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Human Capital and Economic Growth: Pakistan, 1960-2003

Qaisar Abbas[*], **James Foreman-Peck**[**]

Abstract

This paper investigates the relationship between human capital and economic growth in Pakistan with aggregate time series data. Estimated with the Johansen (1991) approach, the fitted model indicates a critical role for human capital in boosting the economy's capacity to absorb world technical progress. Much higher returns, including spillovers, to secondary schooling in Pakistan than in OECD economies is consistent with very substantial education under-investment in Pakistan. Similarly, extremely large returns to health spending compare very favorably with industrial investment. Human capital is estimated to have accounted for just under one-fifth of the increase in Pakistan's GDP per head. Since the 1990s, the impact of deficient human capital policies is shown by the negative contribution to economic growth.

JEL Classification: C13, C22, C51, O15, O53

Keywords: Human Capital, Economic Growth, Cointegration, Pakistan

1. Introduction

Human capital plays a key role in both neoclassical and endogenous growth models (Mankiw, Romer and Weil, 1992; Rebelo, 1991; Sianesi and Van Reenen, 2003). The critical difference is that in the first group, economic growth is ultimately driven by exogenous technical progress. Diminishing returns to accumulated factors, including human capital, eventually halt growth in a neoclassical model, in the absence of intervention from outside influences. Policy changes can raise the level of productivity but not the long run growth rate. Endogenous growth models, on the other hand, need no additional explanation, for human capital investment propels knowledge creation without diminishing returns. A permanent alteration in some policy variable can cause a permanent change in an economy's growth rate.

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Unlike time series evidence for the United States, at first sight the data for many developing economies could be broadly consistent with this prediction (Jones, 1995). Since political independence for these countries after 1945 was accompanied by major policy changes, the shifts could be responsible for accelerated growth after this date in an endogenous growth model[1].

However, Parente and Prescott (1999, 2000) point out that the technical progress in an extended neoclassical model can alter in response to policy as well. Individual choices determine the pace of productivity increase, when time is diverted from normal work to activities that improve technology. These activities can draw on the world stock of knowledge and borrow capital on world markets. Policy-induced constraints, such as taxation, international capital controls, or entry barriers to industries, create disincentives to do so. They give rise to international differences in levels and growth of aggregate productivity, even when the stock of useful knowledge is potentially common to all countries.

For economies behind the world technological frontier, productivity growth is likely to depend critically upon the spread and absorption of technology, rather than upon the generation of new knowledge (Nelson and Phelps, 1966; Benhabib and Spiegel, 2002). Absorptive capacity depends on national institutions and policies; openness to foreign direct investment, regulation of intellectual property rights, and exchange rate regimes affect a follower economy's imports of technology, as well as the generation of new useful knowledge (Shapiro, 2005). But the stock of skills, and the education and training that create them, is likely to be vital to utilizing foreign know-how, in addition to functioning as a conventional factor of production (Saggi, 2002).

Human capital is not restricted to knowledge. Health has been found to be a positive and significant contributor to economic growth in many empirical cross-country models (Bloom and Canning 2000, 2003). Measured simply as life expectancy, health human capital can effect economic growth in several ways. As people live longer, they may save more for old age. Life expectancy can also serve as proxy for the heath status of the whole population, because declines in mortality rates are related to falls in

[1] For instance from 1820 to 1929 Maddison's (1995) estimates show that Pakistan's real GDP per head grew at an average rate of 0.31 percent. Then incomes doubled in the course of the 1960s, and high growth by historical standards became sustained in subsequent years, albeit at varying rates.

morbidity. Important as this form of human capital may be, it will not contribute to technology transfer, in contrast to education and training.

Despite the theoretical significance of knowledge human capital, the empirical evidence from cross-country studies is very mixed. Pungo (1996) showed that the Mankiw et al. (1992) (MRW) human capital-augmented neoclassical specification exhibits structural breaks, such that the coefficient on human capital is insignificant for a sample of labor-abundant countries and if influential observations are excluded. A possible reason for these last results is that schooling in developing economies tends to be of low and very variable quality[2]. In Pakistan, the largest learning gaps are between primary schools. The divergence in English test scores between government and private schools is 12 times that between children from rich and poor families (Das, Pandey and Zajonc, 2006).

Another possible contributor to the lack of impact evidence for knowledge capital is the central contribution of the state in schooling. Variations in the effectiveness and magnitude of state schooling spending, together with the way in which taxes are levied to pay for it, can even create a negative correlation with economic growth (Blankenau and Simpson, 2004). Public spending might crowd out private spending on education. Moreover, in the short-term, increasing the proportion of the potential workforce in full time education reduces the workforce and may be expected to lower per capita output. Not surprisingly then, the macroeconomic evidence is unclear about the effects of public education expenditures on economic growth.

National economies are likely to be especially diverse in the supply and demand for human capital because of distinctive institutions. Yet most empirical research has been concerned with cross-sections or panels of large numbers of countries, thereby ignoring economy-level institutional differences[3]. National time series studies offer a way of eliminating or reducing such heterogeneity (Durlauf, Johnson and Temple, 2004). For this reason the present paper tests and estimates a time series model of human capital and economic growth for Pakistan over the period 1960-2003. As a low income economy that has invested relatively little in human capital over

[2] Tested at the end of the third grade, only 31 percent of Pakistani primary school children could correctly form a sentence with the word "school" in the vernacular (Urdu) (Das, Pandey and Zajonc, 2006).

[3] This may be an explanation for Shapiro's (2005) surprising finding of a negative international technology diffusion effect for East Asia.

the past 40 years, Pakistan is an especially helpful case for understanding the relationship with economic growth (Husain, Qasim and Sheikh, 2003)[4].

Most econometric research on human capital in Pakistan has entailed estimating Mincer (1974) earnings functions on micro data. Nasir and Nazli (2001) find each year of education brings approximately 7 percent (private gross) return for wage earners. Another study by Haroon et al. (2003) estimated that the maximum private gross return (16 percent) is associated with higher secondary education. Their results also indicate that private payoffs from primary education declined during the previous decade, while returns to higher secondary and tertiary education rose. Recent research on rural Pakistan by Behrman et al. (2008) shows that 'social' and private rates of return to low quality primary schooling versus no schooling were 18.2 percent and 20.5 percent respectively[5]. They also estimated that 'social' rates of return to high-quality versus low-quality primary schooling in rural Pakistan were 13.0 percent. Unfortunately, studies of this type are unlikely to capture all indirect benefits of human capital for economic growth, especially the stimulus to technology development and adoption. Therefore, there is a strong case for supplementing them with macroeconomic studies of rates of return, as attempted here.

The paper models the impact of human capital on Pakistani economic growth, provides estimates of social rates of return to human capital in Pakistan, and assesses the policy implications of the findings. Section I presents the theoretical framework of the study, setting out the production function and rate of return approach. Section II outlines the experience of human capital investment and development of Pakistan since 1960, with some international comparisons. Section III elaborates the measurement of variables and estimation procedures, explaining why the Johansen approach is necessary. Section IV presents the empirical results and section V discusses the sources of growth implied by the analysis of the preceding section.

2. Theoretical Framework

One reason for endogenous growth (in Rebelo, 1991) is that human capital is embodied in labor. This implies that a worker's improved human

[4] A previous time series study of Pakistan industrial's growth 1973-1995 (Dutta and Ahmed, 2004) investigated the impact of secondary school enrolment, but there is some question about the signs of the variables in the cointegrating vector.

[5] 'Social' here does not include spillovers but only the public (as well as private) financial costs of providing education.

capital boosts their productivity but cannot benefit another worker in the same way. The total amount of human capital, H, in an economy is the product of the number of workers and their average embodied human capital. If L is number of workers, the total human capital input is the flow of services from L(H/L) = H. More workers without any human capital add nothing to output, so a growing workforce in itself will drive down output per head at the rate at which it grows. Constant returns to all three factors are equivalent to constant returns to human and physical capital alone.

It follows that with constant returns, increased investment in human and physical capital induced by more benign policies, can permanently raise the growth rate of an economy. The steady state growth of output and the two types of capital are obtained by substituting both savings/investment rates into the production function. Ignoring depreciation, if savings and investment in human and physical capital increase from 5 to 10 percent of output, the steady state growth of output and capital rises from 5 to 10 percent. The ratio of human to physical capital in the steady state will not change because their relative accumulation rates are unaltered.

Human capital in a neoclassical model has less dramatic but still fundamental effects. A human capital-augmented Cobb-Douglas production function consistent with the estimates of MRW has coefficients of one-third on each of the three factor inputs; a one percent increase in both human and physical capital increases output by only two thirds of a percent. Accumulation at a constant proportion of output therefore adds less and less to output until the steady state is reached, in the absence of technical progress. Hence the neoclassical model must include exogenous technical progress if it is to explain economic growth in the long run.

The disembodied human capital of MRW (equation 8) implies that a one percent increase in the work force has a greater positive effect on output than a one percent rise in human capital per worker. With H unchanged, greater L boosts output even though H/L falls. Where Y is real output, A the technology level that shifts exogenously, K physical capital and $0<\alpha, \beta, \gamma_0 <1$ parameters, the neoclassical (Cobb-Douglas) production function is:

$$Y = A K^{\alpha} L^{\beta} H^{\gamma_0} = A K^{\alpha} L^{\beta+\gamma_0} (H/L)^{\gamma_0} \quad (1)$$

For Pakistan, and many developing countries with high population and workforce growth, this disembodied model is more optimistic than an

endogenous growth Cobb-Douglas production function specification, discussed above, of:

$$Y = A K^{\alpha} H^{\gamma_0} = A K^{\alpha} (L (H/L))^{\gamma_0} \quad (2)$$

In a low income open economy, technology transfer is likely to be a major source of growth. The scope for transfer will depend on the technological progress of the leaders in the world economy, below assumed to advance at a rate given by the technological frontier economy's Total Factor Productivity index (F). But technology can only be transferred if an economy has the absorptive capacity.

Benhabib and Spiegel (1994) conclude that international technology spillover rates depend on levels of education in the follower countries. So a plausible formulation for a poorer economy allows greater technical progress the higher is the human capital that promotes this capacity. The gap between the follower economy's technology (A) and the leader's (F) depends upon the follower's average human capital and the level of the leader's technology. Taking logs:

$$\ln A - \ln F = (\gamma_1 \ln(H/L) - 1) \ln F + \ln A_0 \quad (3)$$

Technical progress, F, is exogenous (neoclassical) to the domestic economy, but the impact of the technology is endogenous. Substituting (3) into the log of (1) shows that there is a complete offset to the rising human capital elasticity with world technical progress; the labor elasticity of output falls as the world technological frontier extends.

$$\ln Y = \ln A_0 + (\gamma_0 + \gamma_1 \ln F) \ln H + \alpha \ln K + (\beta - \gamma_0 - \gamma_1 \ln F) \ln L \quad (4)$$

With the endogenous growth production function, $\beta=0$, and the labor output elasticity is the same as the human capital output elasticity. An economy with high workforce growth and weak human capital investment will increasingly miss out as the world technology frontier advances. If L actually grows faster than H, output growth on this account is progressively negative.

When, as in (4), human capital supports the absorption of world technology, as well as being a factor of production, the excess of social over private returns may be substantial. Regardless, in a relatively poor economy the returns to factor inputs, including human capital, should be high because of their scarcity. Unfortunately poor quality schooling and an

inappropriate syllabus may lower the return to education as a social investment, but as Behrman et al (2008) have shown, even these returns can be high in Pakistan. However, if education is merely a signal, rather than an investment in human capital, private returns may be high although social returns could be low. For this reason, and because of the technological spillover, macro estimation of social rates of return provides information not available from the more common micro studies.

With the production function assumed in the present model, rates of return to human capital per worker, as measured by the marginal product, are higher the lower is an economy's ratio of human capital per worker to output. The full return to human capital includes the technology absorption component $\gamma_1 \ln F / (H/Y)$.

$$(\hat{H}Y/\hat{H}H) = (\gamma_0+\gamma_1 \ln F)/ (H/Y)$$

When economic development raises the ratio of human capital to output, the rate of return will be driven down. But if world technical progress, F, is faster than the rise in the human capital output ratio, returns will rise.

Whether optimal investment in human capital is achieved might be inferred from the principle that in an efficiently functioning economy, at the margin returns to human and physical assets will be equalized. With human assets, the inability to appropriate returns often deters optimal investment, and thereby allows persistent higher marginal returns, in the absence of adequate investment by non-profit institutions. If the return on comparable alternative physical assets, or on comparable human capital in other economies is known, the measure of underinvestment, the (excess) marginal rate of return on human capital, can be found from the human capital stock to output ratio and $(\gamma_0+\gamma_1 \ln F)$.

3. The Pakistani Economy Since 1960

Consistent with the endogenous growth model, in conjunction with a broad policy or environmental shift, Pakistan's economy experienced an apparent permanent increase in the growth rate by the 1960s. Pakistan's average annual real GDP growth rate of 5.3 percent since then has not matched those of the East Asian miracle countries. Yet, per capita GDP growth surpassed that of the typical developing country (1.3 percent since the 1960s) with an annual average rate of 2.6 percent.

Three groups of Asian countries, now classified as East Asian rapid growers, South Asian developing and Asian least developed, in many respects were at a broadly similar level of economic development in 1960. But by the end of the millennium, there were wide gaps in their per capita incomes. Their human capital endowments, both in terms of education and health, also were hugely different.

In the early 1960s, Pakistan was seen around the world as a model of economic development. Many countries sought to emulate Pakistan's economic planning strategy and one of them, South Korea, copied its second Five Year Plan, 1960-65. In the early 1960s, the per capita income of South Korea was less than double that of Pakistan (Maddison, 2001). But South Korea became by far the more developed, with GNI per capita in 2006 of $22990 compared with Pakistan's $2410, using purchasing power parity (World Bank, 2007).

A possible reason for the divergence, consistent with the fundamental contribution of human capital, is that literacy rates for East Asian developing countries in the early 1960s were as high as 71 percent for the Republic of Korea, and 68 percent for Thailand, while Malaysia achieved a rate of over 50 percent. On the other hand, in all other Asian least developed countries and South Asian developing countries, the literacy rate was low; only 9 percent for Nepal and 16 percent for Pakistan (Table 1). After three decades, during which this group of Asian countries somewhat improved their human capital, literacy rates are still below 50 percent. By contrast, literacy in South Korea reached 98 percent and Malaysia managed a rate of about 90 percent (World Bank, 1982; UNESCO, 1999).

Table-1: Human Capital Measures for Pakistan, 1960-2005

Years Indicator	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
Primary Schooling Enrollment (% of Age Group)	20.4	27.4	30.3	38.2	32.1	35.8	47.5	57.3	60.5	68.1
Secondary Schooling Enrollment (% of Age Group)	3.4	4.6	5.7	7.0	6.4	7.3	9.6	12.2	11.6	12.0
Literacy Rate	16.7	16.8	20.9	24.3	26.1	28.8	33.8	39.6	47.1	52.5
Public Spending on Education (% of GDP)	0.9	1.8	2.5	2.2	2.0	2.7	2.7	2.2	2.0	2.5
Public spending on health (% of GDP)	0.4	0.6	0.5	0.6	0.6	0.8	1.0	0.7	0.7	0.6
Life Expectancy	43.9	46.7	49.4	52.3	55.1	57.4	59.1	60.9	63.0	66.0

Source: State Bank of Pakistan (2006), UNESCO Yearbooks (Various Issues), World Bank (Various Issues).

Another potential contributor to the divergence is health. Measured by life expectancy at birth across the three groups of countries in the Asian region, health shows a similar pattern to literacy. In the 1960s, life expectancy at birth was below 45 years in all Asian least developed countries and South Asian developing countries. On the other hand, the East Asian developing countries had life expectancies well over 50 years, with the Republic of Korea achieving a figure of over 54 years, followed by the 53 years of Malaysia and 51 years for Thailand (World Bank, 1984). In the late 1990s, the Asian least developed countries and South Asian developing countries enhanced their life expectancy to more than 60 years, at least in the case of Pakistan, India, Bangladesh and Bhutan. Yet the life expectancy rate in both Malaysia and Korea is remains much higher; of the order of more than 72 years, with Thailand reaching a figure of 69 years.

Nonetheless human capital has grown in Pakistan. Table-1 shows that primary and secondary schooling enrolment in Pakistan increased substantially in the years after 1960. However public spending on education as a proportion of GDP stopped rising on trend after 1970, while public spending on health peaked as a proportion of GDP in 1990. Human capital per head, as measured by the secondary schooling stock per worker (lnsstpw, Figure-1), increased strongly in the 1960s and in the second half of the 1980s. During the later 1990s the stock fell; the endogenous growth

model of the previous section predicts adverse output consequences, for in 2005 the stock was lower than in 1995.

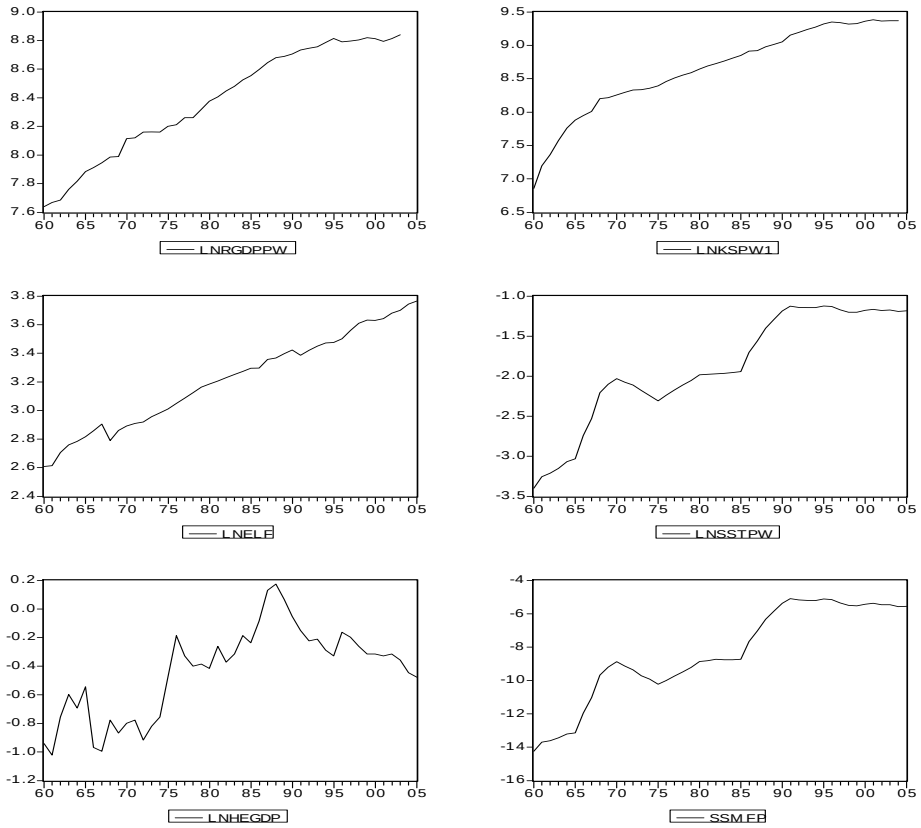
Schooling, particularly in rural areas, remained problematic despite land and other reforms during the 1960s. In 1962, four tiers of government were introduced and each was assigned responsibilities in both rural and urban areas, such as maintenance of primary schools, public roads, and bridges. Much military and economic aid was received and the capital-labor ratio (lnkspw, figure 1) rose most rapidly in this decade. But aid was reduced in 1965, when another war with India over Kashmir broke out. Later the Tashkent agreement of 1966 mediated the conflict. The longer term impact of the war on the economy though was severe, ultimately triggering a downturn in real GDP per worker (lnrgdppw) and the employed labor force (lnelf) between 1967 and 1968 (figure 1).

The 1970s were a difficult decade for some forms of human capital accumulation and economic growth. A third war between India and Pakistan in 1971, the upheaval associated with the establishment of Bangladesh in January 1972, the first oil crisis in 1974 and the populist and restrictive economic policies of new political regime of 1971-77, all adversely affected the economy. After 1973, Prime Minister Zulfikar Bhutto nationalized basic industries, insurance companies, domestically-owned banks, and schools and colleges. The proportion of the workforce with secondary schooling fell in the first half of the decade. Table 1 shows that school enrolments as a proportion of the relevant age group were lower in 1980 than in 1975 and figure 1 reveals a stagnation of the secondary schooling stock per worker (lnsstpw) in the 1970s.

Some incomplete structural reform efforts were implemented in the 1990s. Output and employment fell between 1990 and 1991 but recovered the following year. The second half of the decade was marked by economic uncertainty associated with heightened domestic and regional political tensions. The 1998 nuclear explosions and consequent sanctions, coupled with drought and unsustainable debt, gave rise to macroeconomic instability. Interest payments and military spending by the government exceeded 50 percent of consolidated government spending, shrinking the relative size of public sector development spending, and leaving only limited resources for state-funded education, health and physical infrastructure. External balances deteriorated significantly and foreign reserves fell to dangerously low levels (World Bank, 2002). Health spending as a proportion of GDP (lnhegdp, figure 1) declined. According to the model of the previous section, returns to human capital should be very high because investment

has been so low. But resource misallocation could hold down returns in practice.

