradley and Smith, 1987). These non-bank forms of credit come in the form of circulating bills of exchange, accumulation of accounts payable, subsequent depletion of real cash balances, etc.[3] The creation of these non-bank forms of credit (inter-enterprise credits) and the accommodation of finance to investment demands illustrates that Yugoslav enterprises do, in fact, face a "soft" budget constraint (Kornai, 1986). As Bradley and Smith (1987) point out the emergence of nongovernment money (inter-enterprise credits) besides acting as a medium of exchange eventually become rediscounted by the banks becoming dinar-based reserves and high powered money. Moreover, these "inter-enterprise" credits have grown from the rate of 16 percent over the period 1952 to 1979 to in excess of 58 percent during the period 1980 to 1985. Thus, political pressure is placed upon the National Bank to act as a "lender of last resort" in the monetization of enterprise debt once it has been created through the emergence of inter-enterprise credits.[4] This suggests that money may perhaps be a viable factor in Yugoslav industrial production, both as a conduit in the maintenance of firm production schedules and the eventual monetization of debt created by payments defaults on the part of firms. Thus, the question to address is whether or not money included as an input in the production process enhances productivity?

III. Methodology and Data

[3] Bradley and Smith (1987) perform Granger-Sims bivariate causality tests between major economic aggregates within Yugoslavia finding money to Granger cause output.

[4] For a more detailed discussion of the Yugoslav banking system see Dimitrejvic' and Macesich (1983).

There have been several studies on Yugoslav industrial production all of which concentrated upon explaining the change in the growth rate of industrial output due to the Economic Reforms of 1965.[5] Unlike the prior production studies this endeavor will concentrate upon the issue of whether or not the inclusion of money enhances productivity. The model to be entertained for Yugoslav industrial production will be simplistic for several reasons. First, prior studies had access to a much larger data set than used in this study; the greater number of observations enables one to entertain perhaps a more flexible methodology.[6] Second, using Kmenta's linear approximation of the CES production function one can test whether or not a CES is preferred over a Cobb-Douglas specification.[7] Preliminary empirical work rejects the CES model in favor of the Cobb-Douglas model at the 5 percent level of significance. Thus, the model to be employed will be that of an unconstrained Cobb-Douglas production specification following Sinai and Stokes (1972) and Khan and Ahmad (1985).

$$(1) \qquad Y = BL^{\alpha} K^{\beta} M^{\gamma} \varepsilon^{\mu}$$

where Y = real industrial output, billion dinars, 1972 = 1.00
L = industrial employment, thousand persons
K = real capital stock in use within industrial sector, billion dinars, 1972 = 1.00
M = M1 real money balances, billion dinars, 1972 = 1.00 or ML1 real money balances broad measure encompasing M1 and nongovernmental money, billion dinars,

[5] Sullivan's (1978) work demonstrated that the slowdown in the growth rate of industrial output after 1965 was attributed to a low elasticity of factor substitution. Sapir (1980) expanded upon Sullivan's work by finding that a capital-intensity bias produced by the reform combined with low factor substitution elasticities provided for the decline in growth in the post-1965 period.

[6] Short (1979), Simos (1981), and Subrahmanyan (1980) utilize a translogarithmic production function essentially testing the separability hypothesis. Because of the small sample size the translogarithmic production function of Christensen, Jorgenson, and Lau (1973) will not yield viable parameter estimates.

[7] Given the CES model in log format:

$$\log Y = \log \gamma - \frac{v}{\rho} \log (\delta K^{-\rho} + (1-\delta)L^{-\rho}) + \varepsilon$$

using a Taylor series expansion of log Y around $\rho = 0$ and dropping terms involving powers of ρ higher than one, one obtains

$$\log Y = \log\gamma + v\delta \log K + v(1-\delta)L - (1/2)\, \rho v\delta(1-\delta)\, (\log K - \log L)^2 + \varepsilon$$

the term $-(1/2)\, \rho v\delta(1-\delta)\, (\log K - \log L)^2$ will disappear if $\rho = 0$. The estimation of the parameters above is the same as in the case of estimation with nonlinear restrictions under exact identification (see Kmenta pp. 514-515, 1986).

