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Crowding-in or Crowding-out? Modelling the Relationship between Public and Private Fixed Capital Formation Using Co-integration Analysis: The Case of Pakistan 1964–2000

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This paper uses the Co-integrating VAR's [Johansen (1988); Ericsson, *et al*. (1998)] to examine the relationship between economic growth, public investment, and private investment in the presence of unit roots. Exogeneity is not implicitly assumed but explicitly tested for, and evidence of co-integration and feedback between public and private investment leads to a model in the form of a parsimonious VAR. The analysis is conducted using 37 years of annual data for Pakistan. The analysis suggests that public investment has a positive impact on private investment, and that economic growth drives both private and public investment as predicted by the accelerator-based models.

INTRODUCTION

Most studies of investment in developing countries are single equation models based either on the neoclassical model extensions [Mankiw, Romer, and Weil (1992); Nonneman and Vanhoudt (1996); Khan and Kumar (1997), etc.] or various augmented versions of the flexible-accelerator model of investment [Blejer and Khan (1984); Wai and Wong (1982)]. These models are generally based on the assumptions of stationarity of all variables and exogeneity of the explanatory variables. Where endogeneity is suspected, the usual single-equation methods, such as 2SLS, are used to correct for it in a single-equation model.

In the presence of evidence of non-stationarity (unit roots) of the investment series, such as that presented by Jones (1995) for fourteen of the fifteen developed countries, any assumption of stationarity is untenable without explicit testing. Even where such evidence has been found, either no co-integration is found and the VAR is estimated in differences [Pereria (2001); Pereria (2000)] or co-integration is found among the variables of interest but the estimation is still done in the differences [Ramaswamy and Rendu (2000)]; where co-integration is used in modelling, single-equation methods such as the FM-OLS are used which impose (rather than test for)

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both exogeneity of the regressors, and a direction of causality [Senhadji (2000)]. In addition a number of these studies are panel data or cross-section studies which, in the words of Kenny and Williams (2001, p. 4), are driven "*by a commitment to producing objective, scientific, and universal knowledge of economic growth,… (which) is underpinned by the view that all economies are substantially similar in their components and processes—that there is but one production function driving all economies at all times and in all time frames*". This assumption of homogeneity across countries can be challenged on the basis, among other things, of different institutional capacity, stages of development, and country-specific economic structure and historical inheritances. It follows that country focussed research can substantially supplement the knowledge gained from multi-country studies.

This paper seeks to extend the research in two directions by using VAR-based Cointegration techniques pioneered by Johansen (1988) and further developed in applied work by Ericsson, *et al.* (1998) to look for evidence of feedback between public and private investment. Secondly, it seeks to contribute to the rather sparse literature on investment in Pakistan. The econometric analysis is conducted using 37 years of annual data for Pakistan.[1]

A Review of Selected Investment Literature

In the presence of an established belief that investment (fixed capital formation) is the key to economic development and growth issues, a vast literature has focussed on the empirical and theoretical study of the investment process [see Chrinko (1993a); and Caballero (1999) for discussion]. In addition, a number of studies have differentiated between public and private investment, arguing that the two types of capital have different functions and productivity [e.g., Khan and Kumar (1997); Khan and Rheinhardt (1990), etc.]. Because public investment can also be used as a policy instrument, an extensive literature looks at the crowding- in versus crowding-out effects of public investment on private investment spending [e.g., Aschauer (1989); Erenberg (1993); Pereria (2001), etc.].

Another strand of literature questions the 'capital fundamentalist' assumption of causality running from investment to growth and suggests that it might be the other way around, or bi-directional [e.g., King and Levine (1994); Blomstrom, *et al*. (1996); Podrecca and Carmeci (2001); Easterly and Levine (2001), etc.]. Finally, recent work has highlighted the negative impact of macroeconomic uncertainty on investment activity [e.g., Solimano (1989); Rodrik (1991); Pindyck and Dixit (1994); Hubbard

[1]Although most time-series econometricians prefer to have 100+ data points, most researchers dealing with developing country data are inclined to accept 30+ data points in the absence of viable alternatives. Anything above 30 annual data points for developing countries is a rarity. Indeed 37 years of disaggregated investment data going back to 1964, from Pakistan's national accounts, are among the better data sets in the developing world. In addition, Pereria (2000, 2001) has used a similar data set for a similar time-period for estimating a VAR in differences for the USA.

(1994); Mavrotas (1997); Severn (1998), etc.]. Pindyck and Dixit (1994) and Hubbard (1994) use the options-based approach to emphasise the role of uncertainty in investment decisions. Mavrotas (1997) points out that proxies for macroeconomic uncertainty can be constructed using easily accessible data from the national accounts.

While several very good general studies of the Pakistan economy have recently been published,[2] literature dealing specifically with private investment is scarce. The exceptions are papers by Khan (1988) and Sakr (1993). In addition, there are some papers dealing with specific types of private investment, notably Looney (1999) focussing on investment in the manufacturing sector, Looney (1997) examining the interaction between infrastructure and private sector investment, and Khan (1997) looking at the FDI. Other macroeconomic studies of Pakistan that have given partial attention to private investment include Haque, Husain, and Montiel (1991), and Hasan, *et al.* (1996). Lastly, Hasan (1997) provides an excellent and concise historical overview of the Pakistani economy since independence including factors affecting private investment.

Using data from 1960 to 1986, Khan (1988) studied the impact of macroeconomic policy on private investment in Pakistan using a flexible accelerator-type model. He found the change in output to be insignificant at the 5 percent level. General market condition, defined as the difference between actual and trend output, was indicated to be positive and significant at the 5 percent level, implying that the economy had been operating at below-capacity level and that private investors reacted quickly to excess capacity. Lagged private investment, changes in bank credit, and public investment were reported to be positive and significant explanatory variables at the 5 percent level. When change in public investment was used as an explanatory variable in the specification, the correlation was shown to be negative and significant, indicating that any deviation from the trend value of government investment would have a negative impact.

