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A TEST OF McKINNON'S COMPLEMENTARITY HYPOTHESIS: A CASE STUDY OF PAKISTAN

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Abstract. According to McKinnon (1973) demand for money is complementary to the demand for physical capital in developing countries. This study is an attempt to test the complementarity hypothesis presented by McKinnon using Vector Error Correction Models (VECM) for Pakistan over the sample period (1964-2003). Our results fail to find clear evidence for complementarity between money and capital. However, our findings are in line with Fry (1978) who found a little evidence in support of McKinnon's hypothesis.

I. INTRODUCTION

The seminal work of McKinnon (1973) and Shaw (1973) regarding the role of money in the context of developing countries has attracted a considerable amount of attention of researchers. There have been a number of empirical studies regarding the nature of the relationship between money and capital for developed and developing countries. Some studies found empirical evidence in support of McKinnon's complementarity hypothesis (see for example, Khan and Hassan, 1998; Lumas, 1990; Thorton, 1990 and Abe, 1975) and others failed to find it (see for example, Fry *et al.*, 1975; Harris, 1970 and Akhtar, 1977).

The complementarity hypothesis of McKinnon (1973) states that money and real capital assets are complements in developing countries. It is because

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of the absence of deep financial markets and extensive financial intermediation, money balances have to be accumulated before indivisible investment projects can be undertaken. This implies that higher the real rate of return, the greater the accumulation of money balances and the larger will be the inducement to invest. Furthermore, the indivisibility of investment means that the demand for money will be larger, the greater the ratio of investment to total expenditure. In developing countries, due to the lack of organized capital and money markets, there is no wide spectrum of financial and physical instruments for the individuals to store their wealth. Furthermore, financial instruments other than money cannot be easily marketed due to the lack of information and absence of operating capital market. The important point of McKinnon's hypothesis is that an increase in the desired rate of capital accumulation (private savings) at any given level of income leads to an increase in the average ratio of M/P to income. This implies that a rise in return on capital leads to an increase in the need of real cash balancing holding for accumulation purpose. Thus, money is not a competing asset; rather money is conduit through which accumulation takes place in developing countries. This implies that an increase in real return on money can raise sharply investment saving propensities in contrast to Neoclassical where return on money does not directly affect propensity to save because all firms have perfect access to external finance. So higher return on money enlarges real cash balance holding thus relaxing the saving investment bottleneck in developing countries.

McKinnon hypothesis provides theoretical basis for the policy of financial liberalization and it has brought a shift in the policy priorities of different countries of different regions. Furthermore, it has also affected the policies of IMF and World Bank which is evident from their financial policies embodied in their stabilization packages for developing countries like Pakistan.

Pakistan pursued indirect monetary policies in 1950s and 1960s. In 1960s high cash requirements and direct credit allocation were introduced. In 1970s, due to nationalization of financial institutions and industrial units, the landscape of financial sector was totally changed from privatized to complete nationalized one. The period of 1970s and 1980s is marked with direct monetary controls like direct credit allocation and annual credit plan etc. From 1988, Pakistan is on the policy of financial liberalization. Substantial institutional changes have taken place in financial sector and a number of steps are being taken in this regard. Banking sector is almost totally privatized and monetary policy is being pursued through indirect market

measures. Therefore, it would be very important to have a fresh look over the issue that money and capital are complements or substitutes in Pakistan.

The outline of this study is as follows. In section II, a review of previous studies is presented. Section III presents model specifications and brief methodology. Section IV reports the empirical results and the last section concludes the discussion. Definition of variables and sources of data are presented in the Appendix I.

II. REVIEW OF PREVIOUS STUDIES

This section reviews some of the studies on McKinnon's complementarity hypothesis. The results from developing countries regarding it are mixed.

Fry (1978), using data for 10 Asian countries, has yielded negative coefficient of the saving ratio to money demand. He replaced *I/Y* ratio with *S/Y* ratio in McKinnon's money demand function on the assumption that domestically financial investment is equal to private savings. He failed to find support to McKinnon's complementarity hypothesis and concluded that enterprises accumulate monetary as well as non-monetary assets.

Harris (1979) tried to analyze the McKinnon's complementarity hypothesis for a set of five Asian developing countries. His results provided a weak support to McKinnon's hypothesis.[1] However, his analysis indicated that private investment was affected indirectly by the interest rate through its effects on supply of funds.

