Foreign Capital inflows and Domestic Saving in Pakistan: Cointegration techniques and Error Correction Modeling

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1.Introduction

The various form of inflow of foreign capital (loans, FDI, grant and portfolio) was welcome in developing countries to bridge the gap between domestic saving and domestic investment and therefore, to accelerate growth [Chenery and strout (1966)]. Some other have been challenged the traditional view that foreign aid impedes domestic savings growth and mobilization and have economic growth. [1]

Much attention have been paid in past 30 years, relationship between foreign capital flows and domestic saving, the main purpose of these studies have been determined whether in less developed countries foreign capital inflow and domestic saving are complementary or substitute. However, there is a controversy at theoretical and empirical levels, over the effects of foreign capital on both economic growth and national saving.

A number of studies in Pakistan have been conducted during the early 1990s to examine the relationship between saving and foreign capital inflow. [2]

All studies shows the inverse relationship between foreign capital inflows[3] (aggregate level) and saving rate, but the impact of FCI at disaggregate levels (loans, grants, FDI) on saving rate show different magnitude and signs, similarly impact of FCI on decomposition of saving rate (Public, private, household, corporate) also have different magnitude and sign.

However, the most important problem associated with previous studies is that these are based on the assumption that the time series data that are being used are stationary, in fact

[1] For example, see Griffin and Econ (1970); and Weisskpokf (1972)
[2] Detail of these studies pres ent in appendix
[3] The four measure of foreign capital inflows used in economic literature (1) Current account deficit (2) Foreign loans (3) Foreign Direct Investment (4) Foreign Aid

mean and variance of most economic variables are not constant, therefore, conventional hypothesis testing procedure based on t, F, chi-square tests and like may be suspect.

By now there is compelling evidence that many macroeconomic time series are non-stationary and, as a result, OLS estimates using these data may produce spurious results.

Valid inference is possible when non-stationary variables are cointegrated. Cointegration means that despite being individually non-stationary, a linear combination of two or more time series can be stationary.

Although by now there exist well-developed techniques of handling non-stationary time series data, no attempt has been made to study saving-foreign capital inflow relationship using these methods. As a result, one may express scepticism about the validity of the empirical results of the previous studies.

In this study, we examine the relationship between foreign capital inflow and saving rate using the co integration techniques to time series data for the 1972-2000 period.

The plan of the paper is as follows: Section 2 presents the model and data source, econometric methodology, analysis and empirical results discuss in section 3 and section 4 presents a concluding summary.

2.The Model

To analysis the impact of foreign capital inflow on saving rate, most of studies in economic literature are based on cross sectional data with a lot of explanatory variables. Similarly, in the case of Pakistan, many variables have been used in saving function, aim of these studies to examine the impact of different macroeconomic variables on saving rate of Pakistan. But in this paper, we have used simple model, because in this study our

aim analyzing the long run effect of foreign capital inflow on saving and not the to estimate the saving function, so it is better to use simplest form [Sohan and Islam (1988)].

To examined the impact of foreign aid on saving rate, we have been hypothesized a simple linear saving function as fo llows:

SR=a+? PY+? FC ***E(1)***

Where SR, PY and FC stand for domestic saving rate, per capita GNP, and foreign capital inflows as percent of GDP.

Domestic saving rate is taken from various issues of State Bank of Pakistan and per capita GNP is measured in constant market prices of Pakistan with 1980-81 as a base year is taken from Pakistan Economic Survey. The foreign capital inflows as measure by current account deficit are taken from various issues of Pakistan Economic Survey. These are given in US dollars average exchange rate was used to convert the amount of foreign capital inflow in domestic prices data.

3.Econometric methodology

We first examined the time series properties of the data using Augmented Dickey Fuller (ADF) test are based on inclusion of an intercept as well as a linear time trend and test is also performed without the trend term. The results are given in table (1) and as this table shows, all the variables have a unit root in their levels and are stationary in their first difference.

Table: 1 Test of the Unit Root Hypothesis

Augmented Dickey-Fuller (ADF) Test

	Level				First Difference			
	No Trend	k	Trend	k	No Trend	K	Trend	k
SR	-1.03	1	-2.84	1	-5.82 *	1	-5.66 *	1
SR	-0.95	2	-1.88	2	-4.42 *	2	-4.32 **	2
FC	-1.77	1	-2.80	1	-5.77 *	1	-5.67 *	1
FC	-1.25	2	-1.90	2	-3.09 **	2	-3.83 **	2
PY	-1.65	1	-0.28	1	-3.04 **	1	-3.69 **	1
PY	-1.88	2	-0.26	2	-3.08 **	2	- 3.87 **	2

*** And * indicate significance at the 5% and 1% levels, respectively.*

Thus all three variables (SR, PY and FC) are integrated of order one. Thus the main findings of table (1) are that all the variables of the model are I (1).

Tests for Cointegration

Given the time series properties of the data, we tested for a cointegrating relationship among variables SR, PY and FC using Engle-Granger, unrestricted Error-correction Approach to cointegration and Johansen methods.

Engle-Granger procedure for cointegration

Regression one non-stationary time series on other non-stationary series generating a spurious regression [Granger and Newbold (1974)], but latter work Engle and Granger (1987) identified a situation when such a regression did not yield spurious relationship

when two series was cointegrated. To found the long run relationship among the variables, estimate the equation (1) as the first step of Engle and Granger (EG) procedure:

SR=-2.33+. 003PY-6.88FC ***E(2)***

R^2 = .68 D.W=1.38

To check whether the variables in the model are cointegrated, quicker method is Cointegration Regression Durbin-Watson (CRDW). In CRDW we use the D.W statistics value obtained from equation (2), such as D.W=1.38 is greater than critical value, so we reject the null hypothesis of no contegration[4].

To perform Engle and Granger (EG) cointegration test, as first step performed OLS estimation and obtained the long run relationship among saving rate, per capita income and foreign aid variables. In the second step of EG procedure examined the stationary of residual obtained from equation (2) by applying ADF test at level.

The results Engle and Granger test for cointegrating is given table (2) show that evidence of a cointegrating relationship among SR, PY and FC.

Table: 2 Engle-Granger Cointegration Test

	ADF Test
No Trend	-3.01 **
Trend	-3.07 **

*** Indicate significance at the 5%*

[4] Null hypothesis is that D.W=0 rather than standard D.W=2, the critical values for CRDW test can be found in Maddala (1992), which is .99.Standard errors and t-ratios are not shown in Equation (2) that they do not provide the basis inference in the case of non-stationary data.

Table: 3
Autocorrelation Coefficient of Residuals

Lags	AC	Q-Stat
1	0.224	1.6133
2	0.086	1.8601
3	0.109	2.2674
4	0.142	2.9937
5	0.078	3.2204
6	-0.177	4.4419
7	-0.088	4.7588
8	-0.344	9.8147
9	-0.148	10.797

AC stands for autocorrelation coefficients

We also test the stationarity of residual obtained from equation (2) is based on autocorrelation coefficients and Q-statistics. In the case of small sample examination of autocorrelation function should be important criteria [Hall (1986)].

It is apparent from the table (3) all the autocorrelation coefficients (pk) lies within the confidence interval of [-.364,364] up to the 9^{th} lags, so we do not reject the hypothesis that the true pk is zero. Simularly, to test the joint hypothesis that all pk autocorrelation coefficients are simultaneously equal to zero, one can use the Q-statistic[5]

Now, we are able to conclude that the residuals from cointegrating regression appears to be stationary which in turn, suggests a valid long-run relationship among variables.

[5] The Q-statistic follows the Chi-square distribution. Since critical value at 9 degrees of freedom is 16.91 none of statistics can reject the hypothesis that all autocorrelation coefficients are equal to zero.

Short-Run Dynamic Engle-Granger procedure

Given our finding that SR, PY and FC are cointegrated. We estimated an error-correction model (ECM) to determine the short run dynamic of system.

Short-Run Dynamic Engle-Granger procedure

Table: 4 Estimated Error Correction Model

	Dependent Variable			
Regressors	***Estimated Coefficients***			
	E(1)	***E(2)***	***E(3)***	***E(4)***
Constant	1.401	1.041	0.531	1.32
?SR (-1)	-0.068	-0.042	-0.101	
?SR(-2)	-0.051	-0.442 *		-0.003
? (PY)	-0.005	0.008		0.007**
?PY(-1)	-0.003	-0.002	0.004	
?PY(-2)	-0.006			-0.005
?FA	-0.221	-4.034		-5.48
?FA(-1)	-0.858	0.608	-3.781	
?FA(-2)	-5.253			-1.695*
RES(-1)	-0.75*	-0.67*	-0.76*	-.73*
Diagnostic tests				
Serial Correlation	4.21*	3.15*	4.13*	0.63
Heteroscedasticity	1.05	0.10	0.21	1.53
Functional Form	1.43	0.44	0.32	0.84
Normality	0.62	0.78	2.54	0.22

****, ** And * indicate significance at the 10%, 5% and 1% levels, respectively*
RES (-1), the error correction term, were calculated from OLS method. So, RES=SR+5.98 FA-.007*PY*

Using the notion of general to specific modeling firstly 2 lag of both explanatory and dependent variables and 1 lag of residual from cointegrating regression were included and estimate four error correction models in order to get parsimonious model.

Although all equatons shows, negative coefficient of error correction term and statistically significant at 1%. The results of diagnostic test indicate that saving rate equations passes the test of serial correlation, functional form, normality and heterodasticity, but all models indicate the serial correlation except E (4), so last column of table (4) gives the final error-correction model. It indicates that system corrects its previous periods level of disequlibrium by 73% with in year.

The Unrestricted Error-Correction Approach to Cointegration

We estimated an error-correction model (ECM) to determine the short run dynamic of system. To estimate the short run error correction model, we used general to specific approach [Hendry (1995)]. This approach is viewed as less susceptible to adoptive of an incorrect model

This approach has become more popular than two-step Engle-Granger procedure in recent time. The estimation procedure (UECM) involves only one equation with difference of variables and lags of variables on their levels instead of lag of residuals.

The Unrestricted Error-Correction Model can be written as

$$?SR=C+ a? (PY)+ ß?FA+ r_1SR(-1)+ r_2 PY (-1)+ r_3FC(-1)+u \qquad (2)$$

The long run relationship can be obtained as

$$?SR= ?(PY)= ?FC =0$$

0= C+PY (-1)+FC (-1)+SR (-1)

Thus, SR= - [C/r1] –[r2/ r1] PY – [r3/ r1] FC *(3)*

The coefficient of ***FC*** in equation (3) will provide the long run relationship between foreign capital and saving rate.

Table: 4 Unrestricted Error Correction Model

	Dependent Variable				
Regressors	***Estimated Coefficients***				
	E(1)	E(2)	E(3)	E(4)	E(5)
Constant	0.446	-1.532	0.052	-1.25	-1.32
?SR(-1)	-0.226	-0.079		-1.241	
?SR(-2)	-0.054		-0.051		-0.038
?(PY)	-0.011	-0.011	-0.011	0.004	
?PY(-1)	-0.009	-0.005			
?PY(-2)	-0.012		-0.006		-0.005
?FC	10.37	9.11	12.34	-0.004	
?FC(-1)	-20.77	-4.07			
?FC(-2)	-8.77		-0.861	-4.01	-3.74 *
PY(-1)	0.003	0.003	0.002	0.002	0.002*
FC(-1)	26.66	9.24	6.26	-5.45	-7.81
SR(-1)	-0.66*	-0.64*	-0.69*	-0.72*	-0.8 *
Diagnostic tests					
Serial Correlation	0.018	9.52*	6.141*	5.42**	1.09
Heteroscedasticity	20.85**	11.12	14.75	0.809	10.49
Functional Form	0.002	0.108	0.229	0.07	0.001
Normality	1.02	0.411	1.017	1.262	0.853

****, ** And * indicate significance at the 10%, 5% and 1% levels, respectively*

We estimate the different five models but select the E(5)[6]The last column shows the final (ECM), the negative relation between SR and FC the error correct term is now the coefficient SR (-1) and correctly signed. It indicates that system corrects its previous periods level of disequlibrium by 80% with a year.

The long run estimate obtained from equation (3)

SR=. 103+. 003PY-9.74FC

Test for Cointegration

Unlike the other two methods the Johansen procedure can find multiple cointegrating vector, the Johansen method finds that there is single cointegrating vector.the table (5) shows that the null hypothesis of no-cointegating (r=0) is rejected both under maximum eigen value and trace tests, both test found that there is one cointegrating vector. The cointegrating equation is reported in last row show that there is inverse relationship between foreign aid and saving rate.

Table: 5 ***Johansen's Test For Multiple Cointegration Vectors***

	Hypotheses		Tests Statistics	
Vector	**H_0:**	**H_1:**	**Max Eigenvalue**	**Trace**
[SR, PY, FA]	***r = 0***	***r > 0***	25.857* *	33.79 *
	r = 1	***r > 2***	9.93	10.08
	r = 2	***r > 3***	1.01	1.01

Cointegrating Vector	***SR***	***PY***	***FC***
	-1.00	0.005	-6.87

*** And * Indicate significance at the 5%. And 1% respectively*

[6] Diagnostic tests indicate that except E (5) all other models have not provide valid inferences due to occurrence of Serial Correlation and Heteroscedasticity

4.Conclusion

Domestic recourse mobilization is one of the vital determinants of economic growth. Pakistan's saving performance is deprived as relative to successive countries in the region that had experienced sustained high growth. Therefore, Pakistan heavily rely on foreign capital to fill the gap between domestic saving and domestic investment

In this paper we found by applying three variants of cointegration techniques to time series data for the 1972-2000 period and in every case a valid long run relationship among the variables was found. Three variants of cointegation technique also found inverse relationship between saving rate and foreign capital inflows and short run relationship between these two variables was also found to be negative.

In this paper, our finding support the "Substitution thesis" hypothesis that foreign capital may in fact substitute for domestic saving .One explanation, which has attracted some attention, is that by making recourses easily available, external flows permitted a relaxation in saving effort and encourage an increase consumption and therefore, external flows may particularly impedes the public saving as well as private savings.

Appendix

Authors	Saving Equation	Growth Equation	Estimation Period	Estimation Methods
Muhammad and Qasim	**FCI , FCI^{PUS}, FCI^{PRS}** (-.87*), (.18) , (-1.04)	-	1959-60 to 1987-88	OLS
A.R.Kamal	**FCI , FCI^{PRS} , FCI^{PUS}** (-.26), (-.44*), (.19)	-	1960-1988	OLS
Zafar	**$NFCI^{PUS}$ $NFCI^{CS}$** (-.199**) , (.076*)	-	1969-1989	OLS
Naheed Aslam	**FCI , PCI** (-.72*) (1.56)	-	1963-64 to 1984-85	OLS
Naheed and Rahim	**FA , Loans, FDI** (-.097), (-.3.5), (-2.03)	**FA , Loans, FDI** (.32*),(.52*),(.23)	1960-1988	OLS
Shabbir and Muhammad	**NFPI, TD** **E(1)** (-11.5*), - **E(2)** (-9.6*) (-.09)	**NFPI TD** **E(1)** (8.8**) - **E(2)** (7.9) (.15)	1960-1988	2SLS
Khan, Hassan and Malik	**FCI AID** **E(2)** (-.47*) - **E(3)** (.54*) - **E(4)** - (-.003)	-	1960-1988	OLS
Ch and Ali	**FR** (-.062*)	-	1960-1991	2SLS

Notes:

- * And ** significant at 5% and 10% respectively
- The figures in parentheses are coefficients of FCI different form of foreign of capital inflow used in presenting studies.
- ***FCI*** =Foreign capital inflow,
- FCI^{prs}=foreign capital inflow in private saving function
- FCI^{pus}= foreign capital inflow in public saving function
- $NFCI^{pus}$=net foreign capital inflow in public saving function
- $NFCI^{cs}$=net foreign capital inflow in cooperating saving function
- ***FDI***=foreign direct investment
- ***PCI***=private capital inflow
- ***TD***= total disbursement (included both grant and loans)
- ***FR***=foreign debt to GNP ratio.

E(1) and ***E(2)*** so on show that different equations is estimated by authors to get desire results.

References

R.Kamal (1992), "Self-Reliance and implications in growth and resource mobilization", The Pakistan Development Review.Vol.4, No.31, pp.1101-1110.

Aslam, N (1987), "The impact pf foreign capital inflow on savings and investment: The case of Pakistan", The Pakistan Development Review, Vol.4, No .26, pp. 787-89

.

Ch, Muhammad and Ali (1993), "Pakistan's foreign dependence, its capacity for debt repayment and future prospects", Pakistan Economic and Social Review, Vol.31.No.1

Chenery, H.B and Strout, A.M (1966), " Foreign assistant and economic development" American Economic Review, Vol.4.No.56.pp 679-733.

Dickey, D and Fuller, w. (1981), "Likelihood Ratio statistics for Autoregressive time Series with a unit Root"Econometrica, Vol.49, pp.1057-72.

Engle and Granger C, (1987), "cointegration and Error correction: Representation, Estimation and testing". Econometrica, Vo1.55, pp.251-76.

Granger and Newbold (1974), "Spurious Regression in Economics", Journal of Econometrics, Vol.2, pp.99-112

Griffin, K.B and J.L.Econ (1970) "Foreign Assistant: Objectives and consequences", Economic Development and cultural Change.

Griffin, K.B and J.L.Econ (1970) "Foreign capital, Domestic saving and Economic Development" The Oxford Bulletin of Economics and Statistic, Vol.5, May, pp.99-112.

G.S Maddala (1992), "Introduction to Econometrics, Second Edition

Hall (1986), "An Application of the Granger and Engle Two-step Estimation procedure to UK Aggregate Wage Data", The Oxford Bulletin of Economics and Statistic, Vol.48, No.3, pp.229-240.

Hendry (1995), "Dynamic Econometrics, Oxford University Press, pp.577-619.

Iqbal, Zafer (1993), "Institutional Variations in Saving in Pakistan", The Pakistan Development Review, Vol.4, No .31, pp. 1293-1311.

Johansen (1988),"statistical Analysis of cointegrating vectors," Journal of Economic Dynamic and control, Vol.12, pp 231-54.

Johansen and Juselius (1990),"Maximum Likelihood Estimation and inference on Cointegration with applications the demand for money, "Oxford Bulletin of Economics and statistics, Vo1 52,No.2, pp169-210.

Khan, A.H. and Malik, A. (1992), "Dependency ratio, foreign capital inflows and rate of savings in Pakistan", The Pakistan Development Review, Vol.3, No .4, pp. 843-56.

Khan, N.Z and Rahim (1993), "Foreign aid, domestic savings and economic growth", Pakistan Development Review, Vol.4, No .32, pp. 1157-67.

Muhammad, Z and Qasim.A (1992), "Saving behavior in different trade Regime", The Pakistan Development Review, Vol.4, No .31, pp. 756-61.

Nazneen A and Razzaque A (2000), "A Re-examination of Domestic Saving-Foreign Aid Relationship in the context of Bangladesh", Bangladesh Development Studies Vol.26.No.4, pp.1-37.

Shabbir, T and Muhammad, A (1992), The effect of foreign private investment on economic growth in Pakistan", The Pakistan Development Review, Vol.4, No .31, pp. 831-41.

Sobhan and Islam (1988), "Foreign Aid and Domestic resource mobilization In Bangladesh", Bangladesh Development Studies.Vol.26, June.

Weisskopt, T.E. (1972), "The impact of foreign capital inflow on saving in under developing countries", Journals of International Economics, Vol.1.No.5, pp 245-38.