Using data from 1974 to 1992, Sakr (1993) looked for the determinants of private investment in Pakistan using a flexible accelerator-type model. GDP growth, change in credit to the private sector, and aggregate public investment were found to be significant and positively correlated to private investment. When public investment was disaggregated, it showed a significant positive sign for infrastructural investment and a negative but statistically insignificant sign for non-infrastructural investment. Lagged private investment was tested to account for partial adjustment but was found to be statistically insignificant. The change in output was the least influential of the significant explanatory variables, and infrastructural public investment the strongest effect, as measured by beta coefficients.

Haque, Husain, and Montiel (1991) reported a positive relationship between private investment and government capital stock, which was found to be a function of available credit. Looney (1999), using differenced investment data and the

[2]See Hasan (1998); Husain (1999).

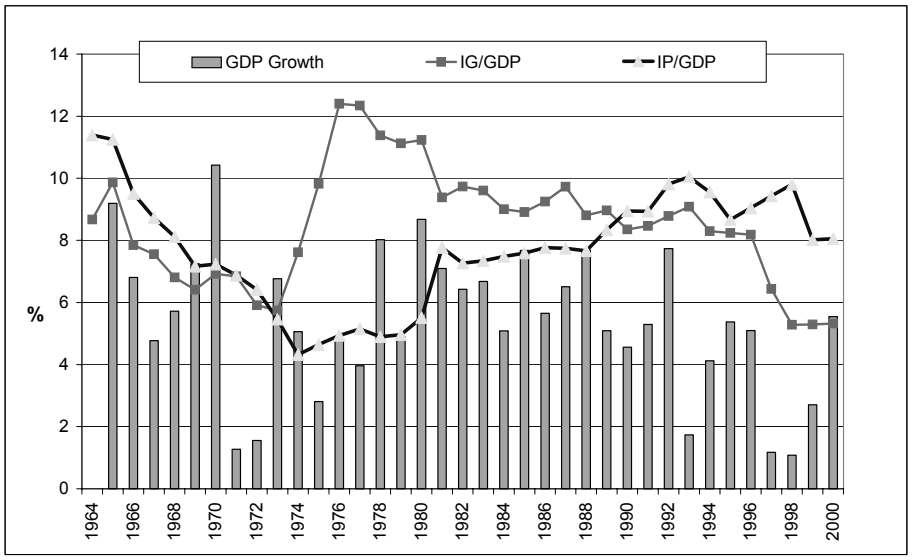
concept of Granger-Causality, found a negative relationship between public and private investment in manufacturing. He argued that public investment had stifled and crowded out investment from the private sector, thereby also discouraging follow-on investments in related areas.

Looney (1997), using co-integration analysis without the error correction representation, also found a long-run relationship between private investment in large-scale manufacturing, GDP, and infrastructural public investment. He suggested that private investment induced follow-on infrastructural investment, implying that public investment in infrastructure had played a passive role in the country's development. Khan (1997) identified lack of political stability, unsatisfactory law and order situation, lack of a trained labour force, inconsistent macroeconomic policies combined with macroeconomic imbalances, and inadequate infrastructure as the reasons for low foreign direct investment. In addition, he pointed out that foreign investors needed to know that local businessmen were investing in their own country. "A satisfied foreign investor operating an efficient, growing enterprise and re-investing…is the best testimony to that country's 'investor-friendly' environment". Since he established that FDI and general private investment were interdependent, it follows that the factors, mentioned above in relation to FDI, applied equally to general private investment.

In view of the forgoing discussion, it seems natural to empirically investigate the relationship between private investment, public investment, and output as these variables form the focus of most models discussed above. The empirical estimation will follow the VAR-based Johansen's (1988) ML approach to cointegration.

Investment in Pakistan: History and Numbers

Pakistan has seen variable real GDP growth rates over the past 37 years. These have ranged, as can be seen from Figure 1, from a high of over 10 percent in 1970 to a low of just over 1 percent in 1997 and 1998. While decade averages indicate that the private sector-friendly 1960s recorded the highest GDP growth rates, the 1990s, with a similar distribution of investment between the private and the public sector, saw the lowest growth rates. The 1970s were dominated by an increasing involvement of government in investment activity, with the result that at one point the government was investing twice as much as the private sector. This followed, in part, from the nationalisation policies of the government of Zulfiqar Ali Bhutto. The 1980s saw a revival of private sector activity encouraged by the military government of the time. Part of the reason for the poor performance of Pakistan in the 1990s has been the slow-down of government investment activity below its trend level, especially in the latter part of the decade. This has resulted from, among other things, cotton crop disease in the early 1990s, which affected the economy for almost two years, international sanctions following nuclear testing in 1998, and a general lack of success in raising tax revenue beyond 14-15 percent of GDP, as a result of widespread tax evasion [Naqvi (2001)].



1964–2000

Fig. 1. GDP Growth, Private (Ip) and Public (Ig) Investment in Pakistan 1964–2000.

In various studies of the public sector, the rationale for its existence is explained in terms of provision of 'social insurance', underpinned by the belief that while public sector may be less efficient it is also less volatile than the private sector [Katsimi (1996)]. It is instructive to look at Table 1 and to note that over the past 37 years, volatility of the public and private investment, measured by Standard Deviation, is similar over the entire period, but it also shows considerably more volatility in the public investment series when the sub-periods are considered. It is even more interesting to compare Pakistan's investment performance with other Asian countries. As can be seen from Appendix A, Pakistan bucks the trend, and unlike any of the other South Asian and South East Asian countries, has a more volatile investment performance in the public sector than in the private sector. This indicates the need to look at the impact of macroeconomic uncertainty on investment activity. In addition, for similar periods, Pakistan has the lowest aggregate investment-to-GDP ratio in the group. Surprisingly, then, its GDP growth, despite turning in the worst performance of its last forty years in the 1990s, has on average performed better than both India and Bangladesh. Clearly, Pakistan's economy has seen better days and stands at the crossroads. If its economic performance does not pick up, it will be left behind economies it has traditionally outperformed. It is against this background that the interaction of public and private investment with economic growth in the presence of macroeconomic uncertainty will be studied.