Thornton (1990),[2] using Indian data covering the period 1964-84, tested the complementarity hypothesis through money demand and saving functions. He found a strong support for the complementarity hypothesis in both demand for money and saving functions. He also used the same methodology and tested this hypothesis for Nepal and found support to McKinnon's complementarity hypothesis for Nepal. His results were in sharp opposite to Fry's results obtained from a sample of more developed countries but supported his assertion that complementarity is most likely to be a feature of the demand for money in countries close to the bottom of the development ladder.

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[1] Harris found that only for Taiwan the estimates consistently support the McKinnon's hypothesis.

[2] Thornton used the same modification as Fry did to test the complementarity hypothesis.

Lumas (1990) using Two Stage Least Squares (2 SLS) undertook a test of complementarity hypothesis only for monetized income in India.[3] His analysis provided support for the importance of the finance motive, complementarity between money and physical capital and a policy of financial liberalization in the context of Indian economy. He also pointed out that inappropriate monetary policy could seriously retard economic growth.

Pentecost and Moore (2004) employed the multivariate cointegration and vector error correction models to test McKinnon's complementarity hypothesis between money and capital for India. They found a strong support for the hypothesis. Their results substantiated the earlier findings of Lumas (1990) and Thornton (1990) regarding the strength of the finance motive for holding money and the complementarity between money and capital and concluded that further financial liberalization is required in India to enhance investment and economic growth.

As far as Pakistan is concerned a few studies have been conducted on this topic and the results are mixed. Akhtar (1977) tested McKinnon's complementarity hypothesis for Pakistan using data from the period 1950-1970. He failed to find much support for McKinnon's complementarity hypothesis.

Fry *et al.* (1975) raised some serious objections on the methodology, data cofllection and variable specifications of the study of Akhtar (1977). Their results showed strong support for McKinnon's complementarity hypothesis in both the demand for money and the saving functions. However, they stressed the need for more empirical analysis on the McKinnon's complementarity hypothesis.

Khan and Hassan (1998), using cointegration regression analysis, have tested the complementarity hypothesis by estimating both savings and demand for money functions for Pakistan. They concluded that in Pakistan money and physical capital are complements over the long period.

The bulk of previous studies in developing countries have investigated the McKinnon's complementarity hypothesis by employing standard econometric techniques.[4] However, these techniques fail to take into account

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[3]Lumas raised the issue that McKinnon model is valid only for monetized sector so it should be tested only for monetized economics.

[4]For an exception, see Khan and Hassan (1998) and Pentecost and Moore (2004).

the non-stationary behaviour of macroeconomic time series resulting in what has become known as spurious regression.

The issue of whether economic time series are non-stationary or not is important for both estimation and hypothesis testing, both of which rely on asymptotic distribution theory. Moreover, the nature of non-stationarity has important implications for the appropriate transformation to attain a stationary series as well as for the estimation of a long-run relationship between non-stationary variables. Most of the economic and financial time series are non-stationary and the basic statistical issue is the appropriate representation of the nature of non-stationarity. In a Monte Carlo experiment, Granger and Newbold (1974) found that when the regression involves non-stationary variables, the OLS regression could be spurious. They concluded that such a regression equation leads to incorrect rejection of null hypothesis of no relationship. When, in fact, there might be none. They also found high R^2 and low Durbin-Watson statistics, which tend to cause the conventional formula to underestimate standard errors and thus overstate t values.

Khan and Hassan (1998) used the single equation methods ignoring the interdependence between investment (savings) leg and the money leg of joint hypothesis. So their findings cannot be considered as robust. The principal contribution of the present study, therefore, would be the use of Multivariate Cointegration and Vector Error Correction Methodology to identify money demand and investment equations for Pakistan.

III. MODEL SPECIFICATION AND METHODOLOGY

McKinnon Model can be presented as follows:

$$\left(\frac{M}{P}\right)^d = F(Y, r, d - p^*)$$

$$\left(\frac{I}{Y}\right)^p = F(r, d - p^*)$$

where

$\left(\frac{M}{P}\right)^d$ = Demand for real money balancing including time deposits

p^* = Expected rate of inflation

$\frac{M}{P}$ = Real money balances

Y = Real GDP

$\frac{I}{Y}$ = Ratio of private investment to real GDP

r = Real return on physical capital

$d - p^*$ = Real return on holding money

For empirical purpose, the main problem with this hypothesis is the inability to compute any sensible measures of real rate of return of capital in underdeveloped countries. McKinnon (1973) suggested that the real rate of return could be replaced by I_p/Y ratio, which is expected to vary directly with the change in real return on capital. So

$$\left(\frac{M}{P}\right)^d = F\left(Y, \frac{I_p}{Y}, d - p^*\right)$$

McKinnon's complementarity hypothesis requires:

$$\frac{\partial\left(\frac{M/P}{P}\right)}{\partial r} > 0 \text{ and } \frac{\partial\left(\frac{I}{Y}\right)}{\partial\left(d - p^*\right)} > 0$$

One shortcoming of investment function of McKinnon (as pointed out by Lumas) is that it did not take into account pre-dominant role of government investment in developing countries. Government investment has important bearing for private investment. It may be complement to private investment. It may crowed out private investment if it is in infrastructure activities. It may be a substitute to private investment if it is in finished goods. There is another view that government investment even in infrastructure may crowed out private investment due to relatively scarce resources in developing countries. It may have effect of biding up prices for the factor of production for the private sector. In the light of these circumstances proper test of complementarity hypothesis should be conducted with the recognition that private and public sector compete for scarce sources or complement to each other. The ratio of private investment to real GDP can be written as:

$$\left(\frac{I}{Y}\right)^p = F\left(d - P^*, \frac{IG}{Y}\right)$$

Another issue is the use of more suitable inflation index. McKinnon suggested the use of wholesale price index (WPI) on the grounds that

consumer price index (CPI) has large service content and rises faster than WPI. Since WPI consists of exclusively of commodities, it is also preferable because services cannot be stored in asset portfolios while commodity prices are compared with nominal rate of interest on financial assets in deciding the stocks of money and near money.

So the model may take the form:

$$\frac{M}{P} = F\left(Y, \frac{I_p}{Y}, d - P^*\right) \tag{1}$$

$$\left(\frac{I}{Y}\right)^p = F\left(d - P^*, \frac{IG}{Y}\right) \tag{2}$$

where

$\frac{I_p}{Y}$ = Ratio of private investment to real GDP

$\frac{I_G}{Y}$ = Ratio of government investment to real GDP

This is the system one of our model.

In initial model of McKinnon it was assumed that economic agents are unable to borrow for undertaking investment and have to save up before they buy expensive indivisible capital equipment. However, to the extent financial liberalization gradually occurs and credit becomes available to business, private investment may rise without a prior increase in money savings. In this scenario, the availability of credit to domestic residents will need to a rise in I_p/Y independent of money demand. This credit channel may be of some importance in the case of Pakistan, because direct credit allocation to the private sector has been an important instrument of Pakistan's monetary policy. Investment function may be formulated as:

$$\frac{M}{P} = F\left(Y, \frac{I_p}{Y}, d - P^*\right) \tag{3}$$

$$\left(\frac{I}{Y}\right)^p = F\left(\frac{d}{Y}, d - P^*\right) \tag{4}$$

where $\frac{d}{Y}$ = Domestic credit to private sector as ratio of real GDP.

This is the system two of our model.

IV. EMPIRICAL RESULTS

The first step is to test for the order of integration of each variable included in the system 1 and system 2 of the models using ADF (1979) test. We estimate the following equation:

$$\Delta X_t = \alpha + \beta X_{t-1} + r_i \sum_{i=1}^{n} \Delta X_{t-1} + \varepsilon_t$$

The results of the variables of system 1 are presented in Table 1 and of system 2 in Table 3.

TABLE 1

Augmented Dickey Fuller Test (System 1)

Level	ADF	1st Difference	ADF
LM	–0.00584	ΔLM	–5.0990*
LPI	–1.8539	ΔLPI	–4.9344*
LY	–0.1995	ΔLY	–5.4120*
RWR	–2.7960	ΔRWR	–4.2467*
LGI	–2.42	ΔLGI	–4.00874*

*indicates significant at 5% level.

It is clear on the basis of ADF test statistics that all the variables are integrated of order 1, *i.e. I* (1) and therefore constitute potential variables for inclusion in a cointegrating vector.

In order to carry out the cointegration tests proposed by Johansen, the first step is to specify the lag length for the VAR. We set this at one period on the basis of the results of diagnostic tests including the likelihood ratio test and Akaike Information criterion. The results of trace as well maximal eigenvalues are presented in Table 2 and Table 4. LR test indicates two cointegrating equations at 5% significance level for both systems.

