Trade Liberalisation and Industrial Growth in Pakistan: A Cointegration Analysis

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ABSTRACT

Using the framework of an endogenous growth model, this paper empirically analyses the relationship between trade policies and industrial growth in Pakistan during the period 1973-1995. The cointegration and error correction modelling approaches have been applied. The empirical results suggest that there exists a unique long-run relationship among the aggregate growth function of industrial value added and its major determinants of the real capital stock, the labour force, real exports, the import tariff collection rate and the secondary school enrolment ratio. The short-term dynamic behaviour of Pakistan's growth function of industrial value added has been investigated by estimating an error correction model in which the error correction term has been found to be correctly signed and statistically significant.

* While writing the paper, Nasiruddin Ahmed was a PhD student at the University of Sydney,

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Section 1

Introduction

In recent years, the relation between trade liberalisation and economic growth in developing countries has become a central topic of debate among development economists. Does trade liberalisation raise economic growth in developing countries, and if it does, why? Firstly, there are number of empirical studies linking economic growth to the openness of the trade regime (Little, Scitovsky and Scott, 1970; Balassa, 1971 and 1982; Bhagwati, 1978; Krueger, 1978; Heitger 1987; World Bank 1987; Romer 1989; Quah and Rauch 1990; Michaely, Papageorgiou and Choksi, 1991; Thomas, Nash and Associates, 1991; Dollar, 1992; Edwards, 1992; Harrison, 1995; Savvides, 1995; Bakht, 1998; Onafowora and Owoye, 1998). On the other hand, some other studies find little empirical evidence to support a link between trade liberalisation and economic growth (Sachs, 1987; UNCTAD, 1989; Agosin, 1991; Taylor, 1991; Shafaeddin, 1994; Clarke and Kirkpatrick, 1992; Greenaway and Sapsford, 1994; Karunaratne, 1994; Jenkins, 1996; Greenaway, Morgan and Wright, 1997). Secondly, the emergence of endogenous growth theory has provided a theoretical framework for undertaking empirical work on the relation between trade policies and economic growth. The contributions of the present paper are two-fold: (i) it augments Lucas's (1988) human capital model of endogenous growth by incorporating an index of trade liberalisation; and (ii) it

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empirically examines validity of the augmented Lucas model in the context of Pakistan economy.

This paper is motivated by the recent attempts in Pakistan to liberalise her foreign trade regime.[1] We apply cointegration analysis, instead of either the cost function approach or the regression methodology usually used in the study of production functions. While the regression methodology appears to encounter spurious regression problems if the variables of interest are non-stationary[2], but standard growth theories provide the conditions for only long-run (steady state) equilibrium. The *cointegration analysis*, on the other hand, not only searches for a linear combination of non-stationary time series that is itself *stationary*, but also makes an attempt (using an *error correction* term) to investigate the dynamic behaviour of the process of adjustments[3] from short run disequilibria to long run equilibrium.

With this background in mind, this paper empirically analyses the relation between trade liberalisation and industrial growth in Pakistan during the period 1973-1995 using the framework of an endogenous growth model. The remainder of this paper is organised as follows. Section 2 spells out the relation between trade liberalisation and endogenous growth. The theoretical framework of the study is presented in Section 3. Section 4 models an aggregate industrial production function for Pakistan. In Section 5 the

[1] Of the recent policy reforms in Pakistan's foreign trade, major ones are: (i) system of export incentives strengthened through concessional tariff treatment of imported inputs and freight subsidy; (ii) import licensing system liberalised by reducing negative list; and (iii) tariffs reduced in stages: from 225 per cent in 1988 to 70 per cent in 1994 (Rana, 1997).

[2] The empirical evidence provided by Nelson and Plosser (1982), Meese and Singleton (1983), DeJong and Whiteman (1991) and Senhadji (1998) have shown that in reality, aggregate economic time-series are not stationary in their levels and therefore contain variances that explode with time.

[3] Some of the theoretical issues relating to tests for *cointegration* and formulation of *error*

empirical results are reported and discussed. Concluding remarks are given in Section 6.