Table 1

Descriptive Statistics for Pakistan 1964–2000

Statistic and Time Period	GDP (Y) Growth (%)	Public Inv. Ig/GDP (%)	Priv. Inv. Ip/GDP (%)	Total Inv. (Ip+Ig)/GDP (%)
AVG 64-70	7.36	7.73	9.06	16.78
AVG 71-80	4.78	9.44	5.32	14.76
AVG 81-90	6.25	9.17	7.79	16.96
AVG 91-2000	3.99	7.34	9.14	16.48
STDEV 64-70	*2.12*	*1.21*	*1.75*	*2.91*
STDEV 71-80	*2.52*	*2.65*	*0.79*	*2.35*
STDEV 81-90	*1.11*	*0.45*	*0.50*	*0.37*
STDEV 91-2000	*2.22*	*1.57*	*0.72*	*2.03*
AVG 64-2000	**5.40**	**8.48**	**7.73**	**16.20**
STDEV 64-2000	***2.32***	***1.88***	***1.84***	***2.16***

Source: Pakistan (1997); Pakistan (2000).

METHODOLOGY

We pursue estimation using VAR methodology for two reasons. First because it implicitly deals with the forward-looking nature of investment spending and proceeds without imposing any *a priori* exogeneity or causality conditions on the variables in the VAR, in effect letting the data uncover the underlying theory; and secondly because the Structural VAR Methodology pioneered by Sims (1980), and contributed to recently in the case of co-integration among non-stationary endogenous variables by Johansen (1988); Davidson (1998) and Ericsson, *et al.* (1998), allows for more rigorous modelling using the long-run relationship if it is present in the I(1) endogenous variables (rather than discarding it by using differenced data without the error correction formulation).

Finally, while co-integrating VAR-based method has been applied by Ghali (1998) to estimate a growth model for Tunisia, his interpretation has been criticised by Kulshreshtha and Nag (2000). The interpretation of the Vector Error Correction Models (VECM) is done by following Ericsson's, *et al.* (1998) with their suggestions for economic policy analysis. In addition, the paper seeks to extend the proposed economic policy analysis by including conditioning variables, consistent with co-integration theory, to enhance the explanatory power of the VECM's derived earlier. Co-integrating VARs, Johansen (1988), Hendry (1995), Enders (1995), Ghali (1998)

Consider a VAR given by

$$X_t = \Phi_1 X_{t-1} + \Phi_2 X_{t-2} + \ldots + \Phi_k X_{t-k} + \mu + \eta_t t = 1,\ldots,T \qquad \ldots \qquad (1)$$

Where X_t = vector of ($n \times k$) dimension

Φ_k = vector of ($n \times n$) dimension

η_t = Vector of unanticipated impulses (movements in X_t) ~ $niid(0,\Sigma)$.

Where n is the number of variables in the VAR, k is the dimension of the VAR, and t is time.

If co-integration is established the short-run dynamics can be studied using the following Vector Error Correction Model (VECM)

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + ... + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + \mu + \eta_t \quad t = 1,...,T \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Where Π is the long-run parameter matrix with rank equal to p, the number of co-integrating vectors, such that $1 \le p \le n-1$. Γs, are estimable parameters in the short-run model, and Δ is a difference operator.

Where $\Pi = \alpha\beta'$

α is a ($n \times p$) matrix representing the adjustment (loading) coefficients which measure the speed of adjustment in the VECM, and β' is a ($p \times n$) matrix representing the long-run coefficients in the co-integrating relations.

A set of variables none of which may be omitted without the loss of the co-integrating property is called an Irreducible Co-integrating Relation by Davidson (1998). Ericsson, *et al.* (1998) discuss concepts of weak and strong exogeneity in the context of conditioning variables for the VECM's. Weak exogeneity of a variable with respect to other variables in the VAR is said to hold when the loading coefficient α_z of the relevant variable(s), z, can be tested to be equal to zero in the loading matrix. Weak exogeneity is a sufficient condition for the efficient inference on the parameters of interest in the conditional model [Ericsson, *et al.* (1998), p. 372]. Although we shall not be undertaking conditional forecasting, it seems pertinent to note that for such forecasting to be valid, strong exogeneity, which is a combination of weak exogeneity and Granger non-causality of the variable(s), z , with respect to other variable(s), y, in the VAR, (i.e., y does not cause z), is a necessary condition.

EMPIRICS

We start by specifying the variables of interest. We tentatively start with 3 variables indicated below, testing them initially for unit roots and then using Johansen's ML approach to look for co-integration among pairs.

Variables in the VAR:

Ip = Private Fixed Capital Formation;

Ig = Public Fixed Capital Formation;

Y = Gross Domestic Product at Market Prices;

All Variables are in Logs and Deflated by the GDP-Deflator (1981=100).

Table 2 gives unit root tests and indicates that the variables contain unit roots. Table 2a includes unit tests that account for a possible structural change as suggested by Perron (1989) and explained by Enders (1995, pp. 243–251). They confirm the results of Table 2. The tests for co-integration in Table 3 indicate that no co-integration was present in any of the pairs. Testing for co-integration among the three variables indicates one co-integrating relation. By Davidson's (1998) definition, this is a structural Irreducible Co-integrating Relation. These tests were carried out in the presence of a restricted trend and an unrestricted constant as suggested by Doornik and Hendry (1996) . The proxy for *Uncertainty* (*UN*) was constructed following Mavrotas (1997) and as the Standard Deviation of the annual change in the Real Exchange Rate[3] over the last 3 years, and was used in the short-run VECMs under the assumption that investment decisions are likely to be affected by recent uncertainty.

The co-integrating VAR is estimated by restricting the trend to lie in the co-integrating space, while the intercept is unrestricted and appears both in the long-run and the short-run relations. Unrestricted trends, which allow for trends in the short-run models, imply a quadratic trend in the long-run relation. As Harris (1995, p. 96) points out, this is economically suspect as it would imply "an implausible ever-increasing or ever-decreasing rate of change", especially if the variables are in logs as in our case. Thus a linear time-trend is included, restricting it to the co-integration space, and allowing for an intercept in the short-run model. The VAR length is determined by the Schawarz Bayesian Information (SBC) criteria for model selection as suggested by Enders (1995, p. 88) and Davidson (1998, p. 106).

Table 2

Unit Root Tests

		Null: Unit Root Exists				
		Intercept		Intercept and Trend		
Variable (in Logs)	Lag Selection (SBC)	ADF Stat.	P-P Stat.	ADF Stat.	P-P Stat.	Variable Type
Y	0	–1.53	–1.56	–0.39	–0.502	I(1)
Ip	0	–0.077	–0.07	–1.9	–2.83	I(1)
Ig	1	–1.70	–1.92	–1.6	–2.34	I(1)
ΔY	0	–4.5	–5.8	–4.7	–9.9	I(0)
ΔIp	0	–4.35	–7.3	–4.28	–8.9	I(0)
ΔIg	0	–3.7	–5.93	–4.07	–6.34	I(0)
95% Critical Values		**–2.957**	**–2.957**	**–3.55**	**–3.55**	

Note: Annual data (in logs) are used for the years 1964–2000. The graphical representation of the data in log-levels is attached in Appendix B.1.

[3]Other variations based on inflation and terms of trade gave similar results.

Table 2a

Unit Root Tests [Structural Change; Perron (1989)]

Variable (in Logs)	Lag Selection (SBC)	Null: Unit Root Exists		Variable Type
		Intercept	Intercept and Trend	
Y	0	–0.85	–0.62	I(1)
Ip	0	–0.57	–1.36	I(1)
Ig	0	–2.01	–2.33	I(1)
ΔY	0	–4.98	–5.15	I(0)
ΔIp	0	–5.06	–4.78	I(0)
ΔIg	0	–4.02	–5.4	I(0)
95% Critical Values [Perron (1989)]		**–3.96**	**–4.24**	

Note: Annual data (in logs) are used for the years 1964–2000. Following Perron (1989) intercept dummies and trend dummies are included in the regressions when testing for unit roots. *The intercept dummies take value of 1 after 1973 and 0 otherwise. The trend dummies start from 1973 and go to 2000.*[4] The date 1973 was decided to coincide with the increase in public investment during the mid-1970s, as is obvious from both Figure 1 and Appendix B.1. *The results do not change.*

Table 3

Testing for Rank of Π

Panel	Variables		λ_{max}			Trace		
		Ho:rank=p	–Tlog (1-\mu)	Using T-nm	95%	–T\Sum log(.)	Ysing T-nm	95%
a	Ip & Ig	p == 0	15.24	13.5	**19.0**	21.82	19.32	**25.3**
		p <= 1	6.574	5.823	**12.3**	6.574	5.823	**12.3**
b	Ig & Y	p == 0	8.021	7.104	**19.0**	9.869	8.741	**25.3**
		p <= 1	1.848	1.637	**12.3**	1.848	1.637	**12.3**
c	Ip & Y	p == 0	17.38	15.39	**19.0**	17.71	15.69	**25.3**
		p <= 1	0.3324	0.2944	**12.3**	0.3324	0.2944	**12.3**
d	Ip, Ig & Y	p == 0	31.18**	25.84*	**25.5**	49.24**	40.8	**42.4**
		p <= 1	15.28	12.66	**19.0**	18.06	14.96	**25.3**
		p <= 2	2.777	2.301	**12.3**	2.777	2.301	**12.3**

Note: The order of the VAR was selected using the SBC selection Criteria as suggested by Davidson (1998, p. 106). All the following calculations are on the basis of a *VAR(2),* and include a dummy for 1981, as all the data is in 1981 prices, in addition to the fact that the Ministry of Finance revised its measurement methods that year. While the effects are not significant in the levels and similar co-integration results are obtained without the dummy, the dummy does enter the VECMs significantly, as growth rates are much more sensitive to measurement errors than levels, and adds considerably to their explanatory power.

[4]Similar tests by taking 1981 as the start year for the structural change also revealed no change to the results of Table 2.

Co-integrating VAR-based Modelling Results

The long-run estimates of β′indicate that *Ip and Ig enter the vector with the same sign* (Tables 4 and 5). In addition, *Y (GDP)* is weakly exogenous to the system, thereby allowing conditional estimation of the error correction models of *Ip* and *Ig*. The error correction models are presented in Table 6. **Panel a** gives the standard VECM, whereas **Panel b** gives the estimated conditional error correction model. This model can be characterised as the *Adapted Flexible Accelerator Model* because of the large positive coefficient on the GDP growth variable (ΔY), and indicates a *positive* impact of lagged Government investment growth on private investment growth, when conditioned on the current GDP growth. **Panel c** augments the model with a measure of uncertainty (*UN*). The proxy has significant and negative sign in the model for private investment, but enters the government investment equation insignificantly. This may be because of the formulation of the proxy, which is based on the Real Exchange Rate. It is possible that the government has an informational advantage as it can influence the nominal exchange rate and other macroeconomic policies that would affect it, and therefore can better anticipate changes. The Granger block-causality tests summarised in Table 7 indicate *Y & Ip* Granger-cause *Ig*, and that *Y& Ig* Granger-cause *Ip*. This indicates that *Causality is bi-directional* between public and private investment. *Ig* has a larger *coefficient on the ECM term* than *Ip*. Both contribute to movement towards equilibrium but *Ig adjusts slightly more quickly than Ip*. The evidence is for both types of investment to recover between a quarter and a fifth of the difference between the long-run relation and the shocked system in each period.

Table 4

The α and β′ from the Unrestricted Model

Variable	β′	α
Ip	1.00	–0.166
Ig	0.391	–0.235
Y	–4.36	0.017
Trend	0.062	

VAR(2) with unrestricted intercept and restricted trend. Also includes a dummy for 1981.

Table 5

The α and β′ from the Restricted Model (Testing for Weak Exogeneity of Y)

Variable	β′	α
Ip	1.00	–0.199
Ig	0.294	–0.258
Y	–4.33	–
Trend	0.0631	

LR-test, rank=1: Chi^2(1) = 1.0632 [0.3025]. Weak exogeneity hypothesis accepted.

Table 6

Estimated Vector Error Correction Models

Panel	a			b		c	
Variable	ΔIp	ΔIg	ΔY	ΔIp	ΔIg	ΔIp	ΔIg
ΔIp_{t-1}	–.0138 [.933]	–.360[.090]*	–.049[.225]	.064[.688]	–.241[.214]	–.194[.254]	–.028 [.898]
ΔIg_{t-1}	.190 [.170]	.139 [.419]	–.003[.926]	.221[.076]*	.172 [.242]	.30 [.024]**	.22 [.195]
ΔY_{t-1}	.60 [.434]	.76 [.428]	.18 [.319]				
ΔY				1.23 [.100]*	2.0 [.025]**	.81 [.224]	2.3 [.011]
ECM_{t-1}	–.18 [.018]**	–.22 [.017]**	. 01 [.387]	–.19 [.010]**	–.25 [.005]**	–.21 [.027]**	–.12 [.320]
D81	.071[.013]**	.020 [.555]	.01 [.063]*	.05 [.047]**	–.004 [.901]	.07 [.007]**	–.016 [.614]
UN						–.33 [.005]**	.24 [.102]
Constant	–3.0 [.018]**	–3.8 [.01]**	.27 [.357]	–3.2 [.009]**	–4.2 [.005]**	–3.6[.027]**	–2.17[.308]
R-squared	**.44**	**.30**	**.17**	**.48**	**.39**	**.60**	**.42**
LM (F) Test for Serial Correlation	.52 [.477]	.15 [.694]	1.5 [.227]	.52 [.474]	.010 [.918]	7.3 [.012]**	2.84 [.104]
Vector AR 1-2	F(18, 59) =	0.4695 [0.9613]		F(8, 48) =	0.5381 [0.8219]	F(8, 44) =	2.16 [0.049] *
Vector Normality	Chi^2(6) =	7.5503 [0.2729]		Chi^2(4) =	3.8127 [0.4320]	Chi^2(4)=	0.439 [0.9791]
Vector Xi^2	F(48, 77) =	0.82118 [0.7667]		F(27, 50) =	0.905 [0.6016]	F(33, 39) =	0.90 [0.6098]

Note: The figures in the brackets are **p-values**. The error correction (ECM) term is from the Restricted Model. The **graphical representations** of these models are included in **Appendix B** as Figures a, b, and c corresponding to the panels above. **Orthogonal impulse responses** based on **Panel a** are included in **Appendix C.**

Table 7

Testing Restrictions on the Vector Error Correction Models

Panel	Null Hypothesis (H0)	Wald Test*	Granger Block Non-causality
a	ΔIg & Δ Y Don't Cause ΔIp	12.642 [0.0055] **	No
	Ip & Δ Y Don't Cause ΔIg	9.2566 [0.0261] **	No
	ΔIg & Δ Ip Don't Cause ΔY	2.4728 [0.4802]	Yes
b	ΔIg & Δ Y Don't Cause ΔIp	15.823 [0.0012] **	No
	Ip & Δ Y Don't Cause ΔIg	15.624 [0.0014] **	No
c	ΔIg & Δ Y Don't Cause ΔIp	23.162 [0.0000] **	No
	Ip & Δ Y Don't Cause ΔIg	8.7902 [0.0322] **	No

* Wald test for general restrictions. The figures in the brackets are **p-values.** A significant p-value rejects H0. The restriction includes restrictions on the lagged error correction term as suggested by Enders (1995).

The impulse response diagrams in Appendix C also reflect this view. A shock to the government investment series may be thought of as coming from that allocation of funds which is made on non-economic grounds. After all, some spending decisions, which may be unjustifiable on purely economic grounds, may be politically feasible, even necessary (such as ensuring that a particular highway project have a link road to the home town of the committee chairman who approved the project). Orthogonal innovations in the output series may be thought of as productivity shocks. Orthogonal innovations in the private investment series are much harder to justify, but may arguably come from global capital looking for a parking space, or from foreign aid to the private sector (e.g., project aid from the IFC). As Ericsson (1998, pp. 378-79) points out, an alternative interpretation of Impulse Response relationship would be to regard them as responses to policy action (a_t) at time t, instead of regarding them as changes to the error term, where they would be required to closely match the underlying economic shock and be consistent with the normal assumptions about the distribution of the error term. By contrast, the policy actions shift the systems intercept and are (by assumption) autonomous. As Ericsson, *et al.* (1998, p. 379) points out, impulse response functions offer only graphical representations of the estimated model and contain information already available in the coefficient estimates of the model.