1972 = 1.00
α = elasticity of output with respect to labor
β = elasticity of output with respect to capital
γ = elasticity of output with respect to real money balances
μ = error term

Converting the multiplicative version into an additive log-linear specification yields the following:

$$(2) \qquad \ln Y = A + \alpha \ln L + \beta \ln K + \gamma \ln M + \mu$$

Moreover, following the work of Desai (1985) and Rusek (1989) alternative specifications of technical change are formulated:

(a) no growth in total factor productivity:
$A = \log B$

(b) constant rate of growth of total factor productivity:
$A = \log B + \lambda_1 t$

(c) variable rate of growth of total factor productivity:
$A = \log B + \lambda_1 t + \lambda_2 t^2$.

Both (b) and (c) are Hicks-neutral, disembodied technical change which can occur either at a constant or variable rate expressed as a linear function of time.

Given the model outlined above, the next step will be to briefly discuss the underlying data. Annual time series data from 1952-1985 is analyzed. The data was compiled by Skegro (1987) collected from such sources as *Bilten Norodne Banke Jugoslavije, Statisticki Godisnjak Jugoslavije,* and *Studije, Analize, Prikazi.* The data is expressed in constant dinars with a base year 1972 = 1.00. The industrial capital stock in use was constructed as follows: real industrial capital stock last period multiplied by intermediate imports. The logic here is that production of industrial output requires the use of intermediate resources applied to the amount of capital stock prevailing at the beginning of the production period (Gapinski, et. al., 1989). Though the capital stock was adjusted for utilization by intermediate imports, the employment data was not adjusted for qualitative changes or variations in utilization rates as was done by Christensen and Jorgenson (1969) in the case of the United States. The narrow measure of real money balances M1 is simply currency plus demand deposits while the broad measure ML1 is M1 plus nongovernment money.

IV. Empirical Results

Equation (2) adjusted by the alternative measures of technical change captured by (a), (b), and (c) was estimated by ordinary least squares with maximum likelihood correction for first-order autocorrelation. The statistical package used was the Time Series Processor version 4.1. Table 1 presents the results of estimating Equation 2(a), 2(b), and 2(c) without any measure of real money balances. 2(a) displays the simple Cobb-Douglas model to have increasing returns to scale of 1.3956 while inclusion of a constant rate of growth of total factor productivity though significant lowers the returns to scale to 1.143 as evidenced by 2(b). Adding a variable rate of growth of total factor productivity to Equation (2) yielded decreasing returns to scale substantiated by the negative and significant coefficient on t^2.

Table 1

PARAMETER ESTIMATES OF THE UNCONSTRAINED COBB-DOUGLAS PRODUCTION MODEL
(without real money balances)

	2(a)	2(b)	2(c)
Constant	−5.690	−4.103	−1.760
	(−10.450)	(−4.418)	(−2.267)
lnL	1.265	1.019	0.6282
	(14.492)	(6.989)	(5.156)
lnK	0.1306	0.1078	0.1001
	(5.235)	(4.136)	(4.423)
t		0.0162	0.0681
		(2.022)	(6.467)
t^2			−0.0009
			(−6.617)
$\bar{R}^2$	0.951	0.950	0.994
F	293	192	1267
DW	1.42	1.38	1.48
ρ	0.9205	0.9366	0.6184
Returns to scale	1.3956	1.143	0.7955

Note: Values in parentheses are the estimated t-values.

Table 2 presents the results of estimating Equation 2(a), 2(b), and 2(c) with the narrow measure of real money balances. The inclusion of M1 increases the returns to scale over the Cobb-Douglas model without M1 from 1.3956 to 1.4422. Paralleling Sinai and Stokes (1972) as well as Khan and Ahmad (1985) the coefficients on labor and capital fall to 1.224 and 0.1233, respectively. This decline in the coefficients of labor and capital suggests that the inclusion of M1 releases labor and capital services from distributional activities to productive activities. Moreover, real money balances is significant at the 5 percent level. Inclusion of a constant rate of growth of total factor productivity is significant at the 10 percent level slightly lowering the coefficient on real money balances to 0.0910

Table 2

PARAMETER ESTIMATES OF THE UNCONSTRAINED COBB-DOUGLAS PRODUCTION MODEL
(narrow money measure)