Section 2

Relation Between Trade Liberalisation and Endogenous Growth

Endogenous growth theory has provided a more convincing and rigorous conceptual framework for the analysis of the relationship between trade policies and economic growth. In this new vintage of growth models it is possible to establish long-run relationships between trade orientation and economic growth in a number of ways. Firstly, import liberalisation is expected to promote technology transfer through the import of advanced capital goods. The import of technologically superior capital goods is also enhanced by growing export receipts and higher inflows of foreign capital, which take into account the country's ability to repay out of export earnings. Secondly, an export-oriented development strategy generally leads to higher growth. This is because there are some strictly economic factors, such as returns to scale, indivisibilities, and the impact of competition, that probably produce a more satisfactory economic performance under an export-oriented strategy than under import substitution (Krueger, 1978). Thirdly, foreign direct investment (FDI) brings export technology from industrial countries to developing countries as was the case in the East Asian economies. Fourthly, outward orientation makes it possible to use external capital for development without encountering serious problems in servicing the corresponding debt (Dollar, 1992). Fifthly, the opening up of an economy is likely to speed up the rate of economic growth by leading to larger economies of scale in

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correction model *etc.* have been discussed by the authors in Dutta and Ahmed (1999).

production due to the positive spillover effects emanating from technological developments in industrial countries. A more open economy and less distorted trade regime is often argued to result in a faster rate of absorption of technological progress originating in advanced countries (Lewis, 1955).

Although some studies mentioned in Section 1 of this paper found a positive correlation between output growth rate and openness of the economy, the role of human capital in explaining growth in different trade regimes has received little attention. Recently, a few empirical studies have focused on the role of human capital in explaining economic growth in different trade regimes and the results tend to validate the endogenous growth model (Romer, 1989; Edwards, 1992; Villanueva, 1994; Ghatak, Milner and Utkulu, 1995; Gould and Ruffin, 1995; Ahmed, 1999) (see *Table 1* below).

Table 1: Studies showing relation between trade liberalisation and economic growth in developing countries using the framework of an endogenous growth model

Authors	**Methodology**	**Findings**
Romer (1989)	Time-series data for 1960-85 for 90 developing countries; regression analysis	Testing the significance of an endogenous growth model, the study finds that economic openness, by taking advantage of a wider range of innovations, increases the growth rate.
Edwards (1992)	Time-series data for 1970-82 for 30 developing countries; regression analysis	Trade orientation and human capital accumulation emerge as significant determinants of

		growth in developing countries.
Villanueva (1994)	Time-series data for 1975-86 for 36 developing countries; regression analysis	The empirical results validate the endogenous growth model, particularly the positive effects of public policies of openness and investment in human capital on growth.
Ghatak, Milner and Utkulu (1995)	Time-series data for 1950-1990 for the Turkish economy; cointegration analysis	A stable long-run relationship exists among real GDP per capita, an index of trade liberalisation, and human and physical capital.
Gould and Ruffin (1995)	Time-series data for 1960-1988 for 98 countries; regression analysis	A positive relation between growth and the external effects of human capital varies according to trade regimes, with growth rates ranging from 0.65 to 1.72 per cent higher in open economies than closed ones.
Ahmed (1999)	Time series data for 1974:1 - 1996:4 for the Bangladesh economy; cointegration analysis	The empirical results validate the endogenous growth model developed by Lucas (1988), showing the positive effect of trade liberalisation and investment in human capital on industrial growth.

Source: Ahmed (1999).

Section 3

The Theoretical Framework

The theoretical framework of the study derives from the 'human capital model of endogenous growth' developed by Lucas (1988). Among the three models[4] he presents in his seminal paper, the one that emphasises human capital accumulation through schooling has received the greatest attention. The theory of human capital is concerned with spelling out the way human capital levels affect current production and the way the current time allocation affects the accumulation of human capital. The decision to accumulate human capital is equivalent to a decision to withdraw effort from production, in order to go to school.