Figure-1: Pakistani Growth Variables 1960-2005 (Logarithmic)



Since 1999, the government committed itself to reversing Pakistan's poor economic performance with a major macroeconomic stabilization effort and structural reforms aimed at strengthening microeconomic fundamentals. Employment (lnelf) growth faltered between 1999 and 2000 but quickly resumed. Real output (lnrgdppw) fell for two consecutive years but in 2002 jumped to a previously unattained height (figure 1). Fiscal measures included the privatization of state-owned banks and strengthening the role of State Bank of Pakistan, together with reform of telecoms and trade policy. Expansion of the U.S. and E.U. textile quotas further helped to stabilize and revive the economy. Economic growth exceeded the 5 percent mark in 2003 for the first time since the mid 1990s, and reached 6 percent in 2004 (World Bank, 2006).

In the modeling below we assess what difference these changes have made.

4. Measurement, Specification and Estimation

Assessing how policy shifts influenced the formation of knowledge human capital first requires definition and measurement. Only proxies, such as the number of graduates, average years of education, literacy rates, school enrolment ratios or proportion of the population that has completed schooling at different levels of education, are available. They do not fully match the concept of knowledge capital.

The production function model postulates a flow of productive services from the human capital stock. More output is generated by an increase in the human capital, so long as the service flow is proportional to the stock. The increase in the stock is gross investment minus depreciation. So for example, considering the stock of workers with secondary education, more secondary educated young people may enter the workforce every year, but both secondary educated and uneducated people leave each year as well. It is the difference between these two magnitudes that is relevant for economic growth, though for the level of gross income, simply the flow generated by the stock of secondary educated workers is pertinent.

When considering year to year variations in human capital, these measurement issues matter particularly. In the case of an increase in the proportion of the relevant age group attending school from one year to the next, while the eventual effect may be to increase human capital services, the immediate effect is to reduce the supply of unskilled labor. If they would have been productive, this will have a negative impact on output, even though eventually there will be a greater positive effect.

Given the limited availability of the data, the proxies for human capital here considered are as follows.

- The stock of human capital at the secondary level of education is defined as the percentage of the workforce that has completed secondary education (H). Estimates are constructed from benchmark figures based on Barro and Lee (2000). Following the perpetual inventory method, net flows of graduates with secondary education are added to benchmark stocks to generate an annual series.

- Health expenditure as a percentage of GDP is the measure of health capital services (HE).

The U.S. (Bureau of Labor Statistics, 2007) multi-factor productivity index is taken to measure the shift in the world technological frontier. Data are annual and cover the period 1960-2003. Sources of data and a description of variables are given in the appendix.

The demand for human capital is derived from the production function and profit-maximizing behavior, but the supply of human capital is typically dominated by non-profit organizations, especially the state. With forward-looking behavior, the supply of human capital might be expected to respond to future demands (derived from GDP), as well as GDP depending upon human capital. Although interest centers on measuring the contribution of inputs to output, output may have a causal effect on inputs as well. For example, output growth may stimulate investments in physical capital and may also augment human capital by facilitating increased schooling and income (see for example Bils and Klenow (2000)). This bi-directional causality creates a correlation between the independent variables and the equation error term that renders OLS estimates of the production function coefficients inconsistent, an important reason for using the Johansen approach below.

The parameters of the production function measure a long run relationship, and the time series from which the function is to be estimated are likely to be non-stationary. Regression models using such series may give rise to 'spurious regressions', even when the series are integrated of the same order. A necessary condition for a regression estimate to be a genuine economic relationship is that the variables are cointegrated, in which case the residuals will be stationary.

Parameter estimates of a cointegrating equation are 'superconsistent'; the distributions are asymptotically invariant to measurement error and simultaneous equation bias. However they may be also subject to small sample bias and have non-standard distributions. This last characteristic means the usual tests of significance do not apply. Moreover there are possibly a number of different cointegrating relations among a group of cointegrated variables. For reasons already stated, all the inputs into the production function can be endogenous, in which case there may be a cointegrating equation and an error correction model for each input, in addition to the production function.

For such circumstances, Johansen (1991, 1995) proposed a maximum likelihood method for estimating and testing for the number of cointegrating equations, as well as their speeds of adjustments. The approach is to test the restrictions imposed by cointegration on the Vector Error Correction model involving all the series under consideration. In this system, the dependent column vector is the first difference of output and all the inputs of the production function ($\breve{\mathbf{u}}\mathbf{Z}_t$). On the right hand side is the column vector of these variables lagged (here we consider only one lag, $\breve{\mathbf{u}}\mathbf{Z}_{t-1}$) and the associated coefficients ($\mathbf{\Gamma}$). Also there is a column vector of the lagged levels of the production function variables ($\mathbf{Z}_{t-1}$). Matrices of adjustment coefficients (**a**) and of cointegrating coefficients (**b**) premultiply this vector. The standard errors of the coefficients in the cointegrating equations of the Johansen method have conventional distributions and so may be used for the usual significance tests.

With a one period lag the system is:

$$\breve{\mathbf{u}}\mathbf{Z}_t = \mathbf{\Gamma}\breve{\mathbf{u}}\mathbf{Z}_{t-1} + \mathbf{ab}\mathbf{Z}_{t-1} + \mathbf{e}_t$$

where $\mathbf{e}_t$ is a vector of error terms.

5. Empirical Results

The elements of the **Z** vector are obtained from (4) in section I, modified to include two human capital variables, secondary education (H) and health spending (HE):

$$Y/L = A_0 F^{\gamma_1 \ln(H/L)} (K/L)^{\alpha} L^{\alpha+\beta+\gamma_0-1} (H/L)^{\gamma_0} (HE/Y)^{\varphi} \qquad (5)$$

The production function (5a) shows how the parameters of (5) are related to the output elasticities:

$$LnY = \ln A_0 + ((\gamma_0 + \gamma_1 \ln F)/(1+\varphi))\ln H + (\alpha/(1+\varphi))\ln K + ((\beta - \gamma_0 - \gamma_1 \ln F)/(1+\varphi)) \ln L + (\varphi/(1+\varphi)) \ln HE \qquad (5a)$$

When $\gamma_1 > 0$, the growth of the technological frontier F increases the human capital elasticity, but reduces the labor elasticity, of output. The education human capital measure influences absorptive capacity, and therefore interacts with the technological frontier. The health human capital variable only affects productivity directly.

Testing for Unit Roots

The degree of integration of each series in (5) is determined with Augmented Dickey Fuller (ADF) tests statistics, reported in table 2. Trend and additional lags were included when they were statistically significant. The ADFs show that all the variables considered are integrated of order one at the one percent level except Lnsstpw, which is significant at the 5% level. We cannot reject the hypotheses that all the variables are stationary in the first difference, and integrated of order I(1). So the series may be used to estimate co-integration regressions.

Co-Integrating Equations

The next stage is the estimation of the long-run relationship. The lag length for the Johnansen VAR is chosen to maximise the AIC. With one lag on the first differenced variables, AIC is -21.3 and with two lags it is -22.4. With increased lag length the AIC becomes smaller, indicating that one lag is the preferred specification.

The cointegrating model specification that fits the data and the theoretical constraints is one with a linear deterministic trend in the data, and an intercept, but no trend in the cointegrating equation(s). The trace and max-eigen tests for numbers of cointegrating vectors reject the hypothesis of none, but not at most one (Table 3). So the data are consistent with one cointegrating vector.

Table-2: Augmented Dickey Fuller (ADF) Tests

Variable	Model	Adf Stat	Lags
	Levels		
Lnrgdppw	C and tr	-0.766	2
Lnkspw	C and tr	-2.137	2
Lnsstpw	C no tr	-1.801	1
Ssmfp	C and tr	-3.460	2
Lnhegdp	C no tr	-2.213	1
Lnelf	C and tr	-4.02	1
	First Differences		
Lnrgdppw	C and tr	-4.634	1
Lnkspw	C no tr	-3.968	2
Lnsstpw	C and tr	-3.823	2
Ssmfp	C and tr	-4.083	2
Lnhegdp	C no tr	-5.157	1
Lnelf	C no tr	-6.048	1

Lnrgdppw: Log of real GDP per worker, ln (Y/L)
Lnkspw: Log of real capital stock per worker, ln(K/L)
Lnelf: Log of employed labor force, ln L
Lnsstpw: Log of human capital stock at the secondary level of education per worker, ln(H/L)
Lnhegdp: Log of government expenditure on health as percentage of GDP, ln(HE/Y)
Ssmfp: ln(H/L)*lnF (where F is U.S. multifactor productivity)
C: Constant
tr: Time trend

Table-3: Unrestricted Cointegration Rank Test

Sample: 1960 2005
Included observations: 42
Test assumption: Linear deterministic trend in the data
Series: LNRGDPPW LNKSPW1 LNSSTPW LNHEGDP SSMFP LNELF
Lags interval: 1 to 1

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	Max-Eigen Statistic	5 Percent Critical Value
None **	0.658140	104.1756	94.15	45.08086	40.07757
At most 1	0.471896	59.09474	68.52	26.81542	33.87687

** denotes rejection of the hypothesis at the 0.05 level by both Trace and Max-Eigen Statistics.

The normalized cointegrating vector (equation 6) is theoretically consistent with an aggregate production function including human capital, although the coefficient on physical capital/labor ratio is small, and on the margins of statistical significance. The other coefficients are more than three times their standard errors (in parentheses).

$$\ln (Y/L) = \underset{(0.092)}{0.175 \ln(K/L)} + \underset{(0.038)}{0.310 \ln (HE/Y)} + \underset{(0.110)}{(0.447 \ln MFP - 1.767)} \underset{(0.498)}{\ln(H/L)}$$

$$+ \underset{(0.095)}{0.357 \ln L} - 6.226 \qquad (6)$$

Log likelihood 518.3626

The adjustment coefficients, (**a**), of the right hand side variables of (6) are not significantly different from zero (not reported), consistent with these variables being weakly exogenous.

Advances of the world technological frontier (F), measured by the coefficient (γ_1) (on Ssmfp or ln (H/L)lnMFP in equation 6), raise the output elasticity of secondary schooling human capital variable from 0.08 in 1960 to 0.25 in 2005[6]. Health expenditure has an elasticity (φ) of 0.24 and the capital elasticity (α) is 0.13. The total human and physical capital elasticity of 0.62 is therefore well below unity in 2005. The labor elasticity is large, at 0.82 in 1960, falling to 0.65 in 2005[7]. Adding all the input elasticities implies increasing returns to scale for all factors together throughout the period.

Implied Rates of Return

The return to educated workers in 2005 can be compared with that discussed by Bassanini and Scarpetta (2001) and by Sianesi and Van Reenen (2003); that is, increasing average education in the population by one year raises output per head by between 3 and 6 percent, and returns are higher for LDCs than for OECD economies. To do so, it is necessary to assume that a rise in the proportion of the workforce having attained a certain level of education can be directly translated into an increase in the average number of years of education in the workforce. Since there is no control for primary education in the model, the secondary education impact must be

[6] $(\gamma_0 + \gamma_1 \ln F) / (1 + \varphi) = ((4.19076 * 0.447) - 1.767) / 1.31$ for 1960.

[7] $(\beta - \gamma_0 - \gamma_1 \ln F) / (1 + \varphi) = ((1.357 - 0.175) / 1.31) - 0.08 = 0.82$ for 1960, to $((1.357 - 0.175) / 1.31) - (((4.6923 * 0.447) - 1.767) / 1.31) = 0.65$ for 2005

assumed to include years of primary education as well, that is, a total of ten years of education. For the comparison, the 2005 value of the proportion of the workforce with secondary education of 0.195 is considered. One extra year of education for the whole workforce translates into 10 years of education for one tenth of the workforce. Ten percent amounts to a (10/19.5 =) 0.513 increase in the workforce with secondary education. With an elasticity of 0.25, a 51.3 percent increase in the workforce with secondary education raises output per head by nearly 13 percent. This falls well outside the Sianesi and Van Reenan range for the OECD, indicating substantial under-investment in education in Pakistan.

To compare with returns to primary education excluding spillovers reported earlier, secondary education must be assigned a financial cost. From section 1, $(\hat{H}Y/\hat{H}H) = (\gamma_0+\gamma_1 \ln F)/ ((H/Y)$, and $(\gamma_0+\gamma_1 \ln F)$ has been estimated at 0.25 for 2005. If the secondary education financial returns, including spillovers, are equal to the Behrman et al (2008) estimated returns to poor quality primary education (20 percent), the secondary educated human capital stock to income ratio in 2005 was (0.25/0.2=) 1.25.

Turning to the second human capital measure, a rate of return from health investment may be obtained directly. Total health spending can be considered as the flow of services from a health human capital stock. A health investment ratio (0.6%) in the year 2005 (Table 1), and the coefficient of (0.31/1.31=) 0.24 implies an even higher return than for education, of $(0.24*0.006^{-1} =)$ 39 percent[8]. As with secondary education, this not only constitutes a very high return to an investment judged by commercial standards, but also indicates an enormous unmet requirement for health spending.

6. Sources of Growth

Proximate sources of Pakistani economic growth can be obtained from a decomposition of the production function (6). Table 4 gives the decadal average annual growth rates of inputs and output. The variation between decades has already been noted, but the decline in human capital inputs in more recent decades is very obvious in the table and remarkable. Both health and schooling input growth rates become negative from the 1990s, and, as a consequence, so to does the absorption of technology variable (technology frontier shift*human capital). Yet the foreign (U.S.) technology frontier shifted faster, and therefore the possibilities for absorption were greater, in most recent years.

[8] $(\partial Y/\partial HE)(HE/Y) = 0.31/1.31$, $(HE/Y)=0.006$, so $\partial Y/\partial HE = 0.236/.006 =39.44$.

Table-4: Pakistani Economic Growth Data 1961-2005

Actual Annual Average Growth Rates							
	Real GDP / Worker	Real Capital / Worker	Secondary Schooling Stock / Worker	Health Expenditure / GDP	Technology Frontier Shift* Human Capital	Labour Force	Tech Frontier
1961-70	3.73	7.42	7.79	2.19	17.15	2.61	1.53
1971-80	2.29	2.97	0.88	3.08	2.45	2.42	0.62
1981-1990	2.63	3.09	5.82	1.91	14.93	1.95	0.57
1991-2000	0.76	1.89	-0.52	-1.79	-4.08	2.19	0.87
2001-5			-0.38	-3.24	-4.16	2.36	1.65

The following growth attribution (Table-5) is derived from the production function estimate, equation 3.

Table-5: Human Capital and Pakistani Economic Growth 1961-2000

	Actual / Worker Real GDP Annual Average Percentage Growth	Model Predicted	Model Predicted due to Human Capital
1961-2003	2.73	2.34	0.41
1961-70	3.73	3.42	0.57
1971-80	2.29	2.32	0.74
1981-1990	2.63	3.53	2.13
1991-2000	0.76	0.12	-1.12

The results in Table 5 indicate that, over the whole period 1961-2003, just under one-fifth (0.41/2.34) of (predicted) growth in output per worker was due to human capital as measured here. Human capital has been responsible for more economic growth in successive decades from the 1970s until the 1990s. The 1980s appears to have experienced the strongest impact of human capital, accounting for 60 percent of predicted economic growth. Most extraordinary for a developing country is the massive negative contribution of human capital to growth in recent years, because of falling inputs[9].

Strong growth during the 1960s was largely due to Pakistan's capital accumulation. During the 1980s, economic growth was almost as high, but based on a greater human capital contribution. Later, economic mismanagement in general and fiscally imprudent economic policies in

[9] There is a substantial error in the decadal predictions for growth.

particular, caused a large increase in the country's public debt and reduced the input of human capital, leading to slower growth in the 1990s. No clearer indication of underinvestment in human capital can be found than the evidence of this decade.

7. Conclusion

Economic growth in Pakistan for practical purposes is endogenous, influenced by government policy. Technical progress is driven by the ability to absorb foreign technology and the rate of absorption depends upon knowledge human capital. Thus the movement of the foreign technological frontier and the stock of human capital (secondary school graduates) are increasingly critical for economic development. Yet the return to years of secondary education indicates substantial underinvestment in knowledge human capital. The marginal output generated by secondary education far exceeds the range calculated for OECD countries. Unlike micro estimates, the macro estimate of this paper takes into account spillovers; it is a wider measure of social costs, and therefore is more appropriate for policy guidance.

The high return is found despite the poor average quality of education shown by, for instance, large numbers of schools lacking buildings and widespread teacher absenteeism (Human Rights Commission, 2005 pp. 243-4). Higher quality education may be expected to achieve greater returns. The extremely large rate of return to health spending of 39 percent suggests such outlays are sound investments, quite independently of their consumption value. It may also indicate that the quality of health care needs less of a boost than does the quality of education.

Compared with the MRW implied production function, the output elasticity of human capital is low[10], and the elasticity of 'raw' labor is high. This may reflect deficiencies in the measurement of human capital. But it may capture shortcomings in the Pakistani education system as well.

A decomposition of the sources of growth implied by the estimated cointegrating equation shows that even the incomplete measures of human capital employed in this study explain just under 20 percent of the increase in output per head during the years 1961-2003. The striking feature of this growth analysis is the impact of human capital policies from the 1990s. Rapid labor force growth was not matched by expansion of secondary education, so that the proportion of the educated workforce declined. As

[10] MRW's implied result is about one third for human capital, and it should be noted that by excluding technical progress, as they do, a similar result can be obtained here.

the opportunities for benefiting from world technology increased, Pakistan's ability to reap the advantages deteriorated.

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APPENDIX

Table-A: Description of variables and data sources

Variables	Definition and Unit of Measurement	Data Sources
RGDPPW	Real GDP per worker (In US $ per worker in 2000 Constant Prices)	Penn World Table 6.2
ELF	Employed labour force (in million)	Handbook of Pakistan Economy by Sate Bank of Pakistan, ILO yearbook statistics
KSPW	Capital stock per worker (in millions)	Miketa, A., 2004: Technical description on the growth study datasets. Environmentally Compatible Energy Strategies Program, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria, October 2004. http://www.iiasa.ac.at/ECS/data_am/index.html
SST	Secondary Schooling Stock (percentage)	Benchmark figures are taken from Barro and Lee (2000) and following the perpetual inventory method, we constructed flows of adult population that are added to bench mark stocks.
LITERACY	Literacy (percentage)	Economic Surveys of Pakistan for different years, World tables by World Bank, Handbook of Pakistan economy by State Bank of Pakistan, Fifty year of Pakistan Statistics by Federal Bureau of Statistics (FBS) Pakistan, and Statistical yearbooks by UNESCO for different years.
HEGDP	Total health expenditure as % of GDP (HEGDP)	Handbook of Pakistan Economy by State Bank of Pakistan
MFP	Multifactor Productivity	U.S., Bureau of Labor Statistics, Office of Productivity and Technology (May 2007 publication)
RHE	Real health expenditure (in millions)	Handbook of Pakistan Economy by State Bank of Pakistan
LER	Life Expectancy Rate	Handbook of Pakistan Economy by State Bank of Pakistan and World Bank
TELE1000	Telephone in use (000 people)	Statistical Yearbooks by United Nation for different years
Education Expenditure	Government Expenditure on Education as % of GDP (GEEGDP)	Economic Surveys of Pakistan for different years, Statistical Yearbooks by United Nation for different years, Handbook of Pakistan economy

Table B: Descriptive Statistics

Statistics Variables	Mean	Standard Deviation
LNRGDPPW	8.379	0.382
LNKSPW	8.640	0.645
LNELF	3.212	0.329
LNLITERACY	3.341	0.367
LNSST	1.421	0.667
LNHEGDP	-0.433	0.309
LNMFP	4.471	0.117

Table-C: Partial Correlations

Variables	LNRGDPPW	LNKSPW	LNELF	LNSST	LITERACY	LNHEGDP
LNRGDPPW	1.000	0.981	0.980	0.969	0.961	0.802
LNKSPW		1.000	0.961	0.975	0.936	0.755
LNELF			1.000	0.937	0.981	0.765
LNSST				1.000	0.924	0.713
LITERACY					1.000	0.711
LNHEGDP						1.000

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Long-Run and Short-Run Dynamics of the Exchange Rate in Pakistan: Evidence From Unrestricted Purchasing Power Parity Theory

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Abstract

The main focus of this paper is to measure the speed of adjustment of the exchange rate by means of the persistent profile approach developed by Pesaran and Shin (1996) to examine the symmetry and proportionality assumptions of the purchasing power parity (PPP) theory of exchange rates for the Pak-rupee vis-à-vis the US-dollar exchange rate over the period 1982Q2-2005Q4. Using cointegration and vector error-correction modeling approaches, we find considerable support for the validity of weak-form PPP in Pakistan. Furthermore, the symmetry and proportionality assumptions of PPP are not verified. In the short-run, the exchange rate and foreign prices play a significant role in the convergence process to achieve long-run equilibrium. However, the speed of adjustment is very slow and the persistence profiles suggest that almost 4-5 years are required to eliminate deviations and bring the nominal exchange rate in line with the long-run equilibrium path.