TABLE 2

Johansen's Cointegration Test (System 1)

Eigenvalue	Likelihood Ratio	5% Critical Value	1% Critical Value	Hypothesized No. of CE(s)
0.610157	83.66951	68.52	76.07	None**
0.465630	47.87310	47.21	54.46	At most 1*
0.321788	24.05974	29.68	35.65	At most 2
0.206263	9.304493	15.41	20.04	At most 3
0.013757	0.526383	3.76	6.65	At most 4

*denotes rejection of the hypothesis at 5% significance level

**denotes rejection of the hypothesis at 1% significance level

TABLE 3

Augmented Dickey Fuller Test (System 2)

Level	ADF	1st Difference	ADF
LM	–0.00584	Δ*LM*	–5.0990*
LPI	–1.8539	Δ*LPI*	–4.9344*
LY	–0.1995	Δ*LY*	–5.4120*
RWR	–2.7960	Δ*RWR*	–4.2467*
LDCsP	–2.11095	Δ*LDCsP*	–5.2019*

*critical values at 5% = –2.9399

It is clear on the basis of ADF test statistic that all the variables of system 2 are also integrated of order 1, *i.e.* $I(1)$ and therefore constitute potential variables for inclusion in a cointegrating vector.

TABLE 4

Johansen's Cointegration Test (System 2)

Eigenvalue	Likelihood Ratio	5% Critical Value	1% Critical Value	Hypothesized No. of CE(s)
0.649153	89.03772	68.52	76.07	None**
0.577706	49.23631	47.21	54.46	At most 1*
0.251823	16.47831	29.68	35.65	At most 2
0.133663	5.453898	15.41	20.04	At most 3
4.24E-05	0.001609	3.76	6.65	At most 4

*denotes rejection of the hypothesis at 5% significance level

**denotes rejection of the hypothesis at 1% significance level

Considering the results of Johansen's cointegration test of system 2, LR test indicates two cointegrating equations at 5% significance level.

The error-correction model for each equation is presented in Appendix II (*see* Tables 5 to 8).

A negative and significant coefficient of lagged error correction term is an indication of cointegration among variables. Indeed, Kremers *et al.* (1992) have shown that a significant lagged error correction term is relatively more efficient way of establishing cointegration.

In Tables 5 to 8 the coefficient estimates of all first-differenced variables of both systems are reported. As can be seen from these tables the lagged error correction terms carry negative sign which is an indication of cointegration among the variables. Not much interpretation could be attached to the short-run coefficients. All they show is the dynamic adjustment of all variables.

The long-run relationship between variables identified in system 1 is shown by the following equations:

$$LM = 3.737 - 0.39\,LPI + 1.23\,LY + 0.003\,RWR + 0.041\,LGI \qquad \text{(A)}$$
$$\quad (12.81) \quad (5.15) \quad (44.28) \quad (1.35) \quad (0.76)$$

$$LPI = \underset{}{11.05} - \underset{(7.03)}{2.96\,LM} + \underset{(5.144)}{0.01\,RWR} + \underset{(1.42)}{3.62\,LY} + \underset{(5.56)}{0.12\,LGI} \qquad \text{(B)}$$
$$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad (0.77)$$

Note: The absolute values of t statistic are given in the parentheses.

Considering the above equations the sign of LPI is negative which indicates that McKinnon's complementarity hypothesis does not hold good in Pakistan. The real income has expected positive sign and its coefficient is close to 1 which is consistent with most of the tests of demand for money. Deposit rate has a small coefficient but it is positive as expected. This indicates that the impact of deposit rate on the demand for money is quite negligible. Deposit rate and government investment have positive sign in equation (B) and both are insignificant. This indicates that these two variables do not have much impact on the private investment.

The long-run relationship between variables identified in system 2 is shown by the following equation:

$$LM = \underset{}{3.624678} - \underset{(2.16)}{0.345\,LPI} + \underset{(5.35)}{1.213\,LY} + \underset{(36.09)}{0.0845\,LDCsP} + \underset{(0.75)}{0.001\,RWR} \qquad \text{(C)}$$
$$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad (0.59)$$

Absolute values of t statistic are given in parentheses.

$$LPI = \underset{}{10.503} - \underset{(3.02)}{2.897\,LM} + \underset{(5.36)}{3.51\,LY} + \underset{(5.90)}{0.245\,LDCsP} + \underset{(0.72)}{0.003\,RWR} \qquad \text{(D)}$$
$$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad (0.60)$$

In equation (C), the sign of private investment is negative which indicates that our results fail to find evidence in favour of McKinnon's complementarity hypothesis in Pakistan. One possible reason of the above result may be that the assumptions of McKinnon's complementarity hypothesis do not hold good in Pakistan.[5] Furthermore, the positive sign between bank credit to private investment indicates that the availability of finance has positive impact on private investment but the view that money balances are accumulated for self-financed investment does not seem to be

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[5]The major assumptions of McKinnon's complementarity hypothesis are: (*a*) No other financial instrument other than money are available to individuals for the accumulation of wealth, (*b*) Government bills and bonds are not attractive to compete with bank deposits, (*c*) Government is frail to take part in economic activity by using bank credits and (*d*) Non institutional credit is not available to the individuals so they will have to rely upon self-finance for investment.

substantiated. The real deposit rate has positive sign but insignificant which indicates that real deposit rate has not much influence on private investment in Pakistan.

V. CONCLUSION

Our results fail to find support to McKinnon's dcomplementarity hypothesis for Pakistan. However, our results are in line with Frey's results. The availability of finance has a positive impact on private investment. The policy implication of this study is that any effort for increasing the availability of finance will lead to an increase in private investment in Pakistan.

Money balance accumulated for self finance investment does not seem to substantiate in case of Pakistan. However, availability of finance (not by accumulation through self finance but through bank credit allocation) has positive impact on private investment. Neoclassicals hold the view that price of capital is a major determinant of private investment. McKinnon's view is that availability of finance is the major determinant of private investment. Our results show that neither price of capital nor availability of finance but other institutional factor like political stability, government policies, prices of inputs, size of the market, skilled manpower, etc. are the important factors which determine the private investment in Pakistan.

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APPENDIX I

Data Sources and Definitions of Variables

Series of M2, domestic credit to private sector and WPI have been taken from IMF publication "International Financial Statistics" Yearbook 2003, while the series of private and government investment have been taken from FBS publication, "50 Years of Pakistan Economy (1947-1997)" and Economic Survey 2002-2003. Series of weighted average deposit rate have been taken from SBP publications, "Banking Statistics of Pakistan, 1985 and 2002" and State Bank Annual Report 2002-2003. The annual data covers the period from 1964 to 2003.

All the variables are in logarithmic form except real deposit rate:

$$LM = \text{Log}\left(\frac{M2}{WPI}\right)$$

$$LPI = \text{Log}\left(\frac{\text{Private Investment}}{\text{RGDP}}\right)$$

$$LY = \text{Log}\left(\frac{GDP}{WPI}\right)$$

$$LGI = \text{Log}\left(\frac{\text{Government Investment}}{\text{RGDP}}\right)$$

$$LDCsP = \text{Log}\left(\frac{DC}{GDP}\right)$$

$RWR = d - P^*$ (Real return on holding of money)

d = Annual weighted average deposit rate more than 1 year and less than 2 years

DC = Domestic bank credit to private sector

APPENDIX II

TABLE 5

Error Correction Model
Dependent Variable M/P [Equation (1)]

Variable	Coefficient	Std. Error	t statistic
Constant	0.0331	0.0089	0.3488
EC(–1)	–1.8892	0.3690	–5.1182
D(LPI)	–0.3235	0.1282	–2.5222
D(LY)	1.5114	0.4740	3.1900
D(RWR)	0.0056	0.0019	2.8378
D(LGI)	–0.0660	0.0716	–0.9212
R^2 (Adj.)	0.69		
F statistic	7.61		

TABLE 6

Error Correction Model
Dependent Variable I_P/Y [Equation (2)]

Variable	Coefficient	Std. Error	t statistic
Constant	0.0053	0.0137	0.3893
EC(–1)	–1.2993	0.5653	–2.2809
D(LM)	1.0416	0.3544	2.9385
D(LY)	1.0700	0.7269	1.4720
D(RWR)	0.0070	0.0030	2.3074
D(LGI)	0.2049	0.1097	1.8775
R^2 (Adj.)	0.63		
F statistic	6.0939		

TABLE 7

Error Correction Model
Dependent Variable M/P [Equation (3)]

Variable	Coefficient	Std. Error	t statistic
Constant	0.0202	0.0203	0.9949
EC(–1)	–0.6890	0.1263	–3.6900
D(LPI)	0.1343	0.1219	1.1036
D(LY)	0.8127	0.5326	1.5259
D(LDCP)	0.1218	0.2118	0.5752
D(RWR)	0.0058	0.0019	3.0836
R^2 (Adj.)	0.53		
F statistic	4.73		

TABLE 8

Error Correction Model
Dependent Variable M/P [Equation (4)]

Variable	Coefficient	Std. Error	t statistic
Constant	–0.4930	0.3060	–1.6989
EC(–1)	–0.0598	0.2906	–0.2058
D(LM)	0.1501	0.3854	0.3895
D(LY)	0.3873	0.8037	0.4819
D(LDCP)	–0.1602	0.3196	0.5013
D(RWR)	0.0032	0.0028	1.1461
R^2 (Adj.)	0.33		
F statistic	2.63		