In the Lucas model, human capital is considered as the engine of economic growth. One of the important features of the model is the dual role of human capital, both internal and external. The internal role is related to the effect of an individual's human capital on one's own productivity, while the external role pertains to the productivity of all factors of production.

Let L_t be the number of workers, q_t be a measure of the average quality of workers and u be the fraction of working hours w orkers spend on production of goods, such that $u q_t L_t$ is the *total effective workforce* used to produce

[4] Three models considered by Lucas are: (i) a model emphasising physical capital accumulation and technological change, (ii) a model emphasising human capital accumulation through schooling, and (iii) a model emphasising specialised human capital accumulation through learning-by-doing.

output, Y_t. In the Lucas model, Y_t depends on the physical capital stock, K_t, the effective work force, uq_tL_t, and the average skill level of human capital (workers), q_a:

$$Y_t = A_t K^b_t (uq_tL_t)^{1-b} q^{\gamma}_a$$

where the term q^g_a represents *externalities* from average human capital (AHC), and A_t stands for the technology level which is assumed to be constant.

In equilibrium, all workers are assumed to have the same skill level ($q_t = q_a$). So the Lucas model becomes:

$$Y_t = A_t K^b_t (uL_t)^{1-b} q_t^{1+\gamma-b}$$

From the above function we get the returns to scale:

$$(2 + \gamma - b) > (2 - b) > 1$$

In the Lucas model (1988), the increasing returns to scale due to externalities from average human capital are the driving force for an economy's sustained positive growth rate. The sustained growth depends on the value of γ.

For simplicity, Lucas also assumes that the workers use a fraction (u) of their non-leisure time in current production, devoting the remaining (1-u) to human capital accumulation, and thus

$$\Delta q_i / q_i = \delta_i u_i$$

where δ_i denotes the positive coefficient representing workers' skill formation in sector i. Such skill formation takes place more in sectors producing 'high-technology' goods: the export sector in particular and the industrial sector in general. Under trade liberalisation policy, both the export

and industrial sectors in developing countries come in contact with more advanced technology through import and/or foreign investment. Therefore, it is very likely that workers' skill level (internal and external) will increase.

Following Hwang (1998), *Table 2* presents a comparative picture of the neoclassical model of Solow (1956) and Swan (1956), the augmented Solow-Swan model of Mankiw, Romer and Weil (1992)[5] and the human capital model of Lucas.

Table 2: A Comparative Study of Solow, Mankiw *et al*. and Lucas Models of Growth

Solow-Swan (1956) growth model with labour augmenting exogenous technological progress	**Augmented Solow (Mankiw *et al*., 1992)**	**Human capital model of endogenous growth (Lucas, 1988)**
Production function[(i)]	Production function[(i)]	Production function[(i)]
$Y_t = A_t K^b_t (E_t L_t)^{1-b}$	$Y_t = A_t K^b_t H_t (E_t L_t)^{1-b-c}$	$Y_t = A_t K^b_t (uq_t L_t)^{1-b} q^{\gamma}_a$
$A_t > 0$, $E_t = E_0 e^{xt}$,	$A_t > 0$, $E_t = E_0 e^{gt}$,	$A_t > 0$, $L_t = L_0 e^{nt}$
$L_t = L_0 e^{nt}$	$L_t = L_0 e^{nt}$	
Subject to[(ii)]	Subject to[(ii)]	Subject to[(ii)]
$\dot{\bar{k}}_t = s\bar{y}_t - (n+x+d)\,\bar{k}_t$	$\dot{\bar{k}}_t = s_k\,\bar{y}_t - (n+g+d)\,\bar{k}_t$	$\dot{K}_t = A_t K^b_t (uq_t L_t)^{1-b} q^{\gamma}_a - c_t L_t$
	$\dot{\bar{h}}_t = s_h\,\bar{y}_t - (n+g+d)\,\bar{h}_t$	$\dot{q}_t = \delta q_t (1-u)$
Steady-state[(iii)]	Steady-state[(iii)]	Steady-state[(iii)]
$y^\circ = k^\circ = c^\circ = x$	$y^\circ = k^\circ = c^\circ = g$	$q^\circ = \delta(1-u) \equiv v$
$Y^\circ = K^\circ = C^\circ = x+n$	$Y^\circ = K^\circ = C^\circ = g+n$	$c^\circ = k^\circ = (1-\gamma-b)v / (1-b) \equiv \chi$
		$C^\circ = K^\circ = \chi + n$
Returns to Scale	Returns to Scale	Returns to Scale (for $q_t = q_a$)
$b + (1-b) = 1$	$b + c + (1-b-c) = 1$	$2 + \gamma - b > 2 - b > 1$