JEL Classification: C13, C22, C51, F31, F37

Keywords: Exchange Rate, Purchasing Power Parity, Cointegration, Vector Error Correction, Pakistan

1. Introduction

The relationships between exchange rates, domestic prices and foreign prices have been at the center of policy discussions since the breakdown of the Bretton Woods system. It is widely acknowledged that stability in exchange rates ensures macroeconomic stability which impacts economic growth favorably. Misaligned exchange rates can lead to a reduction in

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economic efficiency, a misallocation of resources and capital flight.[1] Consequently, the exchange rate has received considerable attention in macroeconomic policy discussions as an important source of macroeconomic disequilibrium. The purchasing power parity (PPP) hypothesis is one of the oldest propositions establishing the link between exchange rates, domestic and foreign price levels. The theory is based on two key assumptions: the law of one price and long-run neutrality of money. These assumptions are necessary but not sufficient because real shocks may require relative price adjustments which violate PPP (Habermeier and Mesquita, 1999).

PPP theory has far-reaching implications at the theoretical, empirical and policy levels. For instance, PPP is used as a fundamental building block of the monetary approach to exchange rate determination.[2] Thus testing the PPP hypothesis is important because its findings are used in many current international financial research studies as well as important policy decisions (Baharumshah and Ariff, 1997). In policy terms, exchange rate management is at the center of many financial stabilization plans and PPP provides a theoretical basis for external adjustment policy. PPP is used in the implementation of economic reform programs sponsored by the World Bank and International Monetary Fund and is used as a criterion of exchange rate overvaluation and undervaluation. It also plays a role in the choice between money supply or inflation targeting in the design of monetary policy and is used to compare living standards across countries. Its analysis is also relevant for assessing whether the flexible exchange rate system is successful in insulating the domestic economy from foreign shocks (Frenkel, 1981). PPP implies a high degree of integration between goods and foreign exchange markets. Consequently, the nominal exchange rate between two currencies will adjust the inflation differential in order to keep the real exchange rate constant (Bhatti, 1996 and 2000). PPP is used as a reminder that monetary policy has no long-run impact on the real exchange rate. Thus, countries with different inflation rates should expect that movements in exchange rates adjust to offset these differentials in the long-run.

Despite its simplicity and theoretical appeal, there is inconclusive evidence regarding PPP. PPP theory is silent on issues regarding the process

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[1] Misalignment of the exchange rate can adversely affect economic growth in three ways: (i) undermine external competitiveness by overpricing exports, (ii) misallocation of resources by distorting domestic prices relative to international prices, and (iii) adversely affecting domestic financial markets by creating uncertainty, encouraging speculation and overvaluation.

[2] For example, the monetary model of exchange rate determination assumes continuous PPP, while the sticky price exchange rate models allows short-run exchange rate deviations from PPP.

of convergence towards the long-run equilibrium. Recently, researchers have shifted their interest from testing long-run PPP or stationarity of real exchange rates to measure the speed of adjustment back to an equilibrium (Coakley and Fuertes, 2000). The slow speed of adjustment and a very high volatility of real exchange rates in the short-run are central to the PPP puzzle (Rogoff, 1996). The consensus suggests a speed of reversion of 15% per annum, equivalent to half-lives of around 3 to 5 years (Boyd and Smith, 1999; Engle and Morley, 2001). The literature suggests that the root cause of the PPP puzzle lie in the different speeds of convergence for nominal exchange rates and prices (Cheung *et al.*, 2004). Engle and Morley (2001) argued that nominal exchange rates do converge at a much slower rate than prices and the half-lives of exchange rates range from 3 to 6 years, whereas half-lives of prices are about 1 to 2 years. However, Cheung *et al.* (2004) shows that around 60-90% of PPP disequilibrium adjustment take place through nominal exchange rate adjustment rather than price adjustment. Hence, the observed rate of PPP reversion depends on the speed of nominal exchange rate convergence.

Many of the existing studies on short-run PPP dynamics follow the structural vector autoregressive (VAR) of Clarida and Gali (1994). Under this approach, orthogonalized impulse response functions are employed to measure the impact of shocks to individual variables. However, one major drawback of this approach is that the impulse response functions are not uniquely identified (Coakley and Fuertes, 2000). Pesaran and Shin (1996) proposes the persistent profile approach to measure the speed of adjustment of the real exchange rate. The persistent profile approach measures the rate of mean reversion of the exchange rate on system-wide rather than variable specific shocks. Unlike the standard approach, it does not require any strong exogeneity property of the variables involved in PPP and provides information on the shape of the whole adjustment path (Helg and Serati, 2000).

Extensive research has been carried out to examine the validity of the PPP hypothesis. This work can be divided into seven main groups.[3] First, a number of studies carried out, *inter alia*, by Frenkel (1978), Krugman (1978), Ardeni and Lubian (1989) and Taylor (1992) examined the validity of the PPP hypothesis and found supportive evidence for almost all exchange rates except for those involving the US-dollar. Second, studies by Taylor (1988), Giovannetti (1989), Patel (1990), Nachane and Chrissanthaki (1991), Crowder (1992), Sarantis and Stewart (1993), MacDonald (1993), Cooper (1994), Corbae and Ovliaris (1988), Arderi and Lubin (1991), Dornbusch (1988) and Moosa and Bhatti (1996) investigated the validity of

[3] For further detail, see Bhatti (2000).

PPP theory for the post-Bretton Woods floating exchange rates system and failed to produce supportive evidence for long-run PPP.[4] Third, studies conducted by McNown and Wallace (1989), Liu (1992) and Mahadavi and Zhou (1994) found supportive evidence for countries experiencing hyperinflation. Fourth, Lothain (1990), Ardeni and Lubian (1991) and Moosa (1994) produced supportive evidence using low frequency data. Fifth, studies by Huizinga (1987), Kaminskyu (1987), Abauf and Jorion (1990) and Whitt (1992) reported supportive results real exchange rate mean reversion. Sixth, studies conducted by Frankel and Rose (1996), Oh (1996), Wu (1996), Pappel (1997), Cheung and Lai (1998, 2000), Taylor and Sarno (1998), Wu and Wu (2001), Engle (2000), Engle and Morley (2001) and Cheung *et al.*, (2004) generally found supportive evidence of PPP reversion. The overall results of these studies suggested estimates of the reversion speed with half-lives ranging from 3 to 5 years. Sixth, studies by Helg and Serati (2000) and Coakley and Fuertes (2000) found that the effect of system-wide shocks on long-run PPP was persistent with the average half-lives ranging between 6 to 8 years. It is clear from the survey of literature that the empirical results have been mixed and conflicting.

The behavior of the exchange rate and its responses to nominal and real shocks as a part of the macro-adjustment process has great relevance for policy-making in Pakistan, which has recently shifted to a market-based exchange rate regime. Pakistan opted for a managed floating exchange rate system in January 1982. In July 2000, the exchange rate policy shifted from a managed float to free flexible exchange rate.[5] Changes in the exchange rate regime are expected to eliminate deviations from parity. Besides changes in the exchange rate regime, trade and financial liberalization and loosening of restrictions on capital inflows during the past decade and a half have reduced many distortions. These structural changes may force the parity condition to converge towards the long-run equilibrium path. It is therefore interesting to determine whether the liberalization of the domestic economy prompts major shifts in the price structure by increasing convergence towards the law of one price.

The empirical evidence associated with Pakistan on this issue is still sparse (Chishti and Hasan, 1993; Bhatti, 1996, 2000; Liew *et al.*, 2004; Tang and Butiong, 1994; Yunus, 2000, Ahmed and Khan, 2002 and Qayyum *et al.,*

[4] It must be noted that the majority of the studies conducted have been on developed countries and a limited number on high inflation developing countries.

[5] Adjustment to parity is made through the movements in domestic price level in a fixed exchange rate regime, while in the case of a managed floating exchange rate, parity reversion takes place through the movements in exchange rates (Froot and Rogoff, 1995).

2004). These studies found supportive evidence, while Chishti and Hasan (1993) found evidence which does not support the PPP hypothesis. Except Yunus (2000), Ahmed and Khan (2002), Qayyum *et al.* (2004) and Khan and Qayyum (2007), these studies do not take into account the short-run dynamics of the exchange rate and domestic and foreign prices. However, all the studies imposed symmetry and proportionality assumptions *a priori* and tested a restricted version of PPP. Furthermore, no serious attempt has been made to measure the speed of mean reversion of PPP in the system-wide context in Pakistan. This study attempts to fill this gap.

Given the paramount importance of exchange rate dynamics in macroeconomic adjustment, this paper attempt to measure the speed of adjustment to PPP by means of the "persistent profile" based on the unrestricted PPP using quarterly data over the period 1982Q2-2005Q4. This study significantly differs from earlier studies conducted on this issue in Pakistan. *First,* unlike previous studies we have estimated unrestricted PPP using cointegration and vector error-correction modeling approaches that encapsulate short-run dynamics and the long-run response of the exchange rate to changes in domestic and foreign prices. *Second*, this study has focused on testing the validity of the symmetry and proportionality assumptions of PPP. *Third*, we have used persistent profiles of PPP to measure the speed of convergence towards the long-run equilibrium path.

The rest of the paper is organized as follows: section 2 deals with the theoretical modeling of purchasing power parity, methodology and data. Cointegration analysis is carried out in section 3. Persistence profiles of PPP are given in section 4, while some concluding remarks are given in the final section.

2. Modeling Purchasing Power Parity Theory, Methodology and Data

PPP is one of the oldest and widely tested propositions in international finance. Its intellectual origins can be traced back to the Salamanca School in the 16th century in Spain. Its revival as a theory of exchange rate determination began with the writings of Cassel (1918).[6] The absolute version of PPP states that the nominal exchange rate is determined by the ratio of domestic and foreign price levels. This version of PPP assumes symmetry and proportionality restrictions *a priori*. These assumptions may be overly restrictive because the effect of domestic and foreign prices need not be proportional and symmetric. Following Ardeni and Lubian (1989), we include domestic prices and foreign prices

[6] An excellent of historical review of PPP can be found in Dorrnbusch (1988).

unrestrictedly. Define s as the nominal exchange rate measured in terms of Pak-rupees per unit of US-dollar and p as the domestic price level. Let an asterisk denote a foreign variable and lowercase letters indicate that the variables have been transformed using the natural logarithms. The testable version of the unrestricted PPP relationship is given by:

$$s_t = \alpha_0 + \alpha_1 p_t + \alpha_2 p_t^* + \omega_t \tag{1}$$

Where α_0 is constant, α_1 and α_2 are the coefficients of domestic and foreign prices respectively and ω_t is a stochastic disturbance term representing deviations of the real exchange rate around the mean. The PPP hypothesis is based on the assumption of the law of one price, which implies that in a competitive and integrated market, the price of a given good would be the same when quoted in different currencies. In the short-run, the exchange rate could diverge from PPP because of various impediments on trade and capital inflows, speculative activities of economic agents, intervention in the foreign exchange markets and productivity differentials in the exports sector.

A large number of researchers have used the cointegration approach to test the validity of the PPP hypothesis and found that the error term is stationary (i.e. $\omega_t \sim I(0)$) and that symmetry ($\alpha_1 = -\alpha_2$) and proportionality ($\alpha_1 = \alpha_2 = -1$) conditions are satisfied (MacDonald and Marsh, 1997). An alternative strand of the empirical literature involves imposing symmetry and proportionality assumptions ***a priori*** on the exchange rate and relative prices to examine whether the real exchange rate is following a mean-reverting process. That is:

$$q_t = \delta + \lambda q_{t-1} + \zeta_t, \qquad 0 < \lambda < 1 \tag{2}$$

where δ and ζ are respectively the intercept and error terms. The real exchange rate q_t is equal to $s_t + p_t^* - p_t$. PPP holds only when the real exchange rate is stationary. But this is the most restrictive form of PPP. Relative PPP requires that $\delta = 0$, while absolute PPP requires that both $\delta = 0$ and $\lambda = 0$ (Doganlar, 1999).

The strong version of the less restrictive PPP implies that $\alpha_1 = -\alpha_2 = 1$, $\alpha_0 = 0$ [7] and ω_t is stationary. However, the homogeneity restriction $\alpha_0 = 0$ is often relaxed due to the presence of transaction costs and other impediments to trade. The symmetry ($\alpha_1 = -\alpha_2$) and proportionality ($\alpha_1 = -\alpha_2 = 1$) restrictions can be relaxed due to measurement errors (Taylor, 1988; Cheung and Lai, 1993; Sercu *et al.*, 1995). In testing the validity of unrestricted PPP we use cointegration and vector error-correction modeling techniques.

In Pakistan, the period after 1990 is associated with significant changes in trade and financial policy. Prior to the reforms of the 1990s, the foreign exchange market was heavily regulated by the State Bank of Pakistan (SBP) through exchange controls. All foreign exchange transactions were conducted through authorized dealers (ADs) and authorized money changers (AMCs) at the SBP's subscribed rate. On the other hand, inter-bank transactions were taking place at rates varying within the range set by SBP's buying and selling spread.[8] The exporters, remitters and tourists were the main suppliers of the foreign exchange, whereas importers and the government organizations were the major users of the foreign exchange. To manage the transactions between suppliers and users of foreign exchange, a system of ADs and AMCs was in place (SBP, 2000). After the 1990s, the government introduced reforms to promote the foreign exchange market and improve the payment system. These reforms included: elimination of black market, rupee opening of resident foreign currency accounts, rupee convertibility on the current account, unification of the exchange rate, and adoption of a free and flexible exchange rate system.[9] Furthermore, several other steps were taken to create a regulatory and institutional framework to enhance the role of market forces in the process of exchange rate determination (Janjua, 2004).[10] These institutional and structural changes complicate the process of exchange rate determination. To capture the

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[7] The proportionality restriction may be imposed on equation 1 by restricting $\alpha_0 = 0, \alpha_1 = 1$, $\alpha_2 = -1$. The symmetry hypothesis implies that $\alpha_0 = 0$, $\alpha_1 = -\alpha_2$.

[8] The spread between the buying and selling rate was equal to Rs. 0.0156 per US-dollar up to April 24, 1978, and afterwards it was changed to 0.5 percent of the spot buying rate (SBP, 2002).

[9] For further detail see SBP's Financial Sector Assessment Reports 1990-2000, 2001-02, and 2005-06.

[10] These steps included development of staffed and well-equipped dealing room of foreign exchange at SBP, upgradation of information systems, creation of dealing rooms by banks, providing guidelines for the proclamation of code of conduct, development of a forward market and liberalization of the limits of foreign exchange holdings by banks (Janjua, 2004, p. 454).

effect of these changes, we introduced two policy dummies and one event dummy in the VAR model.

Thus our VAR model includes restricted intercepts and three unrestricted seasonal dummies. In addition, a dummy variable (D_{91}) for the period 1991-2005 was added to the model to capture the effects of financial sector reforms that took place in the early 1990s. Similarly, in order to identify a possible structural break associated with the May 1998 nuclear tests and the change in the exchange rate regime from managed float to free flexible in July 2000, we introduced two additional dummies D_{98} and D_{00} into the VAR model.[11] The vector error-correction model (VECM) is in general given by:

$$\Delta X_t = \mu - \Pi X_{t-1} + \Gamma_1 \Delta X_{t-1} + ... + \Gamma_{k-1} \Delta X_{t-k+1} + \varepsilon_t \quad (3)$$

Where $X = [s_t \;\; p_t \;\; p_t^*]'$, $\Delta = 1 - L, \Pi$ can be written as $\Pi = \alpha\beta'$, where β is the coefficient matrix, α is a matrix of adjustment coefficients

[11] It can be argued that these transformations could affect not only the real exchange rate but also effect the domestic price level. In May 28, 1998, Pakistan conducted nuclear tests. In response, the world community imposed economic sanctions, which created a situation of economic crisis. Nuclear detonation created the state of uncertainty regarding the ability of Pakistan to meet its external obligations. It is a fact that Pakistan's economy was much more vulnerable to the loss of support from International Monetary Fund (IMF) and other International Financial Institutions (IFIs) when a US-led coalition withheld IMF support. The resulting collapse of confidence created a balance of payment crisis and a significant decline in economic activities. Capital inflows, especially worker remittances, fell drastically and new foreign loans virtually stopped. Foreign exchange reserves fell to extremely low levels. To meet this uncertain situation the authorities froze foreign currency accounts, adopted a two-tier exchange rate system, prevented speculative activity in the inter-bank Forex market, discouraged capital outflows, contained import demand and discouraged overdue export bills among other steps. In November 1998, the US government waived a number of sanctions; at that time, Pakistan's foreign exchange reserves stood at only $458 million. The open (kerb) market rate of the Pak-rupee/US dollar depreciated from Rs. 45 in the early May 1998 to Rs. 63 in mid-July 1998, showing 28% depreciation. At the end of 1998, when most of the sanctions had been lifted, the Pak-rupee remained 16% below its pre-test value. The economic sanctions imposed by the world community caused a collapse in the confidence of investors. As a result, the Karachi Stock Exchange (KSE) index after May 1998 sharply fell by 34%, more than the rest of the Asian Stock markets. The KSE index reached an all time low level 777.26 three days after the announcement of economic sanctions. However, receiving financial support from the Arab world enabled Pakistan to steer the economy successfully from the crisis.

and $\varepsilon_t = [\varepsilon_{1t}\ \varepsilon_{2t}\ \varepsilon_{3t}]'$ is a vector of white-noise innovations. The VECM with the PPP restrictions has the following structure (Chinn (1999, 2000):

$$\Delta s_t = \mu_1 - \phi_1 z_{t-1} + \sum_{i=1}^{k} \gamma_{1i} \Delta s_{t-i} + \sum_{i=1}^{k} \psi_{1i} \Delta p_{t-i} + \sum_{i=1}^{k} \lambda_{1i} \Delta p^*_{t-i} + D' + \varepsilon_{1t}$$

$$\Delta p_t = \mu_2 - \phi_2 z_{t-1} + \sum_{i=1}^{k} \gamma_{2i} \Delta s_{t-i} + \sum_{i=1}^{k} \psi_{2i} \Delta p_{t-i} + \sum_{i=1}^{k} \lambda_{2i} \Delta p^*_{t-i} + D' + \varepsilon_{2t} \quad (3')$$

$$\Delta p^*_t = \mu_3 - \phi_3 z_{t-1} + \sum_{i=1}^{k} \lambda_{3i} \Delta s_{t-i} + \sum_{i=1}^{k} \psi_{3i} \Delta p_{t-i} + \sum_{i=1}^{k} \lambda_{3i} \Delta p^*_{t-i} + D' + \varepsilon_{3t}$$

Where $z_{t-1} = \beta' X_{t-1}$ represents the error correction term with coefficients, $1 > \phi_1 > 0$, $1 > \phi_2 > 0$ and $1 > \phi_3 > 0$. D is the vector of dummies (i.e. three seasonal dummies, two policy dummies and one event dummy). In the above equation system, $\phi < 0$ implies that there is a tendency for the exchange rate to return to the path of long-run equilibrium. When $\phi = 0$, no adjustment takes place to bring the exchange rate towards its long-run equilibrium path and if $\phi > 0$, the exchange rate follows overshooting behavior. We applied the Johansen (1988) and Johansen and Juselius (1990) maximum likelihood method to estimate the VECM and to test for cointegration. Following the Cheung and Lai (1993) testing procedure, we applied the likelihood ratio test to implement the coefficient restrictions, that is $(\alpha_1\ \alpha_2\ \alpha_3\ \alpha_0) = (1\ -1\ 1\ 0)$ and then tested the symmetry restriction $(\alpha_2 = -\alpha_3)$ and proportionality restriction $(\alpha_2 = -\alpha_3 = 1)$.

The data set used in this study consists of quarterly observations covering the period from 1982Q2 to 2005Q4.[12] Our model contains three variables, the exchange rate (s_t) defined as the average market rate measured in terms of units of Pak-rupee per US-dollar. p_t is the domestic price level proxied by the wholesale price index (WPI) and p^*_t is the foreign

[12] Although the sample size in terms of time horizon is relatively small, which affects the performance of PPP because 2-10 years are needed for PPP to be re-established (Hendry, 1986). Due to this we increase sample size by time disaggregating to establish a long-run relationship between the exchange rate, domestic and foreign prices. The effects of increasing the sample size by the use of higher frequency data over a fixed sample period in unit root tests are also analyzed by Shiller and Perron (1985).

price level proxied by the US producer price index (PPI).[13] All the data were retrieved from the International Financial Statistics (IFS) CD-ROM (2006).

