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Foreign Capital Inflows and Domestic Savings in Pakistan: Cointegration Techniques and Error Correction Modelling

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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 mobilisation 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 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.

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[1]For example, see Griffin and Econ (1970) and Weisskopt (1972).

[2]Detail of these studies present 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.

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 analysing 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 hypothesised a simple linear saving function as follows:

$$SR=\alpha+B\ PY+\gamma\ FC \quad .... \quad .... \quad .... \quad .... \quad (1)$$

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. We also perform the Phillips-Perron (P.P) test to examine the stationary of variables.[4] P.P test shows that *SR* and *PY* appears to have unit root in level exception of foreign capital variable at lag two, the presence of an I(0) variable does not pose any problems for cointegrating Theory [Leon (1987)].

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).

Table 1

Tests of the Unit Root Hypothesis

	Level				First Difference			
	No Trend	k	Trend	k	No Trend	k	Trend	k
(1) Augmented Dickey-Fuller (ADF) Test								
SR	–0.39	4	–1.94	4	–5.82 *	1	–5.66 *	1
FC	–1.25	2	–2.80	1	–5.77 *	1	–5.67 *	1
PY	–1.88	2	–0.26	2	–3.04 **	1	– 3.87 **	2
(2) Phillips-Perron (PP) Test								
SR	–1.21	1	–3.01	1	–7.88 *	1	–7.64 *	1
SR	–1.14	2	–3.09	2	–8.32 *	2	–8.12 *	2
FC	–1.98	1	–3.11	1	–7.09*	1	–6.96 *	1
FC	–2.16	2	–.53**	2	–7.52*	2	–7.35 *	2
PY	–1.58	1	–0.35	1	–4.82 *	1	–5.23 *	1
PY	–1.59	2	–0.37	2	–4.83*	2	–5.24 *	2

The optimal lags (k) for conducting the ADF test were determined by AIC (Akaike Information Criteria). ** and * indicate significance at the 5 percent and 1 percent levels, respectively.

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

[4]The ADF test uses parametric correction technique in contrast P.P test that utilises semi parametric ones.

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:

$$SR = -2.33 + .003PY - 6.88FC \quad .... \quad .... \quad .... \quad .... \quad (2)$$
$$R^2 = .68 \qquad D.W = 1.38$$

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.[5]

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*.[6]

Table 2

Engle-Granger Cointegration Test

	ADF Test
No Trend	–3.01 **
Trend	–3.07 **

** Indicate Significance at the 5 percent.

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 9th 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.[7]

[5]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.

[6]The Engle-Granger Cointegration Test was performed using E-View 3.1.

[7]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.

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..

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.

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

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. The coefficients of foreign capital inflow have negative impact on saving. In short run two coefficients of foreign capital inflow have obtained [–4.48 and –3.495] but only $\Delta FC(-2)$ is significant.

Although all equatons shows, negative coefficient of error correction term and statistically significant at 1 percent. 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 Equation (4), so last column of Table 4 gives the final error-correction model. It indicates that system corrects its previous periods level of disequilibrium by 71 percent, with in year.

Table 4

Estimated Error-correction Model

	Dependent Variable			
	Estimated Coefficients			
Regressors	E(1)	E(2)	E(3)	E(4)
Constant	1.401	1.041	0.531	1.42
ΔSR (–1)	–0.068			
ΔSR(–2)	–0.051**	–0.442 *	.064**	–0.004
Δ (PY)	–0.005***	0.008***	.005**	0.007**
ΔPY(–1)	–0.003			
ΔPY(–2)	–0.006			
ΔFC	–0.221***	–4.034***	–4.123***	–4.48
ΔFC(–1)	–0.858			
ΔFC(–2)	–5.253***	5.121***	3.214**	–3.495*
RES(–1)	–0.75*	–0.69*	–0.78*	–.71*
Diagnostic Tests				
Serial Correlation	4.21*	4.12*	4.41*	0.82
Heteroscedasticity	1.05	0.23	1.01	1.79
Functional Form	1.43	0.43	0.73	0.24
Normality	0.62	0.71	2.11	0.32

***, **, * Indicate significance at the 10 percent, 5 percent, and 1 percent, levels, respectively.
RES (–1), the error correction term, were calculated from Equation (2).

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. Using the notion of general to specific modeling firstly 2 lag of both explanatory and second lag of dependent variable.

The Unrestricted Error-Correction Model can be written as

$$\Delta SR = C + \alpha\Delta(PY) + \beta\Delta FC + r_1 SR(-1) + r_2 PY(-1) + r_3 FC(-1) + u \quad \ldots \quad (2)$$

The long-run relationship can be obtained as

$$\Delta SR = \Delta(PY) = \Delta FC = 0$$
$$0 = C + PY(-1) + FC(-1) + SR(-1)$$
$$Thus,\ SR = -[C/r_1] - [r_2/r_1]\,PY - [r_3/r_1]\,FC \quad \ldots \quad \ldots \quad (3)$$

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

It is observed that short run coefficient on foreign capital inflow [–3.74] is statistically significant.

In Table 5, we estimate the different three models but select the Equation (3).[8] 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 percent, with a year.