Evidence of the weak exogeneity of GDP supports arguments advanced against the capital fundamentalist view of the growth process, and finds support from King and Levine (1994), Blomstrom, *et al.* (1996); and Easterly and Levine (2001), among others, and suggests that GDP growth is more closely related to future investment than to past investment.

SOME FURTHER COMMENTS ON THE INTERPRETATION OF RESULTS

In the balance, both methods contribute to a better understanding of the investment process. The VAR-based methodology offers a tractable modelling strategy using the concept of weak exogeneity and conditional modelling. As to the question about the complementarity or otherwise of public investment with private investment, a nuanced view has to be taken, while lagged government investment, possibly because of 'time to build' characteristics, does appear to have a positive effect on private investment. There is some evidence that the reverse may be true for private investments effect on government investment. This *may* be explained as follows. Uncertainty has a much larger impact on private investment than on public investment, as has been shown. In such uncertainty, as in the immediate aftermath of the break-up of Pakistan in 1971, the government compensates by increasing its investment. However, this investment activity builds up a lobby that has a vested interest in keeping the new state of affairs. Counter pressure takes time to build, but once—say in five years—the private sector does start to claim more and more of the

share of total investment (credit) the government sector starts to shrink. The effect of different types of government investment may be different.

Arguably, government investment may have been increased above its trend value even if the policy-maker knew that private investment was more productive, if one considers the arguments advanced by Glazer (1989), who argues that a voter (or a policy-maker) may select a second-best outcome (public investment) in order to prevent the worst-best outcome (no investment). Glazer (1989) also makes the case that in the absence of durability-enhancing institutions, there is a clear bias towards durable capital-intensive projects [Crain and Oakley (1995)]. This may explain the public investment in Pakistan in the 1970s which came ahead of both years of falling total and private investment, and a disastrous civil war. In the balance, the government needs to invest at reasonable rate (say in infrastructure, and social services), both to help boost the productivity of private investment as well as to signal a commitment to improving the general investment environment, and to reduce uncertainty. Pakistan has gone from a private sector-oriented economic policy in the 1960s to a public sector-driven one in the 1970s, which included significant nationalisation of private industry instead of policies that could have instilled confidence in the private sector to complement the public sector investment. A slow rehabilitation of the private sector in the 1980s has been followed by a policy of attempted privatisation in the 1990s, but with limited success. This roller-coaster ride, spectacular as it may seem to some, by its very nature creates doubts about the permanence or predictability of policy,[5] especially since the civil service, which is a source of continuity in many countries, has been increasingly insecure about its own position ever since the constitutional guarantee of service was removed in 1972-73. As Table 6, **Panel c**, shows controlling for uncertainty not only accentuates the positive nature of lagged government investment (increasing its p-value, its coefficient, and the R-squared of the model, compared to **Panel b**), but also indicates a significant negative coefficient on the proxy for uncertainty.

CONCLUDING REMARKS

In conclusion, the paper has presented evidence that past government investment has, on average, had a positive impact on private investment. In addition, the impulse response functions show that it takes about five years for effects of policy change or a shock to either private or public investment growth to disappear from the system. A similar, if slightly longer, period is suggested by the coefficient on the error correction term in the various error correction models. The models also indicate that the growth in the economy generates investment of both types. Judging by the coefficient in the models presented, economic growth is perhaps the most

[5]The military government won plaudits for undertaking difficult economic reforms (*The Economist*, August 4th, 2001, p. 53-54). Yet the issue of their permanence hangs over its head because of the irregular nature of the government undertaking these.

important source of investment growth. However, investment by itself does not seem to be the igniting source of economic growth. This evidence supports the accelerator-based models of investment, and the vast literature against capital fundamentalism. Finally, uncertainty is shown to have a significant negative impact on private investment. Further research can focus on studying investment under uncertainty in Pakistan, using other proxies, as well as the Options-based approach. In addition, there is reason to expect that different kinds of government investment will have a different impact on private sector activity. This suggests a sectoral study of investment where the impact of core infrastructural government investment, such as roads, communication, electricity, construction, etc., on aggregate and sectoral private investment activity is studied and compared with, say, the impact of government investment in manufacturing activities.

Appendices

Appendix A

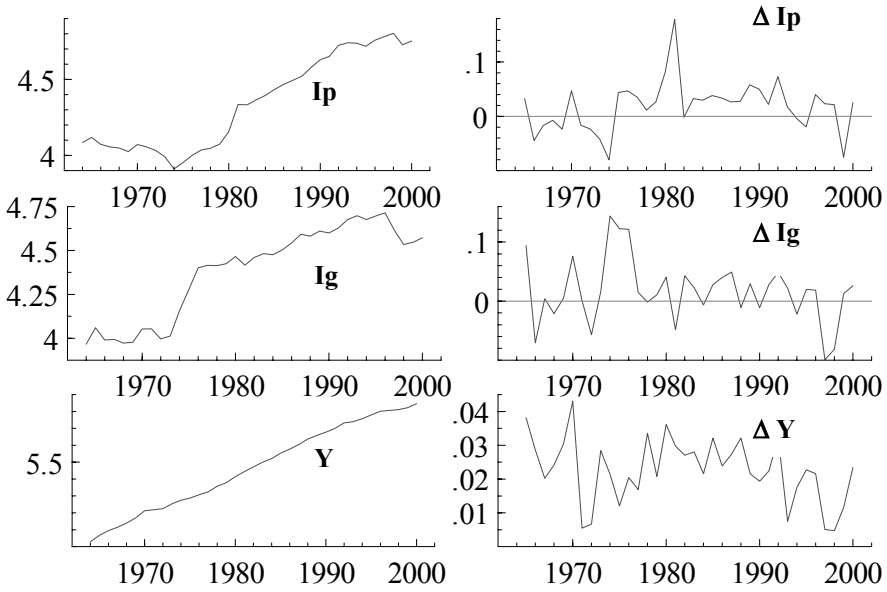
Trends in Private and Public Investment in Selected Asian Countries

Country	Time Period	GDP Growth* (%)	IG/GDP (%)	IP/GDP (%)	(IG+IP)/GDP (%)
Pakistan	AVG 72-80	5.83	9.59	5.84	15.43
	AVG 81-90	6.20	9.17	7.79	16.96
	AVG 91-98	4.90	7.85	9.38	17.23
	STDEV 72-80	*1.84*	*2.53*	*0.99*	*2.77*
	STDEV 81-90	*1.12*	*0.43*	*0.49*	*0.35*
	STDEV 91-98	*2.15*	*1.37*	*0.46*	*1.44*
	AVG 72-98	**5.75**	**8.92**	**7.61**	**16.53**
	STDEV 72-98	***1.63***	***1.75***	***1.58***	***1.90***
Bangladesh	AVG 72-80	5.92	4.45	5.04	9.49
	AVG 81-90	4.01	8.11	11.59	19.70
	AVG 91-98	4.35	6.79	13.21	20.00
	STDEV 72-80	*4.64*	*2.34*	*1.64*	*3.84*
	STDEV 81-90	*1.79*	*1.38*	*1.18*	*1.84*
	STDEV 91-98	*0.44*	*0.26*	*1.29*	*1.38*
	AVG 72-98	**4.68**	**6.58**	**10.07**	**16.65**
	STDEV 72-98	***2.83***	***2.15***	***3.73***	***5.44***
India	AVG 72-80	3.94	7.28	9.70	16.98
	AVG 81-90	5.87	9.69	10.27	19.96
	AVG 91-98	5.12	7.73	14.48	22.20
	STDEV 72-80	*4.81*	*0.98*	*0.68*	*1.55*
	STDEV 81-90	*1.87*	*0.61*	*1.42*	*1.22*
	STDEV 91-98	*2.88*	*1.02*	*1.80*	*1.18*
	AVG 72-98	**5.03**	**8.30**	**11.33**	**19.63**
	STDEV 72-98	***3.33***	***1.38***	***2.47***	***2.48***
Malaysia	AVG 72-80	7.95	9.17	16.50	25.67
	AVG 81-90	6.02	13.40	17.13	30.53
	AVG 91-98	8.68	12.51	26.28	38.79
	STDEV 72-80	*3.43*	*1.33*	*1.99*	*2.43*
	STDEV 81-90	*3.51*	*3.52*	*2.34*	*4.94*
	STDEV 91-98	*0.73*	*1.42*	*4.21*	*3.96*
	AVG 72-98	**7.27**	**11.73**	**19.63**	**31.36**
	STDEV 72-98	***3.20***	***2.98***	***5.22***	***6.55***
Thailand	AVG 72-80	7.36	6.56	17.76	24.31
	AVG 81-90	7.94	7.13	22.69	29.82
	AVG 91-98	8.37	9.08	29.13	38.20
	STDEV 72-80	*2.74*	*1.59*	*1.20*	*1.88*
	STDEV 81-90	*3.34*	*1.48*	*5.40*	*4.42*
	STDEV 91-98	*0.39*	*1.48*	*5.35*	*4.40*
	AVG 72-98	**7.83**	**7.51**	**22.95**	***30.47***
	STDEV 72-98	***2.67***	***1.80***	***6.27***	***6.69***

Source: The GDP growth rates are based on 1990 prices, and cover the period between 1972–96. These are from the *International Financial Statistics Yearbook*, 1997 (IFSYB) published by the IMF. The investment data have been taken from Bouten and Sumlinski (1999), IFC Discussion Paper No. 41, available at: <http://www.ifc.org.>

Appendix B. 1

The Pakistan Data in Logs (as Used in the Estimation)



Appendix B. 2

Figures Based on the Estimated Models in Table 6

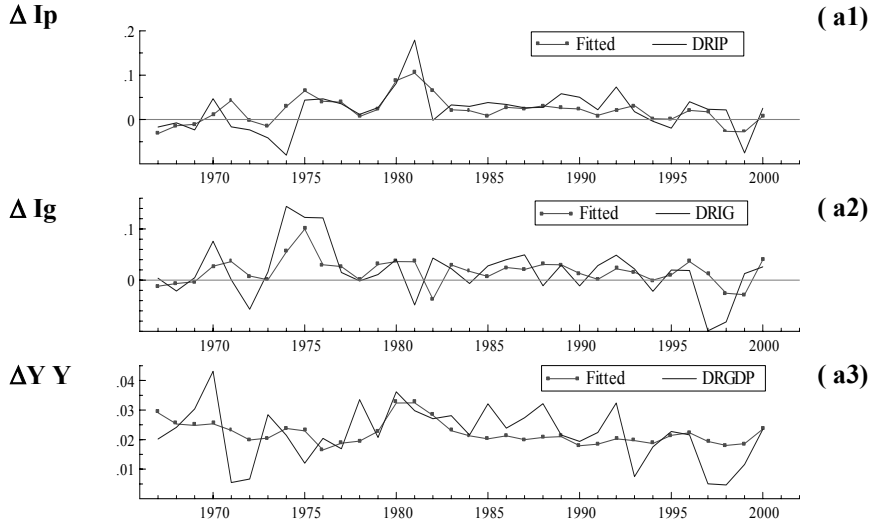


Fig. a.

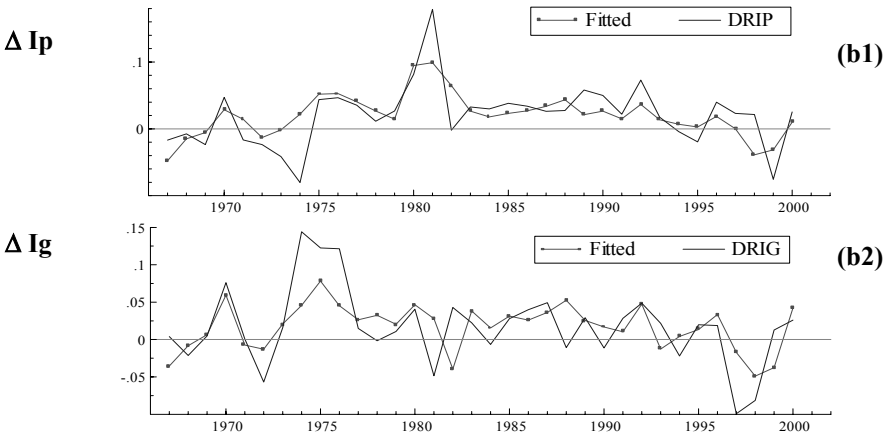

Δ Ip
Fitted
DRIP
(b1)
Δ Ig
Fitted
DRIG
(b2)
1970
1975
1980
1985
1990
1995
2000

Fig. b.

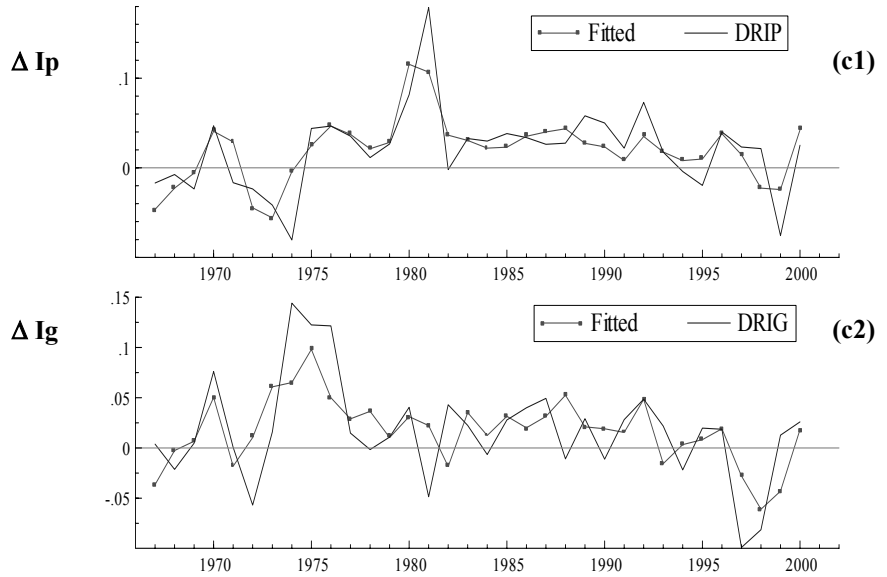
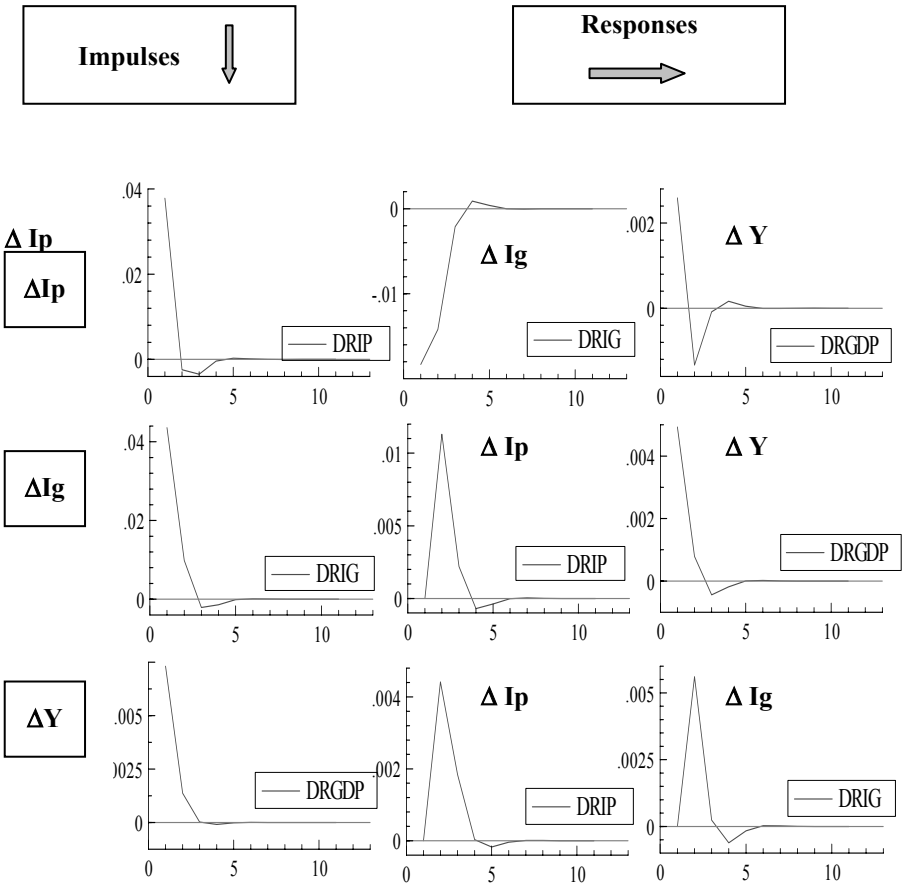

Δ Ip
Fitted
DRIP
(c1)
Δ Ig
Fitted
DRIG
(c2)
1970
1975
1980
1985
1990
1995
2000

Fig. c.

Appendix C

Orthogonalised Impulse Responses Based on the Model in Table 6 Panel a



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