3. Cointegration Analysis: Test of PPP Hypothesis

We first examine time series properties of the data by using the Augmented Dickey Fuller (ADF) unit root test. To capture the effects of seasonality we use seasonal dummies in the ADF test, but this makes no difference in the results. The results of ADF test are reported in Table-1. The results suggest that the real exchange rate (q_t) is non-stationary at log-level and stationary at log-first difference implying no mean reversion. Parikh and Williams (1990) and Wu (1996) argued that the studies based on short spans of data find it difficult to prove that there is any mean reversion in the real exchange rate.

Table-1: Results of ADF Unit Root Tests

Series	Log-Level		Log-First Difference		Decision
	C	C + D	C	C + D	
S	-1.288 (1)	-1.264 (1)	-6.618 (0)*	-6.461 (0)*	I (1)
P	-0.544 (1)	-0.504 (4)	-7.284 (0)*	-3.941 (2)*	I (1)
p^*	-2.524 (3)^T	-2.524 (3)^T	-6.321 (0)*^{T}	-6.321 (0)*^{T}	I (1)
q	-1.612 (2)	-1.517 (2)	-6.769 (1)*	-6.828 (1)*	I (1)

Note: C, T, D stands for constant, trend and seasonal dummies. Figures in brackets indicates lag length, while * indicates significance at the 1% level of significance.

All other series are non-stationary at their log-level and stationary at their first difference. Thus we conclude that s, p, p^* ~ I (1). Since all variables to be entered in the PPP model are integrated of order I (1), it is possible to test for the existence of cointegration between the exchange rate, domestic and foreign prices.

The Johansen multivariate cointegration approach is used to examine the long-run relationship between the nominal exchange rate, domestic and

[13] We used (WPI) wholesale price indices (2000=100) for both Pakistan and the U.S. because the domestic prices based on the consumer price indices (CPI) seems to be I(2) i.e. p^{cpi} ~ I (2) while the exchange rate s ~ I (1).

foreign price levels. The VAR model is specified with two lags.[14] Moreover, single equation and multivariate residual-based misspecification tests with respect to serial correlation up to order 5, ARCH and heteroscedasticity up to order 4 are found to be insignificant except for the assumption of normality (Table-2)[15]. This could be due to the large residuals in the foreign price and exchange rate equations (See Figure-1).

Table-2: Multivariate Residual-based Misspecification Tests

Equation	Equation Diagnostics					
	Portmanteau (10)	F_{AR} (1-5) (5.76)	χ^2_{Nd} (2)	F_{ARCH} (1-4) (4,73)	F_{Het} (12,68)	F_{Het-x} (27,53)
s_t	4.92	0.95	27.04	1.51	0.83	0.72
		(0.45)	(0.00)*	(0.21)	(0.62)	(0.82)
p_t	9.21	1.05	3.92	1.36	0.70	0.70
		(0.40)	(0.14)	(0.26)	(0.75)	(0.84)
p_t^*	10.48	1.23	6.85	1.10	1.28	1.69
		(0.30)	(0.03)**	(0.36)	(0.25)	(0.05)

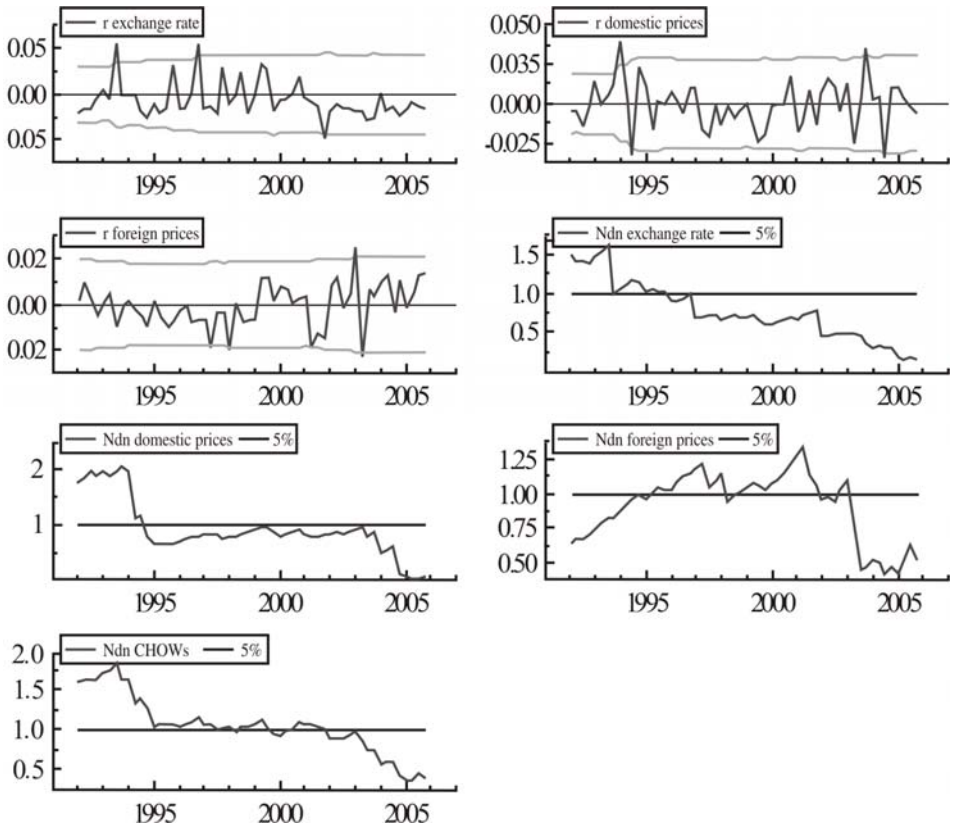
	System Diagnostics				
System Diagnostics	**Portmanteau: 10 lags**	F_{AR} (1-5) (45,190)	χ^2_{Nd} (6)	F_{Het} (72,348)	F_{Het-x} (162,290)
VAR	87.59	1.19	35.65	1.01	1.08
		(0.21)	(0.00)*	(0.46)	(0.28)

Note: In the single equations, the following null hypotheses are tested for each of the three equations in the VAR model: absence of autocorrelation up to order 5, normally distributed errors, no ARCH and heteroscedasticity effect up to order 4. At the system level, the hypotheses of no autocorrelation, non-normality and no heteroscedasticity are tested. Figures in brackets indicate the p-values.

[14] Number of lags selected for VAR is based on the minimum values of Akaike Information Criterion (AIC).

[15] Cheung and Lai (1993) and Gonzalo (1994) have demonstrated the robustness of the Johansen procedure to non-normality. Also see note below Table-2.

Figure-1: Parameter Constancy Test



The model constancy test statistics are obtained by recursive estimation of the VAR model. For each of the equations, one-step ahead residuals +/-2SE in the first three parts of Figure-1 and Chow breakpoints are shown in the second three parts, while Ndn Chows are shown in the last part of the Figure. These Chow statistics are scaled by their critical values at the 5 percent level. As can be seen from the Figure, the Chow test does not reject the hypothesis of parameter stability for exchange rate equation. It implies that estimated parameters of the VAR model are constant.

The results presented in Table-3 (panel A) reveals that there is cointegration between exchange rate, domestic and foreign price levels because the hypothesis of no cointegration is rejected at the 5% level of significance using either maximum eigenvalue (λ - *max*) or trace (λ - *trace*) statistics. Both λ-*max* and λ-*trace* suggest the existence of one cointegrating vector. The existence of cointegration implies that there exists long-run co-movement between the exchange rate, domestic and foreign prices, and weak-form PPP holds for Pakistan.

Table-3: Cointegration Analysis of the PPP Hypothesis
Series [s_t, p_t, p^*_t] and lags = 2

Panel A: Cointegration Analysis				
Eigenvalue	-	0.2235	0.1157	0.0207
Hypothesis	$r = 0$	$r <= 1$	$r <= 2$	$r <= 3$
λ - *max*	23.777 (0.031)**	13.525 (0.213)	1.966 (0.784)	
λ - *trace*	37.302 (0.027)**	13.525 (0.331)	1.966 (0.780)	
Log Likelihood	788.6489	800.5376	806.3169	807.3000
Panel B: Standardized Eigen Vector (Beta Matrix)				
	Vector 1	Vector 2	Vector 3	
s_t	1.0000	-0.4374	0.3298	
p_t	-0.9939	1.0000	-0.3548	
p^*_t	0.47272	-1.6530	1.0000	
Constant	-1.6625	4.9384	-4.0573	
Panel C: Standardized Adjustment Coefficients (Alpha Matrix)				
s_t	-0.1226	-0.0292	-0.0369	
p_t	-0.0150	-0.0371	0.0454	
p^*_t	-0.0392	0.0190	0.0291	

** Indicates 95% level of significance. Figures in parenthesis represent p-values. The critical values are taken from Pesaran *et al.* (2000). Unrestricted variables: D91, D98, D00 and three seasonal dummies.

The long run equation is obtained by normalizing the estimates of the first cointegrating vector on the exchange rate (panel B of Table-3). The cointegrating coefficients of domestic and foreign prices are correctly signed as predicted by the PPP theory. The coefficient on the domestic price level is equal to 0.99, which follows the theoretical prediction. However, the coefficient on the foreign price level is equal to -0.47, which differs substantially from the value predicted by the PPP theory. This implies that the exchange rate responds more quickly to domestic price level than to world price level in the long-run. These results are consistent with the findings by Yunus (2000) in the case of Pakistan.

Table-4: Results for Coefficient Restrictions Test

$(s_t = \alpha_1 p_t + \alpha_2 p_t^* + \alpha_0 + \omega_t)$

Panel A: Coefficients and Coefficient Restrictions	
α_1	0.9939 (0.1105)**
α_2	-0.4727 (0.5485)
α_0	-1.6625 (2.1028)
$\chi^2\ (\alpha_0 = 0)$	0.4820 [0.4875]
$\chi^2\ (\alpha_1 = 1)$	0.0020 [0.9648]
$\chi^2\ (\alpha_2 = -1)$	0.8756 [0.3486]
$\chi^2\ (\alpha_1 = -\alpha_2)$	1.2507 [0.2634]
$\chi^2\ (\alpha_0 = 0,\ \alpha_1 = 1,\ \alpha_2 = -1)$	13.445 [0.004]
$\chi^2\ (\alpha_0 = 0,\ \alpha_1 = -\alpha_2)$	11.419 [0.003]
Panel B: Adjustment Coefficient (α Matrix)	
Δs_t	-0.1226 (0.0303)**
Δp_t	-0.0150 (0.0220)
Δp_t^*	-0.0392 (0.0151)**

* and ** indicates significance at the 99% and 95% level. Figures in (.) indicate standard errors while figures in [.] indicate p-values.

For the validity of strong-form PPP, we test the symmetry and proportionality propositions. The results are reported in Table-4. The coefficient on the domestic price level is statistically significant and close to unity, while the coefficient of foreign price level, although possesses the expected sign, is statistically insignificant and below the value predicted by the theory. The symmetry and proportionality restrictions are rejected, which implies that the exchange rate does not move one-for-one with the prices of two countries. These results are inconsistent with the predictions of PPP theory. Yunus (2000) also found similar results in the case of Pakistan. Wang (2000) also found similar results for seven Asian countries. This implies that the real exchange rate is non-stationary and the long-run PPP conditions are violated.

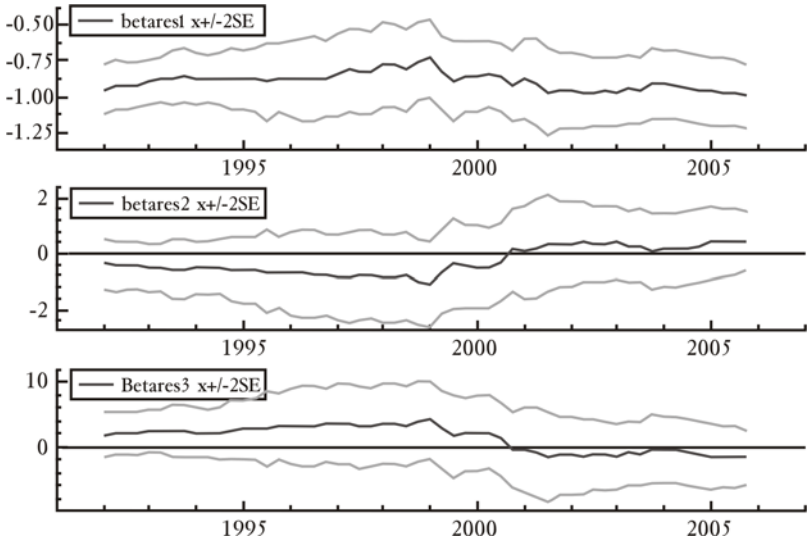
However, the rejection of the symmetry and proportionality restrictions may be possible due to the presence of transaction and transportation costs and measurement errors in the price variables (Taylor,

1988; Cheung and Lai, 1993; Sercu *et al.*, 1995). This could be possibly because of differences in consumption preferences across countries, different economic structure and factor endowments, presence of nontraded goods in consumer price indexes and transport costs and trade barriers between Pakistan and United States affecting the cost of production and prices (Doganlar, 1999; Engle, 1992).

Panel B of Table-4 provides adjustment coefficients indicating how fast the exchange rate and price levels are adjusted towards the long-run equilibrium path. The results indicate that the adjustment coefficients possess the expected negative signs and are statistically significant apart from the coefficient on domestic price inflation. The adjustment coefficient associated with the exchange rate is relatively large as compared to the foreign price level. The results suggest that around 12% and 0.04% of the deviations in PPP are eliminated by changes in the exchange rate and foreign inflation per quarter. This suggests that the response of foreign prices is much weaker than that of the exchange rate, while domestic prices play no role in the adjustment process in the short-run. Furthermore, the exchange rate takes 2-3 years to adjust back towards long-run equilibrium. These results are consistent with the findings of Yunus (2000) in the case of Pakistan.

Recursive estimation of the long-run parameters (Figure-2) indicates that the estimated parameters lie well within the standard error bands. The estimated parameters show some movement from 1998 to 2001 but do not violate the property of parameter constancy. This could be due to perhaps nuclear tests conducted in May 1998 and the events of 9/11.

Figure-2: Recursive Estimation of the Long-Run Coefficients



To verify the adjustment process in the short-run, we estimated the VECM to understand the short-run responses of the exchange rate, domestic and foreign inflation. The results are given in Table-5.

The results suggest that the error-correction coefficient on the nominal exchange rate is correctly signed and highly significant, demonstrating the significant role played by arbitrage and the considerable flexibility of prices in restoring long-term equilibrium. The error-correction coefficient on the foreign price level is also correctly signed and statistically significant, implying that the foreign price level is also a significant variable in restoring long-run equilibrium. However, the insignificance of the error-correction term associated with the domestic price level implies that domestic prices seem to be weakly exogenous.

Table-5: Parameters of the Vector Error-Correction Model

Variables	Δs_t	Δp_t	Δp_t^*
Δs_{t-1}	0.3287 (3.7652)**	0.0072 (0.1138)	-0.7000 (-1.6230)
Δp_{t-1}	-0.3801 (-2.5210)**	0.2860 (2.6315)**	-0.0208 (-0.2800)
Δp_{t-1}^*	0.0485 (0.2263)	0.1428 (0.9233)	0.3593 (3.3915)**
ECM_{t-1}	-0.1226 (-4.0357)*	0.0150 (-0.6850)	-0.0392 (-2.6149)**
*SD*1	-0.0103 (-1.7754)	0.0087 (2.0758)**	0.0004 (0.1342)
*SD*2	8.67E-05 (0.0150)	0.0100 (2.3993)	-0.0017 (-0.6610)
*SD*3	0.0018 (0.3061)	0.0168 (4.0532)*	-0.0019 (-0.6610)
*D*91	0.0023 (0.4271)	0.0036 (0.9301)	-0.0039 (-1.4691)
*D*98	-0.0234 (-1.0374)	0.0038 (0.2323)	0.0035 (0.3179)
*D*00	-0.0020 (-0.2975)	-0.0041 (-0.8546)	0.0081 (2.4683)**
R^2	0.29	0.18	0.28
$\overline{R}^2$	0.21	0.09	0.20
$F-statistic$	3.79	2.05	3.62
S.E equation (sigma)	0.02	0.02	0.01

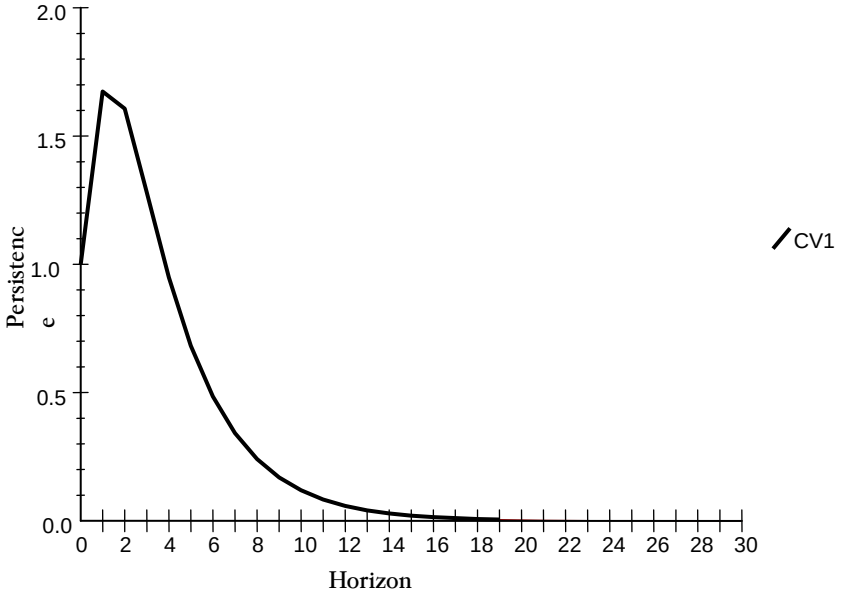
* and ** indicates significant at the 99% and 95% level. Figures in (.) indicate t-values. SDi are the seasonal Dummies, D91, D98 and D00 are the dummies for financial sector reforms, 1998 nuclear tests and regime shift from managed float to free flexible exchange rate respectively.

In the exchange rate equation, policy dummies (i.e. D91 and D00) and event dummy (D98) are insignificant implying the stability of the system over the period of study. These results confirm our results reported in Table-3 and Table-4. However, the ability of the estimated simultaneous equation model is limited as indicated by the low adjusted R^2. Despite this, the estimated VECM provides important information regarding the exchange rate movements in the short-run. The significance of the error-correction coefficients indicates the presence of weak form-PPP and the tendency for the nominal exchange rate to revert to the previous period's equilibrium path. However, the speed of reversion is very slow and takes 2-3 years to converge.

4. Persistence Profiles of PPP

The persistence profiles of the PPP relationship are estimated using a VECM to determine the speed at which the variables in the system revert to their long-run values. The idea of persistence profiles to measure the speed of adjustment was proposed by Lee and Pesaran (1993) and Pesaran and Shin (1996). The main advantage of this method is that it does not require the assumption of exogeneity of the variables. Moreover, this measure also describes the full dynamics of the adjustment over the selected horizon. The persistence profiles provide useful information on the speed with which the different relations in the model, once shocked, will return to their long-run equilibrium. Persistence profiles are different from the impulse response functions because they are unique and do not depend on the specifically defined shocks orthogonalization procedure. The persistence profiles estimates for the unrestricted PPP based on the cointegration relationship are reported in Figure-3.

Figure-3: Estimates of Persistence Profiles of the PPP



The persistence profile estimates show that the effects of system-wide shocks initially overshoot and eventually die out after 16 quarters (4 years). This implies that the adjustment towards the long-run equilibrium takes around 16 to 17 quarters (4 years). After 4 years, the marginal change in adjustment is not very significant. This implies that persistence profile of the PPP cointegrating vector converges rather slowly to its long-run equilibrium path after the introduction of a system-wide shock. The results further suggest that, on average, around 90% of disequilibrium is made up within almost 4 years. Such behavior is visible in Figure-3. The slow convergence of PPP comes from slow convergence of the exchange rate. Frankel (1990) argued that the failure of empirical studies to find evidence in favor of PPP is due to the low speed of adjustment towards PPP. Rogoff (1996) has also pointed out that observed persistence of the real exchange rate is far too high to be explained by existing models of PPP deviations. Engle and Morley (2001) argued that nominal exchange rates do converge at a much slower rate and about 60-90% of PPP disequilibrium adjustment takes place through nominal exchange rate adjustment. Rogoff (1996) discussed the PPP puzzle as:

> *The failure of short-run PPP can be attributed in part to stickiness in nominal prices; as financial and monetary shocks buffer the nominal exchange rate, the real exchange rate also changes in the short-run. This is the essence of Dornbusch's (1976)*

> *overshooting model of nominal and real exchange rate volatility. If this were the entire story, however, one would expect substantial convergence to PPP over 1-2 years, as wages and prices adjust to a shock (p. 654).*

Figure-3 shows that initially, the profile starts increasing for some quarters after the shock and then it monotonically decreases up to the final adjustment. This inverted U-shape is also obtained by Pesaran and Shin (1996). A possible explanation for this overshooting and slow adjustment may be due to price stickiness, asymmetric information, less developed domestic markets, barriers to trade and productivity differentials. Another reason for this overshooting may be the J-effect characterizing the adjustment path of the current account in the presence of monetary shocks (Rogoff, 1996).

Based on the above outcomes, the transmission mechanism from monetary policy can be expressed as:

Increase in domestic money supply (m) leads to an increase in domestic prices (i.e. pass-through effect), which subsequently increases the exchange rate s (a depreciation). This implies that, despite real factors such as the budget deficit, monetary changes can affect both nominal exchange rates and domestic prices.

5. Conclusions and Policy Implications

This paper has examined the validity of unrestricted versions of PPP for Pakistan using quarterly data over the period 1982Q2 to 2005Q4 under the framework of multivariate cointegration and vector error-correction modeling approaches. We find one significant cointegrating vector, which indicates the presence of long-run relationship between the exchange rate, domestic and foreign prices. The important findings of the study include: *first*, the nominal exchange rate is cointegrated with domestic and foreign prices. The cointegration coefficient on the domestic price level is close to unity and the coefficient on the foreign price level is well below unity. However, the symmetry and proportionality conditions are not satisfied. These results support the validity of weak-form PPP in Pakistan. The error-correction terms are negative and significant implying that 12% and 0.04% of the past deviations from PPP are corrected by exchange rate and foreign price adjustments respectively per quarter. *Second,* the persistence profiles suggest that the adjustment of PPP towards the long-run equilibrium path is rather slow. Shocks to PPP are slowly absorbed and take 4-5 years to reach the final adjustment. *Third,* economic reforms helped to increase the

flexibility of prices and nominal exchange rates in adjusting to short-term deviations and shortening the time span required for dampening these deviations[16]. The main policy implications drawn from this study include:

- The findings confirm that exchange rate, domestic and foreign prices are cointegrated. Therefore, the authorities can use PPP as a long-term nominal anchor to adjust to inflation differentials.

- To stabilize exchange rate and reduce deficits, monetary restraint is necessary.

[16] Empirical findings for developed countries suggest that the time period required for re-establishing PPP is shorter under floating exchange rate regimes; in this case, deviations from PPP could have a half-life as short as three to four years.

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Forecasting Wheat Production in Pakistan

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Abstract

This study analyzes the future prospects of wheat production in Pakistan. Parameters of the forecasting model are obtained by estimating a Cobb-Douglas production function for wheat, while future values of various inputs are obtained as dynamic forecasts on the basis of separate ARIMA estimates for each input and for each province. Input forecasts and parameters of the wheat production function are then used to generate wheat forecasts. The results of the study show that the most important variables for predicting wheat production per hectare (in order of importance) are: lagged output, labor force, use of tractors, and sum of the rainfall in the months of November to March. The null hypotheses of common coefficients across provinces for most of the variables cannot be rejected, implying that all variables play the same role in wheat production in all the four provinces. Forecasting performance of the model based on out-of-sample forecasts for the period 2005-06 is highly satisfactory with 1.81% mean absolute error. The future forecasts for the period of 2007-15 show steady growth of 1.6%, indicating that Pakistan will face a slight shortage of wheat output in the future.

JEL Classification: C13, C22, Q13, Q16

Keywords: Wheat, ARIMA, Production Function, Pakistan

1. Introduction

Wheat is the main staple food item in Pakistan. The share of this single item in total household consumption in Pakistan is about 9%. Among rural households wheat is the largest single consumption item, while among urban households it is the second largest consumption item following housing.[1] Over the years, factors including water shortages, increases in the input prices, extraordinary drought conditions, etc., have

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[1] See Government of Pakistan (2005).

affected the wheat crop, although in the recent past Pakistan has experienced good wheat crops. Due to favorable conditions, it became possible to compile healthy strategic stocks.

Crops in general, and wheat in particular, provide leakages through which it is possible to provide stimulus to economic growth in other sectors of the economy. Wheat cultivation has been suffered from various problems, such as shortage of irrigation water, low yields, traditional methods of farming, increases in input prices, shortage of good quality key inputs, and low usage of modern technology. Pakistan has also experienced fluctuations in wheat production; farmers suffered heavy losses in the few years that the wheat crop was in surplus. Also, a negative relationship has been observed between flour prices and wheat production.

Several studies have been conducted to formulate a wheat-forecasting model and to make wheat forecasts in Pakistan. Most of these studies were conducted during the 1970s and 1980s when Pakistan faced shortages of wheat production and policy makers were concerned with food security, especially for staple foods. The most commonly used inputs in these models were rainfall, fertilizer, temperature, tractors and labor. The literature has proposed several alternative measures of rainfall. For example, Azhar et al (1972, 1974) used rainfall during the November to January period, Qureshi (1974) used three variables to capture rainfall: rainfall from July to September, rainfall from October to December and 'maximum effective' rainfall from January to March. Chaudhary and Kemal (1974) found that deviation of rainfall from normal levels during the period from July to January was the most appropriate rainfall variable for wheat production in irrigated areas of Pakistan. This study, along with another study by Griffiths *et al.* (1999), concluded that the choice between actual rainfall and the deviations from normal rainfall was a matter for empirical investigation and the results were not robust.

The empirical literature finds strong correlation of wheat production with fertilizer use. In the absence of any direct measure of fertilizer use for the wheat crop at the aggregate level, the literature adopts alternative procedures such as the purchase of fertilizer during the sowing season for wheat or a fertilizer consumption based on the share of the wheat crop in total cropped area (see Azhar *et al* (1972, 1974); Mukhtar and Mukhtar (1988); Saleem (1989)).

Other variables that had significant effects on wheat output include tractorization (Salam (1981)) and labor (Mukhtar and Mukhtar (2003); Salam (1981)).

Most of the studies cited above also derive wheat forecasts on the basis of the models estimated. A notable study is by Iqbal *et al.* (2005). According to this study, the estimated ARIMA model showed that production of wheat would grow to 29.77 million tones in the year 2022. The study concluded that the expected growth was low and that the scope for higher area and production laid in adequate government policies regarding wheat cultivation in the country.

Thus wheat forecasts have been made either for only one province or two but not for all the four provinces of Pakistan. As mentioned earlier, wheat forecasts that were made for individual provinces have a history in 1970s. A recent study by Iqbal *et al.* (2005) provided wheat forecasts at the aggregate level in Pakistan. Thus a study is needed that can provide updated estimates of wheat forecasts both for Pakistan as well as its four provinces that can predict future trends in the production of wheat over the next few years.

The present study determines the future prospects for wheat production in Pakistan as well as in its four provinces using the past trends. The objectives of the disaggregate analysis at the provincial level is two-fold. First, the province-wise disaggregated data increases the size of the sample four times as compared to the country level aggregate data, thereby increasing the reliability of parameter estimates of the forecasting model. Second, the province-wise data also allow the possibility of variations in parameters of the forecasting model across the four provinces through panel estimation and hence produce more accurate forecasts.

In order to assess the forecast accuracy of the estimated model, the study re-estimates the model after dropping the latest two years' observations (2005 and 2006), then makes wheat forecasts for these two years and compares them with actual production in the same years. Thus, the difference between the actual and predicted production is the wheat forecast error. A positive forecast error means that wheat production has been underestimated and vice versa. Thus, after determining the forecasting ability of the model and finding a basis for future wheat forecasting, the study makes wheat forecasts for the period 2007 to 2015.

The organization of the paper is as follows. In Section 2, the methodology is presented. Data and the estimation procedure are described in Section 3. Results are presented in Section 4. Finally, Section 5 concludes the study.

2. Methodology

One way to determine which inputs are crucial in the production of wheat output is to calculate elasticities of wheat output with respect to these inputs. These elasticities can be found by estimating a production function with an appropriate functional form. For this purpose, the current study estimates a Cobb-Douglas production function. This specification has the advantage that it yields direct estimates of production elasticities with respect to various inputs. For this reason, several previous studies on wheat production have assumed the Cobb-Douglas specification.[2] Thus the regression equation specified is linear in the natural logs of the variables.

Wheat output per hectare is assumed to be a function of labor force per hectare, number of tractors per hectare, fertilizer use per hectare, rainfall in the months of November, December, January, February and March, rainfall in the month of April, weighted standard deviation of rainfall in the months of November, December, January, February and March, and lagged wheat output per hectare. The inclusions of the inputs labor, tractors and fertilizer are easily justified. Rainfall in the November to March period is expected to contribute to wheat output because the supply of canal and tube-well water is limited, especially in NWFP, Baluchistan and northern parts of Punjab. The standard deviation of rainfall is included to consider the potential unfavorable effects of volatile rains as compared to consistent rains. Since April is the wheat-harvesting season in most parts of the country, rainfall during this period is considered harmful. Also note that the use of canal and tube-well water is not included in the production function. The reason is that data on water use is available only on an aggregate basis and it is understood that the water use on wheat can vary to a great extent from the overall water use because: a) different crops have different needs of water and b) water availability during the wheat season varies a lot from the water supply in other seasons like July and August. Thus in the case of water inputs, it is more unrealistic to adopt any procedure for estimating the input use for wheat crop based on the given aggregate data as we have done in case of other inputs like fertilizer.

The study proposes the following specification of the production function.

$$\ln Y_t = \beta_1 + \beta_2 \ln L_t + \beta_3 T_t + \beta_4 \ln F_t + \beta_5 \ln R1_t + \beta_6 \ln R2_t + \beta_7 \ln SR_t + \beta_8 \ln Y_{t-1} + u_i \quad (1)$$

[2] See, for example, Qureshi (1974) and Khan et al. (2003).

where

Y_t = Wheat output per hectare
L_t = Labor force per hectare
T_t = Number of tractors per hectare
F_t = Fertilizer use per hectare
$R1_t$ = Weighted average of rainfall in the Months of November, December, January, February and March
$R2_t$ = Weighted average of rainfall in the Month of April
SR_t = Weighted standard deviation of rainfall in the Months of November, December, January, February, and March.
Y_{t-1} = Lagged output per hectare
u = stochastic disturbance term

The future values of various inputs were obtained by estimating a separate Auto Regressive Integrated Moving Average (ARIMA) model for each input for each province. Dynamic forecasts for the required forecasting period are then made using this model. This exercise is performed for each input and for each province separately using the time series data from 1979 to 2006.

To evaluate the ability of the model to accurately forecast wheat output, the entire analysis was conducted using the time period 1979 to 2004, making forecasts for the years 2005 and 2006. These forecasts were then compared with the actual values of wheat output realized in 2005 and 2006 to assess the quality of forecasts.

3. Data and Estimation

3.1 Data

The study uses province-level data for the period 1979 to 2006. Data on wheat output and area under wheat cultivation are taken from the *Agricultural Statistics of Pakistan and Area Production* (By Districts), Ministry of Food, Agriculture and Live-Stock (MINFAL), Government of Pakistan.

The data on the total number of tractors in Pakistan from 1980 to 2006 have been taken from *World Development Indicators*, World Bank, Washington D.C. *Census of Agriculture Machinery* (1975, 1984, 1994 and 2004), and *Census of Agriculture* (1980, 1990 and 2000), Agriculture Census Organization (ACO), Federal Bureau of Statistics, Government of Pakistan.

To calculate the total labor force used in the production of wheat, data on the total population of Pakistan and its four provinces have been taken from the *Economic Survey,* Ministry of Finance, Government of Pakistan. Labor force participation rates and percentages of persons employed in the agricultural sector of Pakistan and its four provinces have been taken from *Labor Force Survey,* Federal Bureau of Statistics, Government of Pakistan.

Data on total fertilizer consumption have been taken from the *Agricultural Statistics of Pakistan,* Ministry of Food, Agriculture and Livestock (MINFAL), Government of Pakistan. Data on the percentage of fertilizer consumption used for the wheat crop have been taken from the *Fifth and Sixth Five Year Plans* and from the *Fertilizer Use Survey*, National Fertilizer Development Centre, Islamabad.

Data on the monthly average rainfall are taken from the *Agricultural Statistics of Pakistan,* Ministry of Food, Agriculture and Livestock (MINFAL), Government of Pakistan.

3.2 Construction of the Variables

Before the construction of various variables used in this study is explained, it may be noted at the very outset that for quite a few variables, specifically fertilizers, tractors and labor, no direct data could be obtained from any source. These variables are constructed on the basis of certain specific assumptions that are explained where used. Thus the data on such variables is likely to suffer from measurement error and hence may introduce bias in the parameter estimates.

Wheat Output Per Hectare

Wheat output per hectare for each province is found by dividing total wheat output in thousand tones in each province by total acreage in thousand hectares.

Fertilizer Per Hectare

To find the consumption of fertilizer for the wheat crop, first province-wise total consumption of three types of fertilizers, nitrogen, potash and phosphate, on all the crops is obtained. Then, their consumption for the wheat crop for each province is calculated according to the

assumptions about its use during different Five Year Plans and according to the percentage allocated to wheat by the National Fertilizer Development Centre, Islamabad (NFDC) in different *Fertilizer Use Surveys* during different time periods.

Weighted Average of Rainfall

Initially, average monthly rainfall in millimeters for the months of November, December, January, February, March and April, for the available stations in each province has been taken. The sum of the weighted average of rainfall of the months of November, December, January, February and March has been used as one explanatory variable, while the weighted average of April has been used as a separate explanatory variable. Weighted average of rainfall has been calculated with the following formula.

Weighted Average of Rainfall in each month: $\overline{X} = \frac{\sum_i W_i R_i}{\sum_i W_i}$

Where R_i and W_i are the rainfall in millimeters and wheat output in thousand tones in each district of each province, respectively. Thus, the districts with more wheat output get a higher weight. For the wheat growing districts for which data on rainfall are not available, the rainfall of the nearest station (nearest in distance) having data on rainfall has been used as a proxy. Note that in the calculation of the weighted average and weighted standard deviation of rainfall we have used wheat output, rather than the area under wheat cultivation as the weight. The weight based on area assigns more importance to the rainfall that falls on a larger area whereas the weights based on wheat output assign more weight to the rainfall that falls on areas producing more wheat and we have preferred the latter weighting scheme. Note that the two weighting schemes produce different results to the extent that the yield per hectare varies across districts.

Weighted Standard Deviation of Rainfall

The weighted standard deviation of rainfall for the months of November, December, January, February and March has been calculated for each province. First, the weighted standard deviations of rainfall for these months are calculated and then the resulting figures are summed to use it as an explanatory variable. Weighted standard deviation of rainfall for each month for each province has been calculated with the help of the following formula.

Weighted Standard Deviation of Rainfall:

$$S = \sqrt{\frac{\sum_i W_i \left(X_i - \overline{X}\right)^2}{\sum_i W_i}}$$

Where W_i is wheat output in thousand tones in each district of each province; X_i is the rainfall of a particular district or the district that was used as a proxy in each province and $\overline{X}$ is the weighted average of rainfall in each month in each province (as calculated above).

Tractors Per Hectare

Data on the total number of tractors in Pakistan from 1980 to 2004 has been obtained from the *Word Development Indicators 2006*. From the *Census of Agriculture Machinery* and *Census of Agriculture*, conducted by the Agriculture Census Organization (ACO), Federal Bureau of Statistics, the share of agricultural tractors in total tractors for each province can be roughly calculated. The *Census of Agriculture Machinery* was conducted in the years 1975, 1984, 1994 and 2004 while the *Census of Agriculture* was conducted in the years 1980, 1990, and 2000. The number of agricultural tractors for the years between the census years has been obtained by exponential interpolation.

Labor Force Per Hectare

The labor force used in the production of wheat, on which no direct data are available from any source, has been calculated as follows. First of all, figures on the total population of Pakistan have been obtained from various issues of the *Economic Survey*. Exact population figures for Pakistan and its four provinces were only available in the census years. These censuses were conducted in 1972, 1981 and 1998. Figures on Pakistan's population for the years that lie between different censuses years are obtained by exponential interpolation.

From the *Labor Force Survey*, conducted by the Federal Bureau of Statistics in different years, data is taken on the total labor force participation rates for each province of Pakistan. From the *Labor Force Survey*, the percentage of employed persons for each province in the agricultural sector can be known. The total labor force employed in agriculture has been calculated by using the labor force participation rates for each province and then applying the percentage of employed persons in the agriculture sector.

From the *Agricultural Statistics of Pakistan*, published by the Ministry of Food, Agriculture and Livestock (MINFAL), total cropped area and area under wheat cultivation are obtained. Fiinally, an estimate for the labor force engaged in growing wheat is obtained by multiplying the proportion of cropped area allocated to the wheat crop by the total labor force in agriculture.

3.3 Estimation Procedure

Equation (1) is initially estimated for each province separately, yielding a total of 32 parameter estimates. The Wald coefficient test is then applied to find common coefficients across provinces. The coefficient of that variable is taken as common for which the null hypothesis of equal coefficients is accepted with the maximum probability value among the variables. The study again applies the Wald test and notes the probability values for the remaining null hypotheses. Again, the coefficient of that particular variable is taken as common among the remaining ones for which null hypothesis is accepted with the maximum probability value. This procedure is continued until null hypotheses for all the remaining variables are rejected.

The study then estimates ARIMA equations for all the independent variables using the data from 1980 to 2004 and makes forecasts for 2005-06. On the basis of these predicted inputs along with the estimated coefficients of the production function, forecasts for wheat output per hectare are made for the years 2005 and 2006. In the specification of the ARIMA model, we must first choose the order of integration (I), and the orders of autoregressive (AR) and moving average (MA) terms. The order of integration is based on the standard ADF test for unit roots. The orders of AR and MA terms are determined on the basis of careful application of the standard diagnostic procedures that include: a) the study of correlogram along with Q-statistics to determine potential orders; b) estimation of the potential model and consideration of t-statistics of parameters associated with various AR and MA terms and re-estimation of the model after excluding redundant variables; and c) application of AIC and SBC criteria in case two competing specifications seem equally good on the basis of correlogram, Q statistics and t-statistics.[3]

After fine-tuning the forecasting model and assessing its quality, the full sample (1979 to 2006) is used to forecast wheat output for the period of 2007-15.

4. Results and Discussions

4.1 Elasticities of Wheat Output

[3] See Enders (2004) for more details on the subject.

Table-1 shows the elasticities of dependent variable (wheat output per hectare) with respect to the independent variables.

Table-1: Elasticities of Wheat Output With Respect to Inputs

Variable	Baluchistan	NWFP	Punjab	Sindh
Acreage	1.45 (2.66)*	1.32 (2.47)**	1.50 (2.62)*	1.75 (3.15)*
Labor Per Hectare	0.11 (2.41)**	0.11 (2.41)**	0.11 (2.41)**	0.11 (2.41)**
Tractors Per Hectare	0.078 (1.89)***	0.078 (1.89)***	0.078 (1.89)***	0.078 (1.89)***
Fertilizer Per Hectare	0.016 (0.39)	0.016 (0.39)	0.016 (0.39)	0.016 (0.39)
Mean Rainfall Nov-Mar	0.044 (4.32)*	0.044 (4.32)*	0.044 (4.32)*	0.044 (4.32)*
Mean Rainfall April	-0.23 (-2.49)**	-0.230 (-2.49)**	-0.23 (-2.49)**	-0.23 (-2.49)**
SD Rainfall Nov-Mar	-0.013 (-1.04)	-0.013 (-1.04)	-0.013 (-1.04)	-0.013 (-1.04)
Lagged Output Per Hectare	0.7405 (8.36)*	0.3709 (2.53)**	0.6664 (6.60)*	0.4936 (4.06)*
System R-Squared	0.90			
System Adjusted R-Squared	0.89			
System Durban Watson	2.37			

Notes:

1. The t-values, shown in parentheses, are marked by *, ** and *** if these are statistically significant at 1%, 5% and 10% levels of significance respectively.
2. Since all the parameters are estimated from one equation allowing for changes in parameters across provinces using a Fixed-Effects Model, there is one value for each of the R-square, adjusted R-square and Durbin-Watson statistics.

The results show that the values of the intercept for the four provinces of Pakistan: Baluchistan, NWFP, Punjab and Sindh, are 1.45, 1.32, 1.50 and 1.75, respectively. These intercept values show variations in the level of output per hectare in the four provinces of Pakistan. The reason for these variations is differences in the climate, nature of soil, variation in the distribution of rainfall not captured by the mean and standard deviation, and

the temperature, etc. It is also apparent from the table that a one percent increase in labor force per hectare leads to a 0.11 percent increase in wheat output per hectare in all the four provinces of Pakistan. The results also show that there is a positive relationship between the number of tractors and wheat output per hectare. A one percent increase in the total number of tractors leads to a 0.078 percent increase in wheat output per hectare.

Similarly, a one percent increase in the application of fertilizer per hectare leads to a 0.016 percent increase in wheat output per hectare in all the four provinces of Pakistan. However, this relationship is not statistically significant. A possible reason for this may be that farmers may not know at what stage and in how much quantity a particular type of fertilizer should be applied for a good crop. The results further show that a one percent increase in rainfall over the November to March period leads to an increase of 0.04 percent in wheat output per hectare. However a one percent increase in average monthly rainfall in the month of April (during which harvesting as well as threshing takes place) leads to a 0.23 percent decrease in wheat output per hectare.

The results also show that a one percent increase in the level of rainfall deviations, as measured by the sum of the standard deviations in rainfall from November to March leads to a 0.013 percent reduction in wheat output per hectare. However, this relationship is not statistically significant. This means that it is the level of rainfall, rather that its fluctuations, which play an important role in determining wheat output per hectare.

Finally, the results show that wheat output per hectare depends significantly on the output level in the previous year. There may be different reasons for this. Firstly, if the farmers enjoy good harvest this year, their income level increases and now they are in a position to spend more on the next crop as the income from one crop is used for the expenditures on the next one or two crops. If this is true, then due to investment on the wheat crop next year, farmers are expected to enjoy a good wheat harvest next year. Secondly, it is possible that farmers spent more time in looking after the crop in the form of better irrigation by private sources and in the forms of application of pesticides etc. as they expect to receive a high support price for their crop. Another interpretation of the significance of lagged output is that it is capturing

technology improvements in the inputs, better quality tractors, fertilizers, general production techniques, etc.[4]

It is also apparent from the results that, except the intercepts and coefficient of lag output per hectare, all the other coefficients are common for the four provinces. The value of R-squared is 0.90 showing that 90 percent of the variation in the dependent variable is explained by the included explanatory variables. The value of the Durban Watson statistic is 2.37, which falls within acceptable limits.

4.2 Estimates of ARIMA Models

First of all we determine the order of integration of all the variables. The application of ADF tests indicates that the dependent variable and included explanatory variables are non-stationary. Furthermore, the first differences of all the variables are stationary. In other words, all the variables are integrated of order one.

The future values for the various inputs are obtained by estimating a separate Auto Regressive Integrated Moving Average (ARIMA) model for each input. Dynamic forecasts for the required forecasting period are then made using this model. This exercise is performed for each input and for each province separately, first using the time series data from 1979 to 2004 to get the future values of various inputs for the period of 2005-06 and then for the period 1979 to 2006 to make forecasts for the period of 2007-15. The reason for estimating the ARIMA model for various inputs for the shorter time period is that the estimates using the 1979-2004 data help in evaluating the ability of the model to forecast wheat output. These forecasts are then compared with actual values of wheat output realized to assess the quality of forecasts. Finally, the full sample (1979 to 2006) is used to forecast wheat output for the period 2007-15.

The results of the parameter estimates of the ARIMA model equations are shown in Tables 2A - 2D for the period 1979 to 2004 and Tables 3A - 3D for the period 1979 to 2006. One can see that out of 152 parameters, 114 are statistically significant. Further scrutiny establishes that eighty parameters are significant at the 1% level, twenty-three parameters are significant at the 5% level, and eleven are significant at the 10% level of significance. Thus the statistical performance of all the estimated models appears quite impressive.

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[4] The authors are thankful to one of the referees of this paper for suggesting this interpretation.

Table-2 A: Estimates of ARIMA Models for 1979-2004 (Baluchistan)

Variable	Intercept	AR(1)	MA(1)	MA(2)	D.W
Acreage	0.0292 (1.39)	-0.5368 (-3.05)*			2.11
Labor Per hectare	0.0303 (1.68)***	-0.7509 (-5.20)*			1.87
Tractors Per Hectare	0.0623 (5.62)*				1.04
Fertilizer Per hectare	0.0600 (14.70)*		-0.7367 (-5.60)*		2.14
Mean Rainfall Nov-Mar	-0.0053 (-0.09)			-0.5480 (-2.92)*	2.07
Mean Rainfall April	0.0009 (0.14)	-0.5517 (3.00)*			2.26
SD Rainfall Nov-Mar	0.0012 (0.03)		-0.3267 (-1.58)	-0.5570 (-2.55)*	1.90

Note: The t-values, shown in parentheses, are marked by *, ** and *** if these are statistically significant at 1%, 5% and 10% levels of significance respectively.

Table-2 B: Estimates of ARIMA Models for 1979-2004 (NWFP)

Variable	Intercept	AR(1)	MA(1)	MA(2)	D.W
Acreage	0.0024 (0.29)		-0.0004 (-0.002)		1.99
Labor Per Hectare	0.0291 (2.55)**	-0.7939 (-5.29)*			1.95
Tractors Per Hectare	0.0525 (4.54)*				0.92
Fertilizer Per Hectare	0.0448 (13.26)*			-0.9791 (-9.05)*	2.50
Mean Rainfall Nov-Mar	-0.0149 (-0.72)	-0.7566 (-5.10)*		-0.9072 (-11.03)*	1.83
Mean Rainfall April	0.0041 (1.81)***		-0.9897 (-2673)*		1.70
SD Rainfall Nov-Mar	-0.0010 (-0.07)		-0.9659 (-14.03)*		1.85

Note: The t-values, shown in parentheses, are marked by *, ** and *** if these are statistically significant at 1%, 5% and 10% levels of significance respectively.

Table-2 C: Estimates of ARIMA Models for 1979-2004 (Punjab)

Variable	Intercept	AR(1)	MA(1)	MA(2)	D.W
Acreage	0.0091 (6.04)*	-0.7886 (-5.76)*		0.9075 (-4.68)*	
Labor Per Hectare	0.0268 (20.97)*	0.3250 (1.45)	-0.9509 (-17.28)*		
Tractors Per Hectare	0.0659 (2.01)***	0.6320 (2.53)**			
Fertilizer Per Hectare	0.0485 (2.75)**				
Mean Rainfall Nov-Mar	-0.0001 (-0.009)			-0.9791 (-8.07)*	
Mean Rainfall April	0.0065 (2.87)*		-0.9460 (-10.03)*		
SD Rainfall Nov-Mar	0.0134 (0.727)	-0.6349 (-3.67)*		-0.9392 (-11.40)*	

Note: The t-values, shown in parentheses, are marked by *, ** and *** if these are statistically significant at 1%, 5% and 10% levels of significance respectively.

Table-2 D: Estimates of ARIMA Models for 1979-2004 (Sindh)

Variable	Intercept	AR(1)	AR(2)	MA(1)	MA(2)	Dummy	D.W
Acreage	0.0125 (2.12)**					-0.3571 (-11.87)*	1.78
Labor Per Hectare	0.0172 (1.69)***	-0.5928 (-3.29)*					1.60
Tractors Per Hectare	0.0483 (4.13)*						0.90
Fertilizer Per Hectare	0.0340 (13.55)*			-0.9324 - (14.99)*			1.27
Mean Rainfall Nov-Mar	0.0040 (0.11)	-0.5046 (-2.62)**			-0.9537 (-23.87)*		2.02
Mean Rainfall April	0.0013 (0.16)	-0.4767 (-2.499)**					2.23
SD Rainfall Nov-Mar	-0.0007 (-0.07)	-0.4948 (-2.52)*	- 0.6500 (-3.45)*	-0.9894 (-2164)*			1.76

Note: The t-values, shown in parentheses, are marked by *, ** and *** if these are statistically significant at 1%, 5% and 10% levels of significance respectively.

Table-3 A: Estimates of ARIMA Models for 1979-2006 (Baluchistan)

Variable	Intercept	AR (1)	MA (1)	MA (2)	D.W
Acreage	0.0294 (1.25)	-0.5317 (-3.10)*			2.06
Labor Per Hectare	0.0296 (1.75)***	-0.7273 (-5.52)*			1.94
Tractors Per Hectare	0.0621 (6.10)*				1.63
Fertilizer Per Hectare	0.0599 (15.75)*		-0.7316 (-5.77)*		2.15
Mean Rainfall Nov-Mar	-0.0182 (-0.28)			-0.4849 (-2.18)**	2.05
Mean Rainfall April	0.0002 (0.03)	-0.560 (-3.21)*			2.26
SD Rainfall Nov-Mar	0.0147 (-0.37)		-0.6930 (-4.27)*		1.72

Note: The t-values, shown in parentheses, are marked by *, ** and *** if these are statistically significant at 1%, 5% and 10% levels of significance respectively.

Table-3 B: Estimates of ARIMA Models for 1979-2006 (NWFP)

Variable	Intercept	AR (1)	MA (1)	MA (2)	D.W
Acreage	0.0012 (0.16)				1.97
Labor Per Hectare	0.0256 (2.22)**	-0.7281 (-4.96)*			1.97
Tractors Per Hectare	0.0514 (4.83)*				1.47
Fertilizer Per Hectare	0.0447 (10.63)*			-0.9192 (-31.99)*	2.34
Mean Rainfall Nov-Mar	-0.0101 (-0.53)	-0.8326 (-5.75)*		-0.8817 (-14.07)*	1.80
Mean Rainfall April	0.0039 (1.68)***		-0.9538 (-12.05)*		1.70
SD Rainfall Nov-Mar	-0.0820 (-2.58)**		-1.4956 (-4.97)*		1.73

Note: The t-values, shown in parentheses, are marked by *, ** and *** if these are statistically significant at 1%, 5% and 10% levels of significance respectively.

Table-3 C: Estimates of ARIMA Models for 1979-2006 (Punjab)

Variable	Intercept	AR (1)	MA (1)	MA (2)	D.W
Acreage	0.0092 (19.54)*	-0.8638 (-11.06)*		0.9796 (-4732)*	1.79
Labor Per Hectare	0.0256 (9.60)*	0.4346 (2.29)**	-1.76 (-4.78)*		2.44
Tractors Per Hectare	0.0522 (3.11)*	0.3302 (1.64)			2.13
Fertilizer Per Hectare	0.0533 (3.12)*				2.29
Mean Rainfall Nov-Mar	-0.0033 (0.15)	0.2901 (1.55)	-0.9618 (-20.67)*		1.72
Mean Rainfall April	0.0057 (0.57)		-0.9895 (-6.90)*		1.86
SD Rainfall Nov-Mar	0.0043 (0.28)			-0.9377 (-23.27)*	1.88

Note: The t-values, shown in parentheses, are marked by *, ** and *** if these are statistically significant at 1%, 5% and 10% levels of significance respectively.

Table-3 D: Estimates of ARIMA Models for 1979-2006 (Sindh)

Variable	Intercept	AR (1)	AR (2)	MA (1)	MA (2)	Dummy	D.W
Acreage	0.0138 (2.46)**					-0.3584 (-12.03)*	1.73
Labor Per Hectare	0.0171 (1.47)	-0.9321 (-7.64)*		0.5993 (2.28)**			1.97
Tractors Per Hectare	0.0470 (4.37)*						1.43
Fertilizer Per Hectare	0.0364 (10.54)*	0.3001 (1.32)		-0.9510 -(21.55)*			1.82
Mean Rainfall Nov-Mar	0.0313 (0.65)	-0.4258 (-2.05)**			-0.8732 (-6.74)*		1.87
Mean Rainfall April	0.0026 (2.06)***			-0.9895 (-4492)*			1.86
SD Rainfall Nov-Mar	-0.0065 (0.42)	-0.4138 (-2.09)**	-0.7015 (-3.56)*	-0.91 (-6.56)*			1.59

Note: The t-values, shown in parentheses, are marked by *, ** and *** if these are statistically significant at 1%, 5% and 10% levels of significance respectively.

The presence of autoregressive trends as shown by the ARIMA equation results implies that in about half of the cases (26 of 56) there exists a strong autoregressive process of order one, that is, an AR(1) process. This means that the turbulence experienced throughout the time period under consideration is significantly related to the occurrences in the previous period. The AR(1) process has been justified on the basis of geometric decline in the autocorrelation function (ACF). This means that the shocks in output per hectare experienced during a period have a rigid relationship with future output. This effect declines in severity with the passage of time. One can also see that in the province of Sindh, AR(2) is present in the weighted standard deviation of rainfall in the months of November to March for both the periods i.e. in 1979-2004 and 1979-2006.

The moving average (MA) or temporary disturbance terms are also present in most cases. The order of the MA process determines the nature of the one-off relationship between the current and past fluctuations in wheat output. For example, with an MA(1) process, a shock occurring in one period will have an effect on the wheat output per hectare in the next

period. This shock is, however, eliminated from the system within one period. The results show that 20 out of 56 cases experience an MA(1) process while in 14 out of 56 cases an MA(2) process exists.

The results also showed that the dummy variable used in the acreage ARIMA equation for the province of Sindh (representing some shock), is significant at the 1% level of significance. In 2000, wheat output in the province of Sindh declined from 1144.2 thousand tones to 810 thousand tones in 2001. So the use of the dummy variable is justified.

It is also apparent from the results that the intercepts of the estimated ARIMA equations are significant in 32 out of 56 cases. Since the intercept measures the systematic component, it follows from a non-zero intercept that the average growth rate of a particular independent variable is non-zero. Out of 56 intercept estimates, 10 have a negative sign and one (the weighted standard deviation of rainfall from November to March in NWFP) is statistically significant, implying that the average growth rate of this independent variable is negative and significant. On the other hand, the estimates of 46 out of 56 intercepts are positive and 31 are statistically significant, indicating that the average growth rate of these independent variables is positive and significant.

4.3 Results of Forecast Errors for Pakistan and its Four Provinces

Tables 4A – 4E show the results of predicted output, actual output, forecast error (the difference of actual and predicted output) in thousand tones and percent forecast error for Pakistan and its four provinces for 2005, 2006 and combined forecast error (average of 2005 and 2006 error) for 2005-06. As is apparent from the results presented in Tables 4A – 4D, forecast errors as well as percent forecast errors are positive for Baluchistan province, while negative for NWFP and Sindh provinces for the years 2005 and 2006. Combined forecast error for the year 2005-06 is also positive for Baluchistan province and negative for NWFP and Sindh provinces. Forecast error is negative in year 2005 and positive in year 2006 for Punjab province. Combined forecast error for the period 2005-06 for the Punjab province is negative. As far as overall Pakistan is concerned, forecast error is negative in 2005 and positive in 2006. Combined forecast error for the period 2005-06 for overall Pakistan is negative. As forecast error is the difference between actual and predicted wheat output, a positive forecast error means that actual wheat output is greater than its predicted value: therefore wheat output is underestimated and vice versa. In any case, the overall forecast error for Pakistan is small; as a result the model proposed and estimated in this paper performs satisfactorily.

Table-4 A: Wheat Forecast in Thousand Tones (2005-06 Baluchistan)

Years	Actual Output	Predicted Output	Forecast Error	Percent Forecast Error
2005	738.01	637.60	100.41	15.75
2006	715.01	649.90	65.11	10.02
2005-06	1453.02	1287.50	165.52	12.68

Table-4 B: Wheat Forecast in Thousand Tones (2005-06 NWFP)

Years	Actual Output	Predicted Output	Forecast Error	Percent Forecast Error
2005	1070.84	1091.10	-20.26	-1.86
2006	1093.82	1100.60	-6.78	-0.62
2005-06	2164.66	2191.70	-27.04	-1.23

Table-4 C: Wheat Forecast in Thousand Tones (2005-06 Punjab)

Years	Actual Output	Predicted Output	Forecast Error	Percent Forecast Error
2005	16730.01	17375.00	-644.99	-3.71
2006	17065.47	16776.00	289.47	1.73
2005-06	33795.48	34151.00	-355.52	-1.04

Table-4 D: Wheat Forecast in Thousand Tones (2005-06 Sindh)

Years	Actual Output	Predicted Output	Forecast Error	Percent Forecast Error
2005	2243.21	2508.60	-265.39	-10.58
2006	2455.52	2750.30	-294.78	-10.72
2005-06	4698.73	5258.90	-560.17	-10.65

Table-4 E: Wheat Forecast in Thousand Tones (2005-06 Pakistan)

Years	Actual Output	Predicted Output	Forecast Error	Percent Forecast Error
2005	20782.07	21612.3	-830.23	-3.99
2006	21329.82	21276.8	53.02	0.25
2005-06	42111.89	42889.1	-777.21	-1.85

The forecast errors are the largest for the province of Baluchistan followed by Sindh. A possible reason for the large forecasting error for Baluchistan is that this province has been subject to greater volatility in weather conditions, which are not entirely captured by our rainfall variables. Another reason could be that Baluchistan is area-wise the largest province but population-wise (by far) the smallest. Wheat is grown on small farms scattered across rugged lands and, therefore, it is difficult to collect accurate data on inputs and output of wheat. As far as the large forecasting error in Sindh is concerned, there is no obvious interpretation that one can provide. One possible reason could be that wheat growing in this province relies heavily on floodwaters in river Indus, for which we do not have any variable in our model. These floods normally occur in the months of July, August and September and provide a new and fertile layer of earth and the needed moisture for the wheat growing that takes place in September and October.

4.4 Wheat Forecasts for the Period 2007-15

Forecasts for wheat output are made for Pakistan and its four provinces for the period of 2007 to 2015 and are reported in Table-5. The predicted wheat output has a positive trend over the period 2007-2015 for Pakistan and its four provinces.

Table 5: Wheat Forecasts in Thousand Tones (2007-15)

Year	Baluchistan	NWFP	Punjab	Sindh	Pakistan
2007	734	1080	16436	2716	20967
2008	765	1095	16433	2707	21000
2009	833	1098	16512	2689	21132
2010	874	1117	16732	2747	21470
2011	928	1126	16977	2826	21856
2012	972	1144	17306	2855	22276
2013	1020	1155	17638	2913	22725
2014	1065	1172	18026	2992	23255
2015	1112	1184	18410	3078	23785

The growth rate of actual as well as predicted wheat output for Pakistan and its four provinces for the period 2001 to 2015 are reported in Table-6. The table shows actual annual growth rates for the period 2001 to 2006 and predicted growth rates for the period 2007 to 2015. The growth rate of wheat output is positive, ranging from 1.3% in 2004 to 16% in 2001, for the province of Baluchistan for the whole period except in 2005 when it is negative (-3.9%). Wheat output growth rates (actual and predicted) are positive for the province of NWFP, ranging from 0.3% in 2009 to 19.5% in 2003, but were negative in the years 2001, 2004, and 2007.

Table 6: Growth Rates of Wheat Output (Actual and Predicted)

Years	Baluchistan	NWFP	Punjab	Sindh	Pakistan
2001	16.0	-28.5	-6.4	-25.8	-9.7
2002	4.3	16.6	-5.3	-5.6	-4.2
2003	2.2	19.5	5.2	0.4	5.2
2004	1.3	-3.7	1.8	3.0	1.6
2005	-3.9	6.4	11.1	15.5	6.6
2006	1.9	0.9	-3.4	9.6	2.6
2007	13.0	-1.9	-2.0	-1.2	-1.7
2008	4.2	1.4	0.0	-0.3	0.2
2009	8.9	0.3	0.5	-0.7	0.6
2010	5.0	1.7	1.3	2.2	1.6
2011	6.1	0.8	1.5	2.9	1.8
2012	4.7	1.6	1.9	1.0	1.9
2013	5.0	1.0	1.9	2.0	2.0
2014	4.4	1.5	2.2	2.7	2.3
2015	4.4	1.0	2.1	2.9	2.3

Similarly, the growth rate of wheat output was negative in years 2001, 2002, 2006 and 2007 but predicted to be positive for the remaining years for the province of Punjab. The actual and predicted growth rates of wheat output were also negative for the province of Sindh in 2001, 2002, 2007, 2008 and 2009 but is positive for years. As far as Pakistan is concerned, wheat output growth rate is positive except for the three years i.e. 2001, 2002 and 2007 when growth rate was negative.

5. Conclusion

The study finds that lagged output per hectare is the most important factor in determining the current output per hectare in all the four provinces of Pakistan. The other two important variables in determining the current outputs are labor force per hectare and tractors per hectare. The sum of the rainfall in the months of November, December, January, February and March is another important variable in the determination of output.

Wheat forecasts are made for Pakistan and its four provinces using the ARIMA forecasting models for all the inputs for the period of 2005 and 2006. Wheat forecasts errors are negative for the provinces of NWFP, Punjab and Sindh, and positive for the province of Baluchistan, in 2005. These results imply that in 2005, wheat output is overestimated for NWFP, Punjab and Sindh provinces and for overall Pakistan, and underestimated for the Baluchistan province. On the other hand, in 2006, forecast errors are negative for the provinces of NWFP and Sindh, and positive for the provinces of Baluchistan and Punjab. In 2006, wheat output is overestimated for the NWFP and Sindh provinces and underestimated for the Baluchistan and Punjab provinces and for overall Pakistan. As far as overall Pakistan is concerned, wheat output is overestimated and underestimated in 2005 and 2006, respectively. The combined forecast error for overall Pakistan, for the years of 2005 and 2006, is only 1.85%, which implies that on average, wheat output is slightly underestimated for the combined period 2005-2006.

An important conclusion is that wheat forecast errors for Pakistan are mainly determined by the direction and size of forecast error in Punjab, by far the largest contributor to wheat supply in Pakistan. Thus, it is of utmost important to expedite research efforts on making reliable forecasts, especially in the province of Punjab.

Wheat forecasts show positive growth for the period 2007 to 2015, after forecasting for the period of 2005 and 2006. In 2007, the growth rate of total wheat output is negative for the provinces of NWFP and Punjab and for

overall Pakistan while it is negative for the province of Sindh in 2008 and 2009.

The forecasts show that in the next eight years wheat output will on average grow at a rate of 1.6%, which is slightly less than the expected growth rate of population. So Pakistan is likely to see a slight shortfall in the supply of wheat, which can be overcome by taking appropriate steps like timely import of wheat, maintenance of strategic wheat reserves, bringing the wheat price for farmers closer to the world price and removal of other distortions.[5]

The study finds that the expected growth in wheat output is the highest in Baluchistan and lowest in NWPF. The growth in Punjab is also expected to be on the lower side. Thus, if the population and income levels continue to grow at the existing pace, Punjab will no longer be able to provide sufficient surplus output to feed the smaller provinces.

[5] Since the present study is mainly confined to forecasting based on the production function, it cannot be used to make precise policy prescriptions for which other studies exist.

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A Case Study of Milk Processing: The Idara-e-Kissan Cooperative

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Abstract

The paper focuses on Idara-e-Kissan, a vertically integrated cooperative in the dairy sector, which procures fresh milk, processes it and uses the profits earned in urban milk product markets to provide development services to member farmers. The analysis suggests that, compared to a control group of non-members, the cooperative's members had 29% higher net returns per milk animal, 9% more milk buffaloes, 6% fewer dry buffaloes and they used three times more milk fat-enhancing cottonseed cake. The members had better access to animal vaccination, artificial insemination, and visits from livestock extension workers; they were able to secure more animal treatments per year, and reported greater satisfaction with service provision. The cooperative's successes were more modest in areas where the benefits of inputs and services provided were more public, e.g. livestock breed improvement and enhancing fodder productivity, indicating that there is an important role for the government in supplying public goods such as livestock/agriculture R&D.

JEL Classification: L66, Q12, Q16, Q18

Keywords: Milk, Dairy, Livestock, Cooperative, Pakistan

I. Introduction

Pakistan's agricultural development strategy has in the past focused heavily on crops and tended to ignore the other sub-sectors within agriculture, including livestock. The motivation for this asymmetric emphasis came from the requirement to ensure food security by developing the capacity to produce enough grains for a large and growing population, and the need to provide raw materials to the industrial sector that was heavily concentrated in cotton textiles. These efforts, along with the availability of seed fertilizer technologies, contributed to the onset of the Green Revolution, which had a profound impact on the structure of

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Pakistani agriculture. As discussed below, one of these interesting consequences was a change in herd composition within the livestock sector in favor of milch cows and buffalos and a reduction in the number of male bulls. This created tremendous potential for milk production without adding significantly to the demand for feed and fodder resources.

The milk production system in Pakistan is characterized by large numbers of small, geographically dispersed dairy producers who have marketable surpluses of milk but face diseconomies of scale in marketing it to demand centers in distant urban areas. The traditional middlemen who procure milk from rural areas close to the cities offer at best modest returns to the farmers. In the past couple of decades, two institutional developments have taken place in the milk processing sector. One is the penetration by large commercial dairy processing firms that procure milk from farmers, process it, and produce a range of milk products that are marketed in urban markets. The other is a vertically integrated farmers' cooperative that not only procures milk from member farmers but also provides them with development services aimed at increasing productivity. This paper is a case study of *Idara-e-Kissan* (IK), a farmers' cooperative operating in the milk processing sector. IK owns milk processing plants and markets its products in urban centers all over the country.

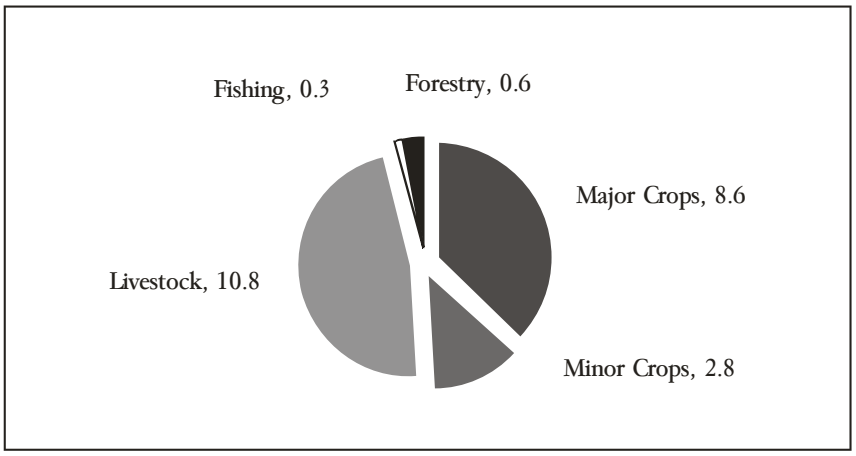
The next section highlights the economic significance of the livestock sector and reviews livestock policies. The two sections that follow describe (respectively) livestock production and marketing systems. The methodology of the paper is discussed in Section V. This is followed in Section VI by a close look at the *Idara-e-Kissan* cooperative, its institutional model, and its operations. Economic analysis of returns on milk production of IK members and a control group of non-members is presented in the next section. Based on this analysis, Section VIII identifies the successes and limitations of the cooperative. The final section draws conclusions.

II. The Livestock Sector in Pakistan

Economic Significance of the Livestock Sector

The livestock sector is the single largest sector within agriculture, contributing a little under half (46.8%) of agricultural value added. Its share in national GDP is 10.8%. The total value of livestock products in 2004-05 was Rs 484,216, which is more than the combined value of all major crops e.g. cotton, wheat, rice, and sugar cane. During the last five years, the average growth rate of the livestock sector was 3.2% per annum compared to 2.4% for the major crops.

Figure-1: Contribution of Agricultural Sub-Sectors to GDP (% Shares)



It is estimated that 30-35 million people are engaged in livestock related activities and generate 30-40% of their income from livestock enterprises. This supplemental income is very significant in view of the tendency of the declining size of ownership holdings in agriculture and the growing number of the landless in the rural economy. Livestock enterprises are particularly important for the landless and small farmers because livestock provides an alternative form of asset ownership, independent of land. For these poorer segments of the rural population, livestock ownership acts as insurance in the event of crop failure and provides a repository of household saving that can be liquidated in case of emergencies. Finally, for subsistence farmers, livestock products in the form of fresh milk and butter or *desi ghee* provide food security for the family and help meet nutritional requirements in terms of calories and protein.

An observation made during the present study was that in contractual milk supply arrangements, the daily supplies of fresh milk can serve as collateral that can be used by small farmers and landless livestock holders to obtain short term credit from the milk buyer (usually traditional *dodhi*[1] or even VMC).[2] This is noteworthy since the small farmers and

[1] The traditional milk collector who goes from door to door collects the milk and sells it to other consumers in the village, nearby town, or to milk shops or *beoparis/dodhis* from the town.

[2] Village milk collector, a term popularized by commercial milk collectors such as Nestle, *Idara-e-Kissan* and others, refers to the person collecting milk from farmers on their behalf. The VMC does not go from door to door but maintains a fixed place in the village where the individual farmers bring their milk.

landless workers have very limited access to credit because of a lack of assets that could serve as collateral. This issue will be taken up in more detail in a later section.

Livestock Policies

The First Five Year Plan (1955-60) document mentions a number of problems facing the livestock sector.[3] Livestock herds had been depleted when evacuees took livestock heads with them while the incoming refugees slaughtered livestock to meet their food needs. The imbalance between supply and demand worsened further because the proportion of meat eaters in the population increased.[4] The requirements for draft power in agriculture placed further demands on the meager livestock population. The livestock breeding farms were producing inadequate numbers of superior breed bulls for distribution. At the same time, there were inadequate feed resources available within the country. Animals was undernourished and disease prone. It was estimated that 15 *lakh*[5] male buffalo calves died each year due to starvation. With only 500 veterinary hospitals and dispensaries available in the country, either the farmers had to bring sick animals from long distances to the veterinary facilities or the veterinary staff had to travel the same distance to reach them. Effective control of disease and the provision of health treatments for the animals were very difficult under these circumstances.

Livestock was reared mostly in rural areas while milk and milk products were consumed both in rural and urban areas. Because the marketable surplus of milk available with individual farmers was too small to justify a trip to the nearest town, it was sold to middlemen who often exploited the farmers by charging an amount in excess of the cost of their services, reducing farmers' returns on the one hand and charging higher prices to the consumers on the other. The Plan document noted that some milk production also took place in 'congested and insanitary pockets by *gujar* colonies in the heart of cities, where animals were kept in unhygienic conditions with the result that the milk was generally contaminated.'

[3] Government of Pakistan (1957), First Five-Year Plan 1955-60, National Planning Board.

[4] This was due to in-migration of meat eating Muslims from India and out-migration of mostly vegetarian non-Muslims.

[5] 1 *lakh* = 100,000.

To deal with the myriad of problems, some of the Plan recommendations were:[6] (i) promoting production of superior breed bulls at subsidized private farms from where the government would procure these animals at ***controlled prices*** for distribution to villages, (ii) emphasis on preventing disease among animals through vaccination and inoculation, with legislation for compulsory mass inoculation to be put in place if there was a 'lack of willing cooperation' from farmers, (iii) removal of livestock from within cities to outskirts, particularly removing *gujar* colonies from Lahore, establishing them outside the towns, and making provision for the government to purchase milk produced by *gawalas* for 'clarifying, straining, cooling and pasteurizing it before distribution to registered depots where it would be sold to consumers in sealed bottles to avoid adulteration; the milk produced outside cities was to be 'checked and tested for purity' and the violators punished, (iv) re-organization of the dairy industry, especially encouraging the small farmers to specialize in dairy farming by keeping about six cows, producing much of the needed feed, and joining together in cooperatives to 'assemble, transport and *perhaps* to process milk [emphasis added].'

The purpose of the above review of the livestock component in the First Five-Year Plan is twofold. First, is to provide a sort of benchmark that would be readily comparable with later policies and developments in the sector. It is clear that the government wanted to keep production in the private sector but saw an important role for itself in marketing, distribution and even processing of livestock and livestock products. It would not hesitate to intervene in the market to alter prices. It sought to institute administrative controls, rather than providing incentives, to address milk quality issues and preferred to replace a whole class of marketing intermediaries with state procurement agencies for the purpose of ensuring compliance with hygienic standards. More interestingly, it anticipated that any collective action in the milk production system would most likely occur through a bottom up process starting with the collection and transportation of milk. Farmers' collectives engaged in the processing of livestock products, while being desirable and in the realm of possibilities, were in its opinion relatively less likely.

Second, while some of the problems mentioned in the First Plan document have been addressed, many remain unresolved even today. It is important to understand (i) which problems have been addressed satisfactorily and which continue to exist, and (ii) whether it is possible to categorize areas of success from areas of failure. The respective

[6] This list of Plan recommendations is not exhaustive. For a full range of recommendations and more details see Government of Pakistan (1957), pp. 246.

commonalities within 'successes' and within 'failures' may hold clues to what works, what does not, and why. We will return to these issues towards the end of this paper.

Reviewing past government policies in the livestock sector, Burki et al (2005) note that the Second Five Year Plan, which shifted the focus towards large-scale manufacturing development, was unable to address the issue of increasing milk production capacity. The authors point out that the seed-fertilizer-water revolution overshadowed non-crop agricultural issues, such as those in the livestock sector. The only exception was perhaps the fact that milk supply schemes for Lahore and Karachi envisaged under the First Plan became operational, and in the late sixties with UNICEF support, subsidized milk was made available in Karachi to low-income families and school children. Both plants however shut down later as government patronage was withdrawn.

A positive spin-off of the industrialization strategy pursued by the government was in the form of 23 milk pasteurization and sterilization plants being set up in the country that relied mostly on recombining and pasteurizing skimmed milk imported under the World Food Program [Anjum et al, (1989)].[7] However, there was limited consumer acceptability of 'recombined milk and its short shelf life.' As a result, these plants failed, indicating that the inability to ensure a supply of fresh milk was a major constraint to the successful development of the milk processing industry (Burki et al, 2005). Fresh milk, however, could only be collected from geographically dispersed farmers with limited marketable surplus. At the time, market mechanisms were not adequately developed to perform this task.

The combination of government incentives to the manufacturing sector[8] in the late seventies and the introduction of ultra high temperature (UHT) milk, along with aseptic packaging material, led to renewed interest in milk processing. But consumer demand was not strong, probably due to the high prices of UHT milk and low household incomes.[9] The emphasis shifted in the eighties towards corporate farming to increase the supply of livestock products while the government focused on animal breeding, nutrition, and creating conditions conducive to induce private investment in

[7] Cited in Burki et al, ibid.

[8] These included tax exemptions, duty free machinery imports and domestic and foreign currency financing.

[9] The price data for UHT milk is not available for the late seventies but a comparison of its price with that of fresh milk in 1994 (the first year when both prices are available) shows that the real price of UHT milk was more than 100% higher than the price of fresh milk.

the sector. Sadly, significant progress could not be made on either front during that period or subsequently in the nineties.

In retrospect, perhaps the single most important factor contributing to increased milk production in Pakistan was the unintended consequence of the Green Revolution era policies, particularly, tractorization. With increasing numbers of tractors imported into the country and later assembled locally, the need to maintain male buffaloes and bullocks for draught purposes diminished, thus freeing up feed and fodder resources that allowed the average herd composition to shift in favor of female cows and buffaloes. A comparison of the results of the 1986 and 1996 Livestock Censuses indicates that in the inter-census period, the population of bullocks reported to be 'for work' declined by 33.5%.[10] Thus, increased milk production came largely from increased numbers of milk animals.

Recent livestock policies aim at increasing private sector participation, raising the productivity of livestock and milk production systems, and enhancing the growth rates of both milk and meat products.[11] The growth in milk and meat production was 3.0% and 2.7% respectively during 2006-07. The Medium Term Development Framework envisages raising the growth rate of milk production to a level between 8.0% to 10% by the year 2010. Similarly, the MTDF target for the meat production growth rate is set at 8.5% by 2010. Key policy initiatives include the deregulation of milk and meat prices, strengthening the policy and regulatory capacity of MINFAL, streamlining credit availability, and creating a level playing field for the local dairy industry.

Current Livestock Policies

It is clear that, unlike the early livestock policies reviewed above, the current policies are more market oriented. The government seems to be moving away from directly intervening in the markets and carving a role for itself in processing and distribution. The emphasis now is on encouraging the private sector to operate in these spheres and regulating its activities, rather than replacing it with the public sector. However, as the analysis in this paper shows, although the private sector and especially cooperatives have tremendous potential in enhancing productivity in the sector, there are critical areas where the private sector may not be able to operate on its own

[10] Government of Pakistan (1998), 'Livestock Census 1996-Punjab,' Agriculture Census Organization, Statistics Division, Lahore.

[11] See MINFAL, Food Agriculture & Livestock Division, Livestock Wing website http:///www.pakistan.gov.pk/divisions/ContentInfo.jsp?DivID=10&cPath=91_97560&C otntentID=5335.

without government support. These areas are primarily those requiring government investments in providing public goods required by the sector. The central message of this paper is that a basis for healthy division of labor exists between the private and public sectors, whereby both focus on activities in which they enjoy their respective comparative advantage.

Cooperatives Movement in Pakistan

This section briefly reviews the cooperatives movement in Pakistan with a view to providing background for a case study of *Idara-e-Kissan*. The cooperative movement dates back to the British-era Cooperative Credit Societies Act, 1904. After independence, cooperatives expanded in scope to include commercial activities, but in 1952 due to inefficiency and mismanagement, the government directed the movement to withdraw from these activities upon the recommendation of the Cooperative Inquiry Committee (Sarwar et al, 1986). The Cooperatives Development Board was established in 1962 and it successfully implemented projects in agricultural credit, marketing and processing. The Board was abolished in 1966. Several ordnances issued by the government thereafter curtailed the autonomy of the cooperatives movement. In 1976, the Federal Bank of Cooperatives was established to provide credit facilities to Provincial Cooperatives Banks and to regulate them. At present, cooperatives are the responsibility of the provincial governments and are registered with the Registrar of Cooperative Societies.

Attempts were made in the mid-1970s to extend activities of cooperatives to the dairy sector but success was modest due to constraints related to poor infrastructure and private sector intervention (Uotila and Dhanapala, 1994). However, the experience of *Idara-e-Kissan* has been encouraging in collecting, processing and marketing milk and milk products, using the cooperative model. More recently, the Competitiveness Support Fund has decided to provide a grant for the Balochistan Dairy Cooperative Project. A Memorandum of Understanding has been signed for the Dairy Cooperative between the Balochistan Rural Support Program (BRSP), the University of Balochistan, SMEDA, and the Livestock and Dairy Development Department, Quetta.[12]

III. Livestock and Milk Production System in Pakistan

The Livestock Census 2006 indicated that there were 27 million buffaloes and 30 million cattle in the country. About 65% of buffaloes were

[12] Dairy Strategy Working Group, see http://www.psidac.com/ver/2/index.php?m=static&e=dairy.

found in the Punjab, followed by 27% in Sindh; the shares of NWFP and Balochistan were small. Likewise, slightly fewer than half the cattle were found in the Punjab, 23% in Sindh, 20% in NWFP and 8% in Balochistan (Table-1a).

Table-1a: Livestock Population and its Regional Distribution

	Cattle	Buffaloes	Sheep	Goats	Camels	Horses	Mules	Asses
	In Million							
Pakistan	29.56	27.33	26.49	53.79	0.92	0.34	0.16	4.27
Province	Per Cent Distribution							
NWFP	20	7	13	18	7	22	43	13
Punjab	49	65	24	37	22	47	41	52
Sindh	23	27	15	23	30	13	12	24
Balochistan	8	1	48	22	41	18	4	11

Source: Livestock Census, 2006.

The livestock population includes a range of large and small animals including buffaloes, cattle, camels, horses, mules, goats, sheep and poultry. Data on the populations of selected types of livestock are presented in Table-1b.

Table-1b: Livestock Population in Pakistan (million)

Year	Buffaloes	Cattle	Goat	Sheep
1990-91	17.8	18.7	37.0	26.3
1995-96	20.3	20.4	41.2	23.5
2000-01	23.3	22.4	49.1	24.2
2004-05 (P)	26.3	24.2	56.7	24.9

Source: Pakistan Economic Survey, 2004-05.

Since 1990-91, the population of milk animals increased from 17.8 million buffaloes and 18.7 million cattle, to 26.3 million buffaloes and 24.2 million cattle. During this period the buffalo growth rate was higher at 3.4% compared to the growth rate in the cattle population, which was only 2.2%. The data from the 1986 and 1996 Censuses suggest that in-milk cows

increased 60% during the decade compared to an increase of 36% in the numbers of in-milk buffaloes.[13] The population of goats has also increased over the last fifteen years, but their contribution to total milk supply is small.

Table-2: Production of Fresh and UHT Milk (million liters)

Year	Fresh Milk	UHT Milk
1971-72	6,181	
1975-76	7,562	
1980-81	9,730	
1985-86	12,519	
1990-91	16,108	
1995-96	20,725	91.4
2000-01	26,284	194.2
2004-05 (P)	29,472	354.9 (predicted)

Sources: Economic Survey of Pakistan 2004-05, and Burki et al, 2005.

The increase in the livestock population, particularly of in-milk cows and buffaloes, is reflected in increased milk production in the country.

The supply of fresh milk has increased at an average annual growth rate of 11.4% between 1971-72 and 2004-05. Looking at the period covered by the two livestock censuses (i.e. 1986-1996), the average annual growth rate of fresh milk supplies was 6.6%.

A more recent phenomenon has been the rapid increase in the supply of UHT milk. The supply of UHT milk, which was only 91.4 million liters in 1995-96, increased to 305.2 million liters in 2003-04, registering a growth rate of 29.2% per annum during this period. The phenomenal growth in supplies of processed milk indicates that Pakistan's dairy sector is coming of age. This has been a result of a structural change that is beginning to take place in the milk collection, marketing, processing and distribution systems. The institutional innovations that accompany this shift are quite interesting and form the key focus of this case study. Before proceeding to a more formal analysis of these shifts, we look at milk production systems in Pakistan.

[13] See Government of Pakistan (1998), 'Livestock Census 1996,' Agriculture Census Organization, Statistics Division, Gulberg, Lahore. Also see Burki, et al, 2005.

A general typology of milk production systems in Pakistan is presented below based on previous studies that identify the following four dairy production systems.[14]

Rural Subsistence Small Holdings: These farmers have no more than 2-3 animals, including young stock, and produce mainly to meet family needs. The input use levels in this group are very low.

Rural Market Oriented Small Holdings: These consist of mostly stall-fed herds of fewer than six animals. To enhance milk production, farmers add concentrates to the feed, consisting of green fodder and straw. According to the 1996 Livestock Census, about 82-83% of the households owning cattle and buffaloes own up to six animals (Burki et al, 2005). The majority of the milk-selling households belong to this category, which provides the bulk of the marketed milk supply.

Rural Commercial Farms: This group comprises specialized dairy farms and mixed crop-livestock farms having more than 40 animals, mostly buffaloes. Because of economies of scale and the availability of adequate financial resources, it becomes possible to maintain breeding bulls on such farms. Many farmers in this category pursue breed development and keep highly productive milk animals. Although these farms tend to have a high turnover and are more organized, their overall contribution to total milk supply is insignificant because of their small numbers, as less than 0.5% of total dairy households have herds of this size.

Peri-Urban Commercial Dairy Farms: This system flourishes around all the big cities in the form of *gawala colonies*. The typical herd sizes range from 15-50 animals, mostly buffaloes. This is a high-turnover, high-cost system. Their cost disadvantage stems primarily from their distance from cheap fodder sources in agricultural hinterlands. As a result, the *gawalas* keep only the animals that are lactating or very close to the lactation stage. Dry buffaloes and cows are either sold back to farmers or to the slaughterhouses. However, marketing margins for this group tend to be high because there are few or no market intermediaries between them and the final consumers.

Sharif et al (2003) suggest that 80% of milk is produced in rural areas, another 15% in peri-urban areas and about 5% is produced in cities.[15] The study estimates that 90% of marketed milk is from what it describes as 'subsistence farmers' and the remaining is supplied by commercial farms.

[14] See for example, Sharif et al (2003), which presents a similar typology following Ather and Raja (2002), and Mohyuddin and Wahla (1994). Also see Burki et al (2005).
[15] See p. 25.

The former category is broadly defined and seems to include what the above typology describes as the "rural market-oriented small holdings" because the really small subsistence farmers have little or no marketable surplus.

IV. Milk Marketing and Distribution System

Information on milk marketing channels was collected from key informants during fieldwork for the present study. Descriptions of the milk marketing system are also found in Sharif et al (2003) and SDPI (2004).

The milk marketing system in Pakistan consists of two main channels:

(a) Traditional channels that market unprocessed milk

(b) Non-traditional channels, primarily specialized in the marketing of processed milk, and dominated by procurement and distribution activities of commercial milk processing firms.

While the traditional channels supply unprocessed milk, the range of products moving through non-traditional formal channels include ultra heat treatment (UHT), milk marketed in aseptic packing (Tetra Pack) as well as in Poly pack. Processed milk is also available in the form of pasteurized milk sold either in pouches or as open milk available from milk shops. The market shares of various types of milk are shown in Table-3.

Table-3: Market Share by Milk Type

Processed/Raw	Type of Milk	Market Share in Volume (%)
Processed Milk	UHT Tetra pack	5%
	UHT Poly pack	-*
	Open pasteurized milk sold at milk shops	3.8%
	Pasteurized pouch	-*
Raw/Unprocessed Milk	Open milk sold at milk shops	1%
	Open *Gawala* milk	90%
	Direct home delivery	-*

* less than 0.5% share

Source: Sustainable Development Policy Institute, Islamabad, 2004.

Traditional Milk Marketing Channels

The traditional milk marketing channel involves the collection of milk from farmers in remote areas by the village ***dodhi***,[16] who then transports it by means of a bicycle, motor-cycle, or horse-tonga to small towns or transaction points along the main roads and highways linking towns with cities, where it can be purchased by a ***dodhi*** from the city for onward supply to urban consumers. At some point in this journey, unprocessed milk may be brought to a creamery where it undergoes skimming and re-constitution in accordance with its intended use in urban areas (see Box-1 below). The unprocessed milk reaches the final consumer through a variety of vendors, including retail milk shops, ***halwai*** shops, and ***gawalas***. The latter typically are based in large ***gawala*** colonies on the periphery of urban centers. ***Gawalas*** supply directly to the urban consumers.

Transportation costs for moving milk from small towns or transaction points on main highways, to cities, ranges between Rs 10-50 depending on the size of the utensil, mode of transportation and distance involved (Sharif et al, 2003). The lower transportation costs apply to buses. Because of the distances involved and hot climatic conditions in summer, the danger of milk spoilage is great, forcing ***dodhis*** to add water or ice to milk, both of which are generally of unacceptable quality because of the severe problem of water cleanliness in Pakistan. Other additives used for prolonging the life of milk include antibiotics, hydrogen peroxide, carbonates, bicarbonates, caustic soda, and formaline.[17] Moreover, the vendors, especially ***gawalas***, also add water as well as starch and reconstituted powder milk to increase the volume, and hence their profits. In general, due to adulteration with various additives, the milk supplied through the traditional channels does not meet hygienic standards. Households in middle to low income groups, who are the main consumers of unprocessed milk, are therefore at risk because of such practices.

An important issue with respect to the traditional milk marketing channels is the price received by the farmers. As a rule of thumb, the longer the supply chain and the less the competition (especially by non-traditional marketing intermediaries), the lower the price received by farmers selling through the traditional channels.

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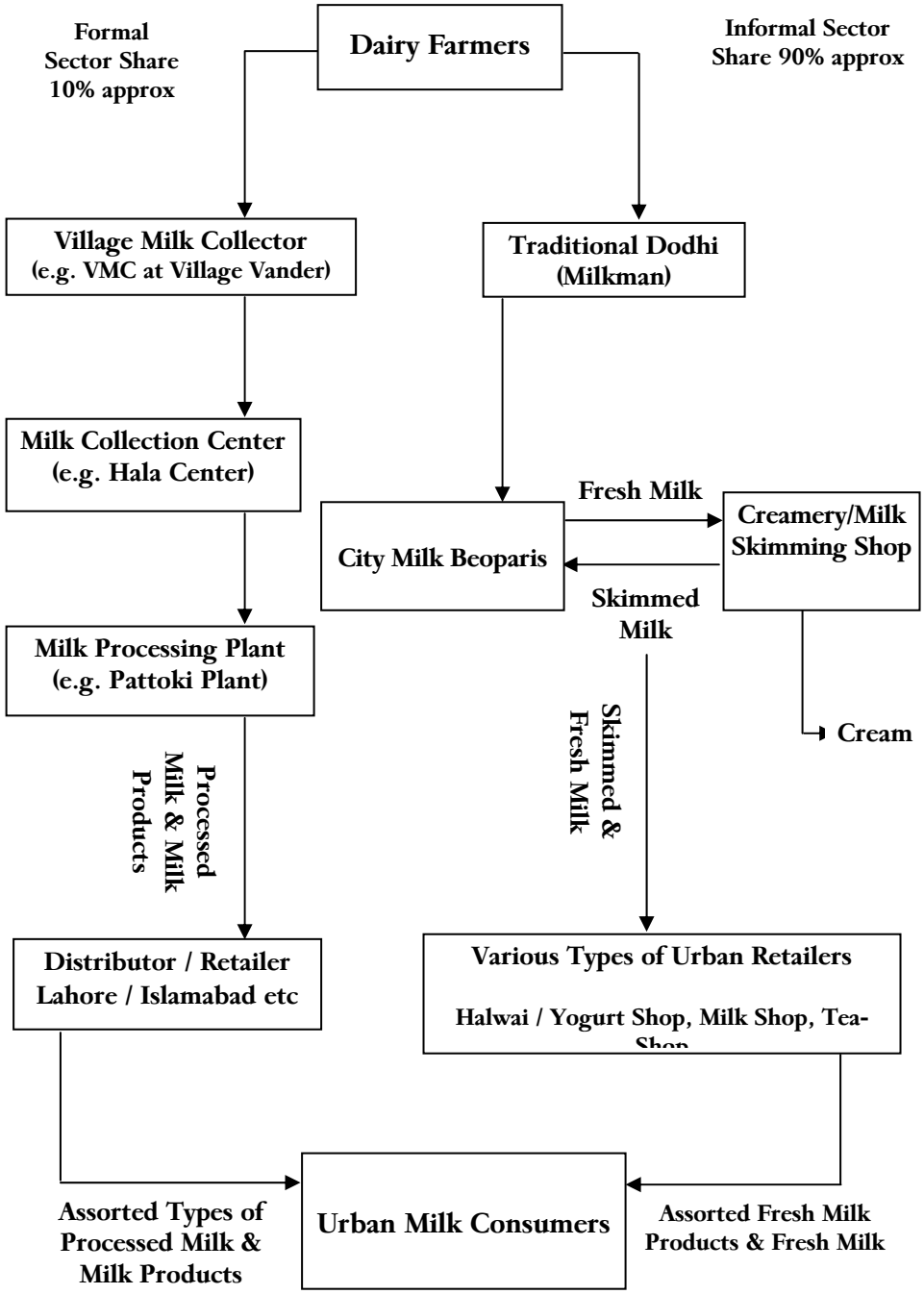
[16] The village *dodhi* is often referred to as a *katcha dodhi* while the city *dodhi* is called a *pakka dodhi*.

[17] See Small and Medium Enterprise Development Authority, 2000. Also see Sustainable Development Policy Institute , 2004.

It must be appreciated however that the relationship between the *dodhi* and the farmer is complex. Milk sales by farmers are not spot market transactions but involve longer-term quasi-contractual arrangements. The *dodhi* wants an assured supply of milk at the lowest price. The farmer, on the other hand, wants a good price for milk in addition to a supply of credit at times of need. This mutual dependence has resulted in a loaning or 'advance' system whereby from time to time the *dodhi* provides an advance to the farmer for production expenses, or to meet occasional social obligations (childbirth, wedding, and funeral expenses, etc). The advance is offset against a regular supply of milk during the season at a fixed price.

Schematic Representation of Milk Marketing Channels



Box –1: Case Study – Creamery/Milk Processing Shop

Location: ***Jamber, Lahore-Multan Road, District Kasur, Tehsil Pattoki***

Farmers sell milk to a *village-dodhi* living in the same village. The price is Rs 500 per 40 kilograms or Rs. 12.5 per one kilogram. The *village-dodhis* sell milk to *city-beoparis* who come to Jamber from Lahore to buy milk. The going price is about Rs. 550 per 40 kg or Rs 13.75 per kg. Before transporting the milk from the area to Lahore, the city-beoparis bring it to a creamery/skimming shop located at Jamber on Multan Road, for skimming the cream.

The amount of cream extracted depends on the planned end-use for the milk. The end-uses are:

Khoa (concentrate) used in making *methai* i.e. Pakistani sweets
Kounda milk for making yogurt
Thanda Doodh (chilled milk) sprinkled with crushed nuts and sold at retail outlets for drinking during summer
Karahi Doodh (boiled milk) boiled and sold to urban consumers for household uses
Tea milk sold to teashops and restaurants mostly in urban areas and along main highways and roads.

The fat-intensive uses such as making *khoa* have relatively less fat removed from them, while milk sold to teashops has most of the fat removed from them.

The *khoa* milk is made by mixing 8 parts pure fresh milk with 12 parts skimmed milk. Buffalo milk has 6-8% fat. Eight liters of pure fresh milk would contribute 480-640 grams of fat to 20 liters of reconstituted *khoa* milk (8 liters pure and 12 liters skimmed). Thus the fat percentage in *khoa* milk would range from 2.4-3.2%. For comparison purposes note that the proportion of fat in commercially available UHT and pasteurized milk (including IK's 'Hala' brand) is 3.5%.

The fat percentage in milk intended for other purposes could not be known because the key informant refused to provide this information.

The fat extracted from milk is purchased by the skimming shop at the rate of Rs 60 per 40 kg. The key informant said that 4 kg fat could be extracted from 40 kg milk. This works out to be 10%, which is on the higher side because buffalo milk does not have more than 8% fat, and cow milk has an even lower fat percentage.

The fat purchased by the creamery is sold at Rs 80 per 40 kg. This fat is sold in Lahore, Karachi or Hyderabad, depending on price. The dairy owner has a brother in Karachi and a friend in Hyderabad, who handle sales in their respective markets.

Source: Field Investigations (August-September 2005).

There are basically two models for milk procurement in the formal sector:

(a) Commercial procurement

(b) Vertically integrated cooperatives

The commercial procurement model is based on a more or less arms length relationship with the farmer. This approach relies on relatively higher prices offered for raw milk to ensure continued supplies. Some of the suppliers may be traditional *dodhis* who, taking advantage of the arms length relationship, serve as intermediaries between small farmers and milk procuring firms.

The second model comprises a vertically integrated cooperative working within a participatory framework. This is the approach used by *Idara-e-Kissan* (IK), which is a vertically integrated farmers' cooperative. IK procures milk from geographically dispersed dairy farmers through a network of village milk collectors, transports it to its processing plants and markets milk products under the brand name of *Hala*. We study this organization in detail in section 6. Under this modality, instead of price, the incentive is a package of livestock related development services provided to member farmers either free or at cost.

Idara-e-Kissan membership is open to anyone with at least one cow or buffalo in villages where a milk collection center is in place. The organization does not collect membership fees. But members need to supply 300 liters of milk in a six month period, to become eligible for receiving member services for the next six months. Of course, the choice of IK operational areas is made strategically by IK management, which serves to limit membership. This is necessary if the cooperative is to realize economies of scale in bulk procurement, transportation and handling. Nevertheless, the organization has been expanding its operations into new areas (see section 6.1.2 below for details). Being a non-profit organization, all IK profits must be used to finance member services.[18]

[18] IK's internal financial information was not available to the author. It should be noted however that IK accounts are audited.

Table-4: Milk Processing Firms

Firm Name	Location	Installation Year	Capacity in 2003 (Liters/Day)	Remarks
Milko	Lahore (Vita)	1977 (2000)	50,000	Not Operating
Nestle Milkpak	Sheikhupura	1981	1,250,000	UHT, Powder
Pakistan Dairies	Sahiwal	1983	40,000	Not Operating
Halla	Lahore	1984	75,000	UHT, Pasteurized
Chaudhry Dairies (CDL Foods Ltd.)	Kasur	1986	509,000	UHT Milk
			8,000	Milk Powder
			1,000	Desi Ghee
Milkways	Tandlianwala	1987	90,000	Being Initiated
Ravi Dairies			50,000	UHT Milk in Pouch
Pakistan Milkfoods	Jhang	1988	25,000	Condensed Milk
Premier Dairies	Raiwind	1999	100,000	Powder milk
Millac Dairies	Sialkot	1985	300,000	Not Operating
Sialkot Dairies	Sialkot	1985	100,000	Powder Plant
KNK Dairies	Raiwind			Being Installed
Patpattan Dairies	Pakpattan	1989	100,000	Not Operating
Noon Dairies	Bhalwal	1956	80,000	Milk, Butter, Cheese
Milk Flow	Karachi	1998	100,000	UHT Milk
Prime Dairies	Raiwind	1980	25,000	Ice Cream, Yogurt
Pak. Dairies	Sahiwal	1979	100,000	Not Operating

Source: Niazi, M.A., and U. Farooq, "*Estimation of Demand for Milk in Pakistan".* Socioeconomic Research Studies 2003-2004. Federal-SSI, Pakistan Agriculture Research Council, Islamabad.

Regardless of the institutional aspects, both models rely on village milk collection points where a designated Village Milk Collector (VMC) is present for collecting milk from individual farmers, both in the mornings and in the evenings. The payments to farmers are usually made on a weekly basis. The firm announces a base price for milk containing 6% fat and the VMC tests the milk brought in by each farmer for fat content.

Table-5: Base Prices Paid for Milk by IK and Nestle (6% Fat)

Milk Processor	Base Price Paid Rs/ Liter*
Idara-e-Kissan	Rs. 13.5
Nestle Milkpak	Rs. 15.5

** **Source:*** Fieldwork conducted from late August to early September 2005.

The price paid to the farmer depends on the fat content of the milk. In the lean (summer) season, there is usually a premium added to the base price of milk. *Idara-e-Kissan* paid a premium on milk delivered during the lean period from 15 April –15 August.

The village milk collector is responsible for transporting milk to the collection centers, such as 'Hala'. These centers are equipped with chillers and Plate Heat Exchange (PHE) systems, both meant for cooling milk to 2°C. From thereon, insulated trucks are used to transport milk to processing plants to produce a range of products including UHT milk, pasteurized milk, yogurt, and *desi ghee,* etc. Milk products are marketed to urban consumers through retail outlets.

V. Methodology and Scope of the Study

The objective of this study is to analyze the experience of *Hala/Idara-e-Kissan* (IK) in milk collection, processing and marketing activities with a view to learn lessons useful from the perspective of rural growth and poverty alleviation in Pakistan. The scope of the study is limited to IK operations in the Punjab but the lessons learnt have wider applicability.

The methodology of the study consisted of conducting structured and semi-structured interviews and meetings with a range of key informants that included dairy farmers, milk market intermediaries, staff of IK and government officials in livestock sector organizations. In addition, a small structured survey of dairy farmers was conducted in Kasur and Okara districts.

Farmer meetings were conducted in the following villages:

(i) Village Bhoneke Uttar, Tehsil Pattoki

(ii) Village Vander, district Kasur

About 15-20 farmers attended each meeting.

In addition, key informant meetings were held with market intermediaries, including the traditional *dodhi*, IK village milk collector, and the owner of a milk skimming shop/creamery at locations listed below.

(ii) Village 15-R district Okara (meeting with dodhi)

(iii) Village Vander (meeting with IK village milk collector)

(iv) Location, Jamber on Lahore-Multan Road (meeting with the owner of the creamery)

To gain an understanding of the IK organization and its operations, several meetings were held with the IK senior management and staff and visits made to their operational facilities in the field. The following IK facilities and Operational Centers were visited.

(i) IK Head Office, Lahore

(ii) IK milk processing plant, Pattoki

(iii) IK center, feed production facility and semen production unit, Chochak

(iv) IK center, 4-GD

The structured survey of dairy farmers was conducted in Kasur and Okara districts. Before initiating the survey, two formal questionnaires were developed and pre-tested in the field. One questionnaire was for IK member farmers and the other for non-members. The latter served as the control group.

The IK members were selected from village Vander in district Kasur. This village is 8 km from IK's 'Hala' milk collection center and 25 km from the IK Pattoki milk plant.[19] This is an IK operational village where the organization has two village milk collectors (VMCs). In operational terms, this means that farmers had milk collection points located in close proximity, where they could easily take their milk supplies after the morning and evening milking.

[19] The IK processed milk products are sold under the brand name 'Hala', named after this first IK operational center.

The control group farmers were selected mainly from village 15-R in district Okara. IK does not operate in this village but Nestle has a milk collection point here. In addition to the main cluster of houses in the village, many livestock keepers were scattered in *dairas*[20] around the village. Most of the farmers interviewed came from *dairas*. This means that a Nestle VMC was not located in their proximity and they would have to travel greater distances on foot to bring milk to the VMC twice a day.

Because the focus of this study is on poverty alleviation, a sample was selected from small farmers owning between three to five milk animals. Households owning fewer animals, while poor, are not expected to have significant marketable surplus to benefit fully from the operation of organizations such as the IK. On the other hand, households with larger herds are not truly representative of typical dairy households in Pakistan and are expected to be relatively better off.

For the purpose of sample selection in the IK operational village, a list of IK members was prepared with the help of the IK staff. This list also indicated members' livestock holdings. A sample of households with a herd size of between 3-5 animals was randomly selected to be interviewed.

The control group sample was selected by first preparing a list of farmers owning 3-5 animals with the help of an informant in this village. A random sample was selected for interviewing. Substitutions were made for non-available farmers by selecting other farmers with similar herd sizes.

A team comprising the author and two enumerators conducted the interviews. The filled survey questionnaires were reviewed in the field by the survey team before proceeding to data entry. For the purposes of entering survey information, a data input template was created. The entered data were checked for errors and consistency before undertaking analysis.

VI. Idara-e-Kissan

[20] A '*daira*' is a location away from the main villages but near their fields where farmers have a few rooms for storing implements and keeping animals. Some farmers return to the villages in the evening. Many farmers, especially smaller ones take up full time residence at a daira, as they have no house in the village.

Genesis of Idara-e-Kissan Organization

The genesis of IK was the 1983 Pattoki Livestock Production Project (PLPP)[21], initially supported by the German Government and implemented through technical assistance from GTZ. The emphasis was on extension and education of farmers with a view to improve productivity and farmers' incomes through the development of a participatory organization. During an in-house workshop of the project, it was realized that extension alone was not enough to achieve these objectives.[22] So a service provision element was added that included animal health, reproduction, feeding, extension and social components. This decