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FURTHER EVIDENCE ON REAL MONEY BALANCES IN THE PRODUCTION FUNCTION

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ABSTRACT

Real money balances as a factor input in Yugoslav industrial production is examined within a simultaneous equation framework. In addition to labor and capital, real money balances turned out to be a significant factor of production. However, unlike Khan and Ahmad in their work on Pakistan, the two definitions of real money balances used in this study do not uniformly support the contention that real money balances and labor seem to be complementary.

I. INTRODUCTION

The hypothesis of real money balances as an input in the production function has been widely tested.[1] The theoretical underpinnings for the inclusion of money in the production function stem

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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 serve 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 balances 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 forth. Short (1979), Simos (1981), and Subrahmanyan (1980) develop structural models based on Cobb-Douglas and the more generalized translogarithmic production specifications yielding results which support the inclusion of real money balances 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. Nguyen (1986) reexamines previous evidence casting doubts on the inclusion of real money balances.

from the monetary growth models of Levhari and Patinkin (1968), Johnson (1969), Stein (1970), Friedman (1969), Bailey (1971), and Nadiri (1970). The general reasoning for the inclusion of real money balances in the production function centers on the increased productivity gains derived with 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). By releasing capital and labor from the process of distribution to produotion, 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).

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. 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. Utilizing a simultaneous equation framework, 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. The task of this note is to extend the work of Khan and Ahmad (1985) to the case of the industrial sector of Yugoslavia. Given the industrial sector produces approximately half of overall output, this sector is studied in isolation. The remaining sectors namely, social and private agricultural production as well as other nonagricultural production are suppressed. Moreover, the data on money holdings by sector were not available.[2] The simultaneous equations model parallels Khan and Ahmad (1985) with minor adjustments tailored to the Yugoslav economy. Section II discusses the methodology and data. The emperical results are presented in Section III while Section IV provides concluding remarks.

II. METHODOLOGY AND DATA

Paralleling Sinai and Stokes (1972) as well as Khan and Ahmad (1985) the production function is specified as an unconstrained Cobb-Douglas specification expressed as follows:

$$Y = AL^{\alpha 1} K^{\alpha 2} M^{\alpha 3} e^{\mu} \tag{1}$$

[2] An anonymous referee makes a very good point that sectoral structure of money holdings varies a lot, thus monetary aggregates may not be a good proxy for money holdings in the industrial sector. However, there is no readily available substitute for the measure used in this study.

where

Y = industrial output
L = industrial employment
K = industrial capital stock
M = real money balances
A = efficiency parameter
μ = error term.

α_1, α_2, α_3 are elasticities of output with respect to labor, capital, and real money balances, respectively with the hypothesized signs $\alpha_1, \alpha_2, \alpha_3 > 0$. Equation (1) can be implemented empirically by converting the multiplicative version into an additive log-linear specification as follows:

$$lnY = lnA + \alpha_1 ln\, L + \alpha_2 lnK + \alpha_3 lnM + \mu \tag{2}$$

The factor demand equations for labor, capital, and real money balances are specified in order to close the simultaneous model. Labor demand is specified in log-linear format as follows:

$$lnL = \beta_0 + \beta_1 lnY + \beta_2 lnW + \varepsilon_1 \tag{3}$$

where L = industrial employment
Y = industrial output
W = real wage
ε_1 = error term.

β_1 and β_2 are the elasticities of labor demand with respect to output and real wages, respectively with $\beta_1 > 0$ and $\beta_2 < 0$.

Capital stock is defined by the following identity:

$$K_t = I_t + (1 - \delta)\, K_{t-1} \tag{4}$$

where K is industrial capital stock, I is industrial investment, δ is the depreciation rate, and t is the time subscript. For capital stock, a flexible accelerator is specified for investment demand as follows (Gapinski, 1989 and Payne, 1989):[3]

$$I_t = \delta_0 + \delta_1 [Y_t - Y_{t-1}] + \delta_2 I_{t-1} + \varepsilon_2 \tag{5}$$

where the hypothesized coefficients are $\delta_1, \delta_2 > 0$. Finally, following work by Tyson (1979) and Payne (1990a) the demand for real money balances appears as a partial adjustment model in log-linear format below

[3] Gapinski (1989) entertains alternative investment specifications for industry, social agriculture, private agriculture, and other nonagriculture sectors of Yugoslavia. Payne (1989) utilizes a flexible accelerator for investment within a macroeconometric model context.

$$lnM = \psi_0 + \psi_1 \, lnY + \psi_2 \, \Delta \, lnCR + \psi_3 \, lnM_{t-1} + \\ + \psi_4 \, ln \, (P/P_{t-1}) + \varepsilon_3 \qquad (6)$$

where M = real money balances
Y = industrial output
CR = consumer credit
P/P_{t-1} = current inflation rate
Δ = first difference operator
ε_3 = error term.

The coefficients are hypothesized as $\psi_1, \psi_2, \psi_3 > 0$ and $\psi_4 < 0$. Industrial output Y is the scale variable which measures the volume of transactions. Tyson (1979) recognizing the ineffectiveness of the unchanging behavior of interest rates as an opportunity cost variable utilizes as proxy for credit market conditions, namely, the change in consumer credit.[4] The premise is that tightened credit markets mean more rationing of credit which in turn means a higher opportunity cost for holding cash balances. On the other hand, relaxed credit markets mean the increased availability of credit thus a lower opportunity cost to rebuild cash balances to prior levels (see Tyson, pp. 55—56, 1979). Thus, the opportunity cost variable utilized is the change in consumer credit, ΔCR. Finally, a model of money demand would not be complete without some measure of inflationary expectations. As Gapinski, et al. (1989) suggests economic agents are "nearsighted" with regard to the formulation of inflationary expectations. Thus, under the assumption of perfect foresight and the equality between the expected and observed rates of inflation, the actual rate of inflation will be used as a proxy for inflationary expectations (Darrat, 1985; Cardoso, 1983; Crockett and Evans, 1980; Tyson, 1979).[5]

Given the model outlined above via equations (1) through (6), the next step will be to briefly discuss the underlying data. An annual time frame 1952—1985 is analyzed. The data was compiled by Skegro (1987) collected from such sources as *Bilten Narodne Banke Jugoslavije, Statistički Godišnjak 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 U. S.

[4] The discount rate set forth by the National Bank of Yugoslavia was utilized in preliminary empirical work yielding statistically insignificant results at the 5 percent level.

[5] Crockett and Evans (1980) in their study of money demand in Middle Eastern Countries use the actual rate of inflation as a proxy for the expected rate of inflation. Tyson (1979) also utilizes the actual rate of inflation as one proxy for the expected rate of inflation.

III. EMPIRICAL RESULTS

The simultaneous equation model is estimated via two-stage least squares corrected for first-order autocorrelation. The results are displayed in Table 1. In the estimation of the Cobb-Douglas production function, two definitions of money were used: M_1 (currency in circulation plus demand deposits) and M_2 (M_1, plus "inter-enterprise" credits).[6] Thus, a few words concerning "inter-enterprise" credits is warranted. Interenterprise credits refer to noncollaterized business borrowing along the lines Kornai's (1986) concept of a "soft budget" constraint (Gapinski, 1989). These non-bank forms of credit come in the form of circulating bills of exchange, accumulation of accounts payable, etc., on the part of industrial firms. As Bradley and Smith (1987) point out the emergence of nongovernmental money (inter-enterprise credits) in addition to acting as a medium of exchange eventually become rediscounted by the banks becoming dinar-based reserves and high powered money. Thus, the broad money measure accounts for the presence of "inter-enterprise" credits.[7]

From Table 1, the coefficients of real money balances yield significant results. Equation (2) and (3) find the coefficients on M_1 and M_2 statistically significant at the 10 and 5 percent level, respectively. The coefficients of labor and capital are statistically significant in the presence of real money balances. The returns to scale associated with equation (2) and M_1 definition of money is 1.5797 with M_1 accounting for 7.18 percent of the returns to scale. The returns to scale associated with equation (3) and M_2 definition of money is 1.3572 with M_2 accounting for 5.29 percent of the returns to scale. Utilizing the same database, Payne and Zuehlke (1989) within ordinary least squares estimation find that returns to scale associated with M_1 definition of money to be 1.3091 and with M_2 1.246. In the same study M_1 accounted for 6.45 percent of the returns to scale and M_2 5.64 percent.

The inclusion of M_2 did not significantly change the returns to scale; however, with M_1 there was significant advancement in returns to scale. A further comparison of equations (1), (2), and (3) reveals that the coefficient of labor increased from 1.254 to 1.343 with the inclusion of M_1 while the coefficient of labor fell from 1.254 to 1.160 with the inclusion of M_2. Just as Khan and Ahmad (1985) find in the case of Pakistan and Sinai and Stokes (1972) in the case of the U. S., the drop in the coefficient of labor due to the inclusion of M_2 suggests that labor services may be released from distribution activities when M_2 increases. However, the increased coefficient on labor with the inclusion of M_1 suggests the opposite. On the other hand, the coefficient on capital decreased slightly with the inclusion of both M_1 and M_2, suggesting that capital services may be released from distribu-

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[6] Gapinski (1989) points out in accordance with Kornai's (1986) "soft budget" constraint that Yugoslav firms issue credits which are in turn circulated amongst other firms.

[7] M_2 defined and used in this study is a broad measure unlike the traditional measure of M_2. Tyson (1979) and Kornai (1986) discuss the details of inter-enterprise credits and the soft budget constraint.

tion activities when both M_1 and M_2 increase respectively. Moreover, inclusion of a time trend variable was insignificant.[8]

The labor demand specification yields correctly signed and statistically significant coefficients on industrial output and real wages at the 5 percent level. The output elasticity suggests that a 1 percent increase in industrial output will increase industrial employment by .57 percent. Likewise, a 1 percent increase in the real wage rate will induce a .165 percent decline in industrial employment. The investment function yields the coefficient on the acceleration variable to be correctly signed and significant at the 1 percent level while lagged investment is equally significant. Finally, the demand for real money balances in the cases of both M_1 and M_2 performs very well. In the case of equations (6) and (7), the coefficients on industrial output and the change in consumer credit are correctly signed and significant at the 5 percent level. The Koyck adjustment mechanism renders lagged real money balances either in the case of M_1 or M_2 significant at the 5 percent level. The Koyck adjustment mechanism renders lagged real money balances either in the case of M_1 or M_2 significant at the 5 percent level. The current rate of inflation is surprisingly significant and correctly signed.[9]

IV. CONCLUDING REMARKS

The purpose of this note has been to extend the recent work of Khan and Ahmad (1985) to the case of the Yugoslav industrial sector. A simultaneous equation framework consisting of a Cobb-Douglas production function and factor demand equations for labor, capital, and real money balances is entertained. The results support the inclusion of real money balances as an input in the production function. Both labor and capital inputs are also found to be significant in the wake of real money balances. Increasing returns to scale dominated the production functions estimated. The inclusion of real money balances denoted by M_2 reduces the coefficient on labor with the coefficient on capital decreasing only slightly. This finding suggests that both labor and capital services are released from distributional activities to productive ones. Paralleling Khan and Ahmad's (1985) work, labor and real money balances M_2 seem to be complementary. On the other hand, real money balances defined as M_1 increases the coefficient on labor suggesting that perhaps labor and real money balances M_1 are not complementary within the production process.

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[8] Payne (1990) in analyzing both real money balances and alternative specifications of technical change finds similar returns to scale. However, the Hicks-neutral disembodied technical change modelled either at a constant or variable rate expressed as a linear function of time are significant. (see Payne 1990b, p. 183).