The long-run estimate obtained from Equation (3)[9]

$$SR = .103 + .003PY - 9.74FC$$
$$t\text{-ratio} \quad (.75) \quad (4.1) \quad (2.89)$$

Table 5

Unrestricted Error-correction Model

	Dependent Variables Estimated Coefficients		
Regressors	E(1)	E(2)	E(3)
Constant	0.541	–2.11	–1.32
ΔSR(–2)	–0.211***	.042 ***	–.038
Δ(PY)	–0.023**	0.004	
ΔPY(–1)	–0.005***	0.008	
ΔPY(–2)	–0.213***	–.003***	–0.005
ΔFC	11.23		
ΔFC(–1)	–18.71		
ΔFC(–2)	–7.12**	–4.01**	–3.74 *
PY(–1)	0.005**	0.002**	0.002*
FC(–1)	20.15***	–5.45***	–7.81
SR(–1)	–0.66*	–0.71*	–0.8 *
Diagnostic Tests			
Serial Correlation	4.32**	5.12**	1.09
Heteroscedasticity	0.251	0.45	10.49
Functional Form	0.01	0.12	0.001
Normality	1.41	1.32	0.853

***, **, * Indicate significance at the 10 percent, 5 percent, and 1 percent, levels, respectively.

[8]Diagnostic tests indicate that except Equation (3) all other models have not provided valid inferences due to occurrence of Serial Correlation.

[9]Appropriate *t*-ratio were obtained from White's hetroscedasticity adjusted variance-covariance matrix.

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 6 shows that the null hypothesis of no-cointegrating (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 and positive relationship between per capital real income and saving rate.[10]

Table 6

Johansen's Test for Multiple Cointegration Vectors

	Hypotheses			Tests Statistics	
Vector	H0:	H1:		Max Eigenvalue	Trace
[SR, PY, FC]	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

**, * Indicate significance at the 5 percent, and 1 percent, respectively.

4. CONCLUSION

Domestic recourse mobilisation 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. The Unrestricted Error Correction Model found short run significance inverse relationship between domestic saving and foreign inflows but Short-Run Dynamic Engle-Granger procedure found insignificant inverse relationship between foreign capital inflow and domestic saving.

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

[10]With regarding size of coefficient of per capital variable is similar to Khan and Malik (1992) findings.

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

Notes:

*, ** Significant at 5 percent and 10 percent 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.
- $NFCI^{s}$=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.

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Comments

The authors have chosen a very important topic for empirical investigation. The prime objective of the study is to investigate saving and foreign capital inflow relationship by using econometric methods tailored for non-stationary time series data that is unit roots and cointegration. This analysis is very important for situation analysis and future policy formulation.

Though it is a commendable attempt by the honourable authors, but I have some observations on the application of methodology. I would like the authors to clarify these in the final version of the paper. The observations are related with unit root testing, cointegration analysis and analysis of causality.

1. Testing of Unit Roots

The authors have used Augmented Dickey Fuller (ADF) test to test the stationarity of data. While testing the unit root hypothesis authors have used different lag structure, along with two options trend and no trend case. It is not clear from the paper, what criteria are used to select lag length. Theoretically, it should be white noise property of error term.

Moreover, if boarder hypothesis, that is existence of significant intercept, trend and unit root is accepted, there is no need to go down to test the hypothesis of Unit Root without trend term.

2. Testing of Co-integration

The paper used three different methods to test the cointgrating relationship between the variables. These include Engle-Granger two step method, unrestricted vector Error correction method and Johanson maximum likelihood method. There are procedural and conceptual problems which are not clearly address during the testing of co-integration. For example on page 5 the Authors used Engle-Granger Two Step Method. After estimating long-run relationship, the ADF test is applied on the residual from co-integrating relationship. The results may be seen in Table 2. Authors conclude that there is co-integrating relationship between the variables. For this purpose the critical values used by the authors are not correct. I suspect that critical value for 30 observations for 5 percent level, is – 4.08. If this value is considered then the result of paper does not hold. In this case we are forced to conclude that there is no long-run relationship between the variables. I would like, authors, to explain this and look into results again.

Second the paper have estimated Error Correction model by using general-to-specific methodology. On cursor look there are some problems with the estimated error correction model.

1. In this model authors used error correction variable (ES) completely different from what they obtained from the first step of Engle-Granger method, and reported in Equation two (E-2).
2. The paper presented general model in Equation E (1) of Table 4. On close inspection of the equation it reveals that only one variable that is RES is statistically significant at conventional level, all others would not pass significance test. The important question here is that how authors reached at the specific model. It seems that the choice of variables is arbitrary rather than based on some statistical ground.

The above, number 2, criticism also applies to modelling technique of Unrestricted Error Corrections approach. Further, Equation E (5), indicates that there is no relationship between saving rates and flow of capital both in the long-run as well as short run.

Third method used to test the co-integration relationship is due to Johanson. Application of this method also leads toward unresolved questions? These include selection of lag length, significance of individual variables among others.

For policy implications what worries me is coefficient of per capita income. It implies that per capita income has little role in the determination of saving rate in the long-run and no role in the short-run? If this is true, then there is big question mark.

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