	2(a)	2(b)	2(c)
Constant	−5.725	−4.228	−2.053
	(−11.610)	(−5.006)	(−2.583)
lnL	1.224	0.9943	0.6541
	(15.051)	(7.481)	(5.294)
lnK	0.1233	0.1018	0.0907
	(5.342)	(4.249)	(3.990)
lnMl	0.0949	0.0910	0.0530
	(2.598)	(2.640)	(1.732)
t		0.152	0.0628
		(2.093)	(5.755)
t^2			−0.008
			(−5.508)
$\bar{R}^2$	0.962	0.961	0.993
F	255	190	882
DW	1.30	1.38	1.51
ρ	0.9157	0.9290	0.6648
Returns to scale	1.4422	1.2023	0.8598

Note: Values in parentheses are the estimated t-values.

while also yielding a lower returns to scale 1.2023.[8] The inclusion of a variable rate of growth of total factor productivity yielded a negative and significant coefficient at the 1 percent level. The coefficient on real money balances though still significant at the 10 percent level falls from a coefficient estimate of 0.0901 to 0.0530 due to the inclusion of t^2. Moreover, the returns to scale falls further from 1.2023 to 0.8598 reflecting decreasing returns to scale.

Table 3 presents the results of estimating Equations 2(a), 2(b), and 2(c) with the broad measure of real money balances. The inclusion of the broad measure of real money balances is significant at the 1 percent level. The coefficient of labor falls when compared to the Cobb-Douglas production function without any measure of real money balances while the coefficient on capital slightly increases. This finding parallels that of Sinai and Stokes (1972) in that the coefficient on capital increases given the inclusion of a broad money measure. The inclusion of constant rate of growth of total factor productivity is insignificant at the 10 percent level. However, the inclusion of a variable rate of growth of total factor productivity yields a negative and significant coefficient at the 1 percent level. As in the two prior models presented in Tables 1 and 2, the inclusion of a variable rate of growth of total factor productivity yielded decreasing returns to scale.

Within Table 1, equation 2(c) reflecting declining total factor productivity growth out performs 2(a) and 2(b) with regard to predictive power as evidenced by an adjusted R^2 of 0.994 and overall F-statistic of 1267. Equation 2(c) of Table 2 with the inclusion of the narrow moeny measure and declining total factor productivity exhibits excellent predictive capacity with an adjusted R^2 of 0.993 and overall F-statistic of 882. Finally, equation 2(c) of Table 3 parallels the results of Table 2 with the broad money measure and declining total factor productivity producing an adjusted R^2 of 0.992 and overall F-statistic of 807.[9]

V. Concluding Remarks

The task of this paper has been to investigate the relevance of real money balances as a factor input in Yugoslav industrial production.

8 Sinai and Stokes (1972) in their initial work on real money balances find similar results with regard to the decline in returns to scale.

9 As pointed out by a referee, the lower and upper bound of "inconclusive region" of DW statistics at the 5 percent significance level is, respectively, 1.193 and 1.730 since K = 4 and T = 33. Thus, all the DW statistics are in the inconclusive region.

Table 3

PARAMETER ESTIMATES OF THE UNCONSTRAINED COBB-DOUGLAS PRODUCTION MODEL
(broad money measure)

	2(a)	2(b)	2(c)
Constant	−5.319	−4.317	−2.236
	(−11.743)	(−5.533)	(−3.029)
lnL	1.160	1.009	0.6978
	(15.529)	(8.253)	(5.744)
lnK	0.1425	0.1265	0.1110
	(6.919)	(5.618)	(5.343)
lnMLl	0.0788	0.0715	0.0537
	(3.988)	(3.628)	(2.794)
t		0.0105	0.0540
		(1.535)	(4.796)
t^2			−0.0007
			(−4.798)
$\bar{R}^2$	0.968	0.966	0.992
F	310	219	807
DW	1.22	1.24	1.42
ρ	0.9206	0.9319	0.7136
Returns to scale	1.3813	1.2175	0.9158

Note: Values in parentheses are the estimated t-values.

Entertaining an unconstrained Cobb-Douglas production model alternative measures of real money balances as well as alternative formulations of the rate of total factor productivity were empirically tested. Both measures of real money balances with and without consideration of alternative rates of growth in total factor productivity yielded significant results. As hypothesized by Sinai and Stokes (1972) the respective coefficients of labor and capital fell with the inclusion of a narrow measure of real money balances suggesting that money allows both labor and capital services to be released from distributive to productive activities. However, the inclusion of a variable rate of growth in total factor productivity presented evidence of decreasing returns to scale and declining total factor productivity. Thus, there appears to be some evidence that both real money balances as well as declining total factor productivity influence output growth within the Yugoslav industrial sector.

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