[9] Empirical work on developing economies have not been successful in finding significant and stable coefficients for inflation elasticities. Galbis (1979) found only some evidence of significant negative inflation elasticities.

The results support the inclusion of real money balances as a factor input in the production function in the case of Yugoslavia. However, the results do not uniformly find labor and real money balances to be complementary as Khan and Ahmad (1985) find in the case of Pakistan.

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Table 1

Real Balances in the Production Function of the Yugoslavia Industrial Sector 1952—1985

(1) $\underset{}{\ln Y} = \underset{(-3.349)}{-7.207} + \underset{(4.140)}{1.254}\ \ln L + \underset{(2.375)}{.1359}\ \ln K$

$\bar{R}^2 = .578 \quad DW = 1.77 \quad S.E.E. = .0317 \quad \rho = .9972$

(2) $\underset{}{\ln Y} = \underset{(-3.998)}{-7.774} + \underset{(5.014)}{1.343}\ \ln L + \underset{(1.809)}{.1232}\ \ln K + \underset{(1.680)}{.1135}\ \ln M_1$

$\bar{R}^2 = .623 \quad DW = 1.64^{-} \quad S.E.E. = .0304 \quad \rho = .9968$

(3) $\underset{}{\ln Y} = \underset{(-3.875)}{-6.868} + \underset{(5.412)}{1.160}\ \ln L + \underset{(3.265)}{.1254}\ \ln K + \underset{(2.422)}{.0718}\ \ln M_2$

$\bar{R}^2 = .700 \quad DW = 1.54 \quad S.E.E. = .0246 \quad \rho = .9989$

(4) $\underset{}{\ln L} = \underset{(11.485)}{6.552} + \underset{(21.619)}{.5726}\ \ln Y - \underset{(-2.588)}{.1653}\ \ln W$

$\bar{R}^2 = .999 \quad DW = 1.91 \quad S.E.E. = .0181 \quad \rho = .8168$

(5) $\underset{}{I} = \underset{(-.5227)}{-.7836} + \underset{(3.096)}{1.019}\ [Y_t - Y_{t-1}] + \underset{(13.949)}{.8443}\ I_{t-1}$

$\bar{R}^2 = .929 \quad DW = 1.94 \quad S.E.E. = 3.033 \quad \rho = .0929$

(6) $\underset{}{\ln M_1} = \underset{(-.6954)}{-.1141} + \underset{(2.228)}{.1896}\ \ln Y + \underset{(3.468)}{.2199}\ \Delta \ln CR$

$$+ \underset{(8.487)}{.8633}\ \ln M_{1\,t-1} - \underset{(-3.810)}{.7308}\ \ln\left(\frac{P_t}{P_{t-1}}\right)$$

$\bar{R}^2 = .965 \quad DW = 1.97 \quad S.E.E. = .0804 \quad \rho = .1442$

(7) $\underset{}{\ln M_2} = \underset{(-.1071)}{-.0270} + \underset{(3.674)}{.6192}\ \ln Y + \underset{(2.122)}{.2628}\ \Delta \ln CR$

$$+ \underset{(2.607)}{.4308}\ \ln M_{1\,t-1} - \underset{(-2.074)}{.7426}\ \ln\left(\frac{P_t}{P_{t-1}}\right)$$

$\bar{R}^2 = .930 \quad DW = 1.97^{-} \quad S.E.E. = .1593 \quad \rho = .0344$

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DODATNI PODACI O REALNIM NOVČANIM BILANSIMA U PROIZVODNOJ FUNKCIJI

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Realni novčani bilans kao input faktor u jugoslovenskoj industrijskoj proizvodnji razmatran je u okviru modela simultanih jednačina. Pored rada i kapitala ispostavilo se da je novčani bilans značajan faktor proizvodnje. Međutim, za razliku od Khana i Ahmada u njihovom radu o Pakistanu, dve definicije realnog novčanog bilansa u ovoj studiji ne podržavaju jednako tvrdnju da realni novčani bilans i rad izgleda da su komplementarni.