Notes: (i) Y_t, K_t, L_t, H_t, E_t, q_t, q_a, u respectively represent output, physical capital, number of workers, human capital, labour augmenting technological factor, a measure of average quality of human capital, externalities from average human capital, the fraction of working hours workers spent on production.

[5] Using an augmented Solow model that includes accumulation of human capital, Mankiw, Romer and Weil (1992) provide an excellent description of the international variation in income per capita.

(ii) Small letters denote 'per capita', while capital letters denote 'level'; '~' indicates per efficiency unit of labour; '•' denotes first order time derivative; 'd' represents depreciation; s_k and s_h respectively denote saving share of physical capital and human capital, and 'c' stands for individual per capita consumption.
(iii) '^' denotes growth rate of corresponding variable.

In *Table 2* the Solow model and the augmented Solow model have similar properties in the steady state. The only difference between these two models lies in the human capital accumulation allowed for in the augmented Solow model. Despite the assumption of human capital accumulation, the same steady-state conditions hold. In the steady state, each per capita variable grows at the same exogenous rate of labour augmenting technological progress, being at the rate of x and g in Solow and the augmented Solow models respectively. As opposed to the exogenous productivity model of Solow and the augmented Solow models, the assumption of non-diminishing returns in the production of knowledge technology is crucial in the endogenous growth model and drives the economy to a sustained positive growth rate. Therefore, sustained growth is possible as the accumulation of knowledge continues.

Section 4

Modelling an Aggregate Industrial Production Function for Pakistan

The link between trade liberalisation and the growth rate of industrial production is verified by using an aggregate production function framework. Following Lucas we specify an industrial production function for Pakistan in the following way:

$$Y = f(K, L, H, TL) \qquad (1)$$

where Y is the industrial value added; K, L, H and TL represent, respectively,

capital and labour inputs, human capital and an index of trade liberalisation.

Thus in equation (1) the Lucas model is augmented by the *TL* variable. Based on the availability of time-series data and relevance to the industrial production function for Pakistan, we use two measures of trade liberalisation in this paper: real exports (REXPORT) as an *outcome-based* measure and the average import tariff collection rate (TARIFF) as the *incidence-based* measure. In the first measure, real depreciation of the domestic currency is used. Because such depreciation usually raises the price of tradeables relative to that of non-tradeables, resources start moving out of the non-tradeable sector into the tradable sector. In the case of second measure, the decline in import price relative to export price due to the reduction in import tariff rate causes resources to move from imports to exports. Thus, as a result of a real exchange rate-based trade liberalisation policy, real exports would be expected to rise.

Following Mankiw , Romer and Weil (1992), the *effective workforce* of Lucas is proxied by the variable EDU which measures the percentage of the working-age population that is in secondary school. An advantage of this proxy is that it focuses on labour augmenting technological progress, which is the type of technological knowledge we would like to capture in our model. Consequently, our aggregate (industrial) production function becomes:

INDUSVA= f (RCAPITAL, LABOURP, REXPORT, TARIFF, EDU) (2)

Specifying the production function in log-linear form (with an error term, u_t),

the following equation may be written:

$$LINDUSVA_t = \alpha_0 + \alpha_1 LRCAPITAL_t + \alpha_2 LLABOURP_t + \alpha_3 LREXPORT_t + \alpha_4 LTARIFF_t + \alpha_5 LEDU_t + u_t \quad (3)$$

It is expected that the elasticity parameters $(\alpha_1, \alpha_2, \alpha_3, \alpha_5) > 0$, and $\alpha_4 < 0$.

This leads to the specification of a general ECM of the industrial production function of the following form:

$$\Delta LINDUSVA_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta LINDUSVA_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta LRCAPITAL_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta LLABOURP_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta LREXPORT_{t-i} + \sum_{i=0}^{n} \beta_{5i} \Delta LTARIFF_{t-i} + \beta_6 LEDU_{t-1} + \beta_7 EC_{t-1} + \varepsilon_t \quad (4)$$

where EC_{t-1} = error-correction term lagged one period.

Section 5

Empirical Analysis

5.1 Summary Statistics

Data on INDUSVA, RCAPITAL, LABOURP, REXPORT, TARIFF and EDU for the 1973-1995 period are shown in *Table 3* as their mean, standard deviation (SD), coefficient of variation (CV), and annual compound growth rate.

Table 3: Summary Statistics of Variables

Variable	Description	Mean	SD	CV	Growth rate (%)
INDUSVA	Industrial value added	109744.02	49044.91	0.45	7.0
RCAPITAL	Real fixed capital formation	110021.77	47357.24	0.43	7.1
LABOURP	Labour force as % of population	35.04	0.59	0.02	0.1
REXPORT	Real exports	844.17	463.72	0.55	7.8
TARIFF	Import tariff collection rate	24.81	4.82	0.19	2.1
EDU	Secondary school enrolment ratio	18.35	4.21	0.23	2.9

Note: Annual growth rates are trend values significant at the 5 per cent level.

5.2 Unit-Root Tests

The data used in the empirical investigation cover the period from 1973 to 1995. In this section we perform unit root tests for stationarity on the levels and the first differences of all six variables. The Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) unit-root tests (*Table 4*) show the existence of unit roots, and therefore non-stationarity, in the levels of some variables (LINDUSVA, LLABOURP, LREXPORT, and LEDU). However, the first

differences of four variables (LINDUSVA, LREXPORT, LTARIFF & LEDU) and second differences of two variables (LRCAPITAL & LLABOURP) are stationary under the DF/ADF tests. The Phillips-Perron (PP) unit-root test does confirm stationarity for all the six variables in similar level and differencing stages (*Table 5*). Hence we conclude that these variables are integrated of order 1.

Table 4: DF-ADF Unit Root Tests for Stationarity

		DF		ADF (1)		
Variable	**Levels or First Diff.**	**Without Trend**	**With Trend**	**Without Trend**	**With Trend**	**Conclusion**
LINDUSVA	Levels	-0.32	-2.83	-0.31	-2.29	I(1)
	First Diff.	-5.69	-5.58	-2.77	-2.64	I(0) under DF test
						I(1) under ADF test
LRCAPITAL	Levels	-2.92	-4.55	-2.32	-5.35	Inconclusive
	First Diff.	-3.38	-3.46	-3.56	-3.85	I(0) under ADF test
	Second Diff.	-5.51	-5.50	-5.73	-5.75	I(0) under both DF & ADF tests
LLABOURP	Levels	-3.23	-2.93	-2.88	-2.76	I(1) under ADF test
	First Diff.	-3.05	-2.84	-2.24	-1.86	I(1) under ADF test
	Second Diff.	-6.46	-6.55	-4.14	-4.40	I(0) under both DF & ADF tests
LREXPORT	Levels	-0.54	--2.68	-0.22	-2.33	I(1) under both DF & ADF tests
	First Diff.	-5.28	-5.11	-2.75	-2.51	I(0) under DF test
LTARIFF	Levels	-3.87	-2.94	-3.69	-2.43	Inconclusive
	First Diff.	-4.83	-5.32	-2.57	-2.99	I(0) under DF test
LEDU	Levels	-0.03	-2.54	-0.12	-2.53	I(1) under both DF & ADF tests
	First Diff.	-3.91	-3.72	-2.56	-2.32	I(0) under DF test

Notes:
(i) Unit root tests are performed using Microfit 4.0
(ii) 95% critical values for DF & ADF statistics (variables in level) = -3.01 (without trend) & -3.65 (with trend).
(iii) 95% critical values for DF & ADF statistics (variables in first dif.) = -3.02 (without trend) & -3.66 (with trend).

(iv) 95% critical values for DF & ADF statistics (variables in second dif.) =-3.03 (without trend) & -3.67 (with trend).

Table 5: Phillips -Perron (PP) unit root test for stationarity

Variables	Levels/ First Differences	Constant, No Trend	Constant, Trend	Conclusion
LINDUSVA	Levels	-0.69	-2.44	I(1)
	First Differences	-5.87	-5.73	I(0)
LRCAPITAL	Levels	-2.77	-2.90	I(1)
	First Differences	-2.86	-3.37	I(1)
	Second Differences	-5.46	-5.29	I(0)
LLABOURP	Levels	-3.41	-2.93	Inconclusive
	First Differences	-2.83	-2.66	I(1)
	Second Differences	-6.76	-6.95	I(0)
LREXPORT	Levels	-0.14	-3.06	I(1)
	First Differences	-5.59	-5.37	I(0)
LTARIFF	Levels	-2.22	-1.65	I(1)
	First Differences	-5.29	-6.28	I(0)
LEDU	Levels	-0.19	-1.84	I(1)
	First Differences	-4.08	-4.20	I(0)

Notes: (i) PP test was performed using SHAZAM 8.0.

(ii) The critical values for PP statistic at 95 per cent level are –2.90 (for constant and no trend) and –3.46 (for constant and trend).

5.3 Cointegratio n Tests

Having found that all the six variables (LINDUSVA, LRCAPITAL, LLABOURP, LREXPORT, LTARIFF and LEDU) are integrated of order one, our next step is to determine whether any combinations of the variables are cointegrated. Before undertaking the *cointegration* tests, we first specify the relevant order of lags (p) of the *vector autoregressions* (VAR) model. Since the sample size is relatively small, we select 1 for the order of the VAR (Pesaran and Pesaran, 1997). The results obtained from the Johansen-

Juselius (JJ) method are presented in *Table 6*.

Table 6: Johansen -Juselius Maximum Likelihood Cointegration Tests

Null	Alternative	Statistic	95 % Critical Value
Maximal Eigenvalue Test			
r = 0	r = 1	42.45	39.83
r ≤ 1	r = 2	32.18	33.64
r ≤ 2	r = 3	26.68	27.42
r ≤ 3	r = 4	13.65	21.12
r ≤ 4	r = 5	9.14	14.88
Trace Test			
r = 0	r ≥1	128.37	95.87
r ≤ 1	r ≥2	85.92	70.49
r ≤ 2	r ≥3	53.73	48.88
r ≤ 3	r ≥4	26.05	31.54
r ≤ 4	r ≥5	12.39	17.86

Notes: (i) The test was performed using Microfit 4.0.
(ii) *r* stands for the number of cointegrating vectors.

The maximal eigenvalue test suggests r = 1, while the trace statistic shows r =3. A recent attempt by Haug (1996) using the Monte Carlo Method for ten alternative tests for cointegration has found that Johansen and Juselius (1990) maximum eigenvalue test has the overall least size distortions over the trace test, so we take r = 1. Therefore, our annual data from 1973 to 1995 appear to support the proposition that in Pakistan there exists a long-run relation between level of industrial value added and its determinants of the real capital stock, the labour force, real exports, the import tariff rate and the secondary school enrolment ratio. Estimates of long-run cointegrating

vectors are given in *Table 7*.

Table 7: Estimates of Long-Run Cointegrating Vectors (Linearised)

LINDUSVA	LRCAPITAL	LLABOURP	LREXPORT	LTARIFF	LEDU
1.00	0.91	-7.62	-0.54	-0.31	1.43
	(0.69)	(5.65)	(0.75)	0.49)	(1.17)

Notes: 1. The long-run equilibrium relation is:

LINDUSVA = 0.91 LRCAPITAL - 7.62 LLABOURP - 0.54 LREXPORT - 0.31 LTARIFF + 1.43 LEDU

2. Figures in parentheses indicate standard errors.

5.4 Estimation of an Error-Correction Model

In this section we estimate an *error-correction* model (ECM). The ECM shown in *Table 8* is found to fit the data best.

Table 8: Estimated Error-Correction Model

Dependent Variable = ΔLINDUSVA			
Regressor	**Parameter Estimate**	**T-Ratio**	**P-Values**
Intercept	-5.12	-2.40	0.03
Δ^2LRCAPITAL	0.09	1.60	0.14
Δ^2LABOURP(-1)	2.00	5.42	0.00
ΔLREXPORT(-1)	0.07	2.34	0.04
ΔLTARIFF(-1)	-0.01	-0.32	0.75
LEDU(-1)	0.07	1.21	0.25
EC(-1)	-0.21	-2.43	0.03
Adj R^2 = 0.79			
D. W. = 1.79			
Serial Correlation = 1.31 (0.25)			
RESET = 0.01 (0.92)			
Normality = 0.46 (0.79)			

HET = 0.02 (0.89)

Note: Figures in bracket indicate p-values.

In the model, growth rates of labour force lagged one year, real exports lagged one year and real fixed capital formation (at above the 10 per cent level of significance) have emerged as significant determinants of the growth rate of industrial value added in Pakistan. The error correction coefficient, estimated at -0.21 is statistically significant at the 5 per cent level, has the correct sign, and suggests a moderate speed of convergence to equilibrium. The diagnostic test statistics show no evidence of misspecification, no serial correlation, nor any problem of heteroscedasticity and no problem of non-normality in the residuals.

Section 6

Summary and Conclusions

This paper studies the relation between trade policies and economic growth in Pakistan. The 'human capital model of endogenous growth' developed by Lucas (1988) is taken as the theoretical framework for undertaking empirical work on the relation between trade liberalisation and industrial growth in Pakistan.

In the empirical investigation of the aggregate growth function of industrial value added in Pakistan, cointegration and error correction modelling approaches have been applied. A unique cointegral relation between the industrial value added function and its major determinants of the real capital formation, the labour force, real exports, the import tariff collection rate and

the secondary school enrolment ratio is found.

In order to determine the short-term dynamics around the equilibrium relationship, we estimated an error correction model (ECM). The study shows that real capital formation, the labour force and real exports have emerged as significant determinants of industrial value added function in Pakistan. The results, however, do not provide evidence of the importance of human capital in the Pakistan economy.

The policy implications are simple. The results of the study seems to suggest the importance as well as the imperative for developing countries to embark on comprehensive trade liberalisation policies in order to accelerate and sustain economic growth. However, one of the major limitations of the study is the aggregate nature of the model. So, for effective policy analysis, further studies may be undertaken using data at a disaggregate level. Another limitation is with the variable EDU, which is clearly imperfect: the variable does not include the input of teachers, and it completely ignores primary and higher education. So a better measure of human capital accumulation may be used in the future.

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APPENDIX 1

Variable Definitions and Data Sources of an Aggregate Industrial Production Function for Pakistan

This paper uses annual data for the period 1973-1995. Wherever needed, variables are expressed in real terms.

INDUSVA: Industrial value added (in Million of national currency and at 1987 prices). **Source**: World Bank (1998), *World Development Indicators 1998 on CD-ROM*.

RCAPITAL: Real gross fixed capital (in Million of national currency and at 1990 prices). **Source**: IMF, *International Financial Statistics* (various issues).

REXPORT: Nominal exports deflated by unit value index of exports. **Source**: IMF, *International Financial Statistics* (various issues).

LABOURP: Labour force as a percentage of total population (in Million). **Source**: World Bank (1998), *World Development Indicators 1998 on CD-ROM*.

TARIFF: Average import tariff collection rate (as a ratio of import duty collected to value of imports *c.i.f.*). **Source**: IMF, *International Financial Statistics* (various issues) and *Government Finance*

Statistics Yearbook (various issues).

EDU: Secondary school enrolment (as a percentage of the working-age population that is in school). **Source**: UNESCO, *Statistical Yearbook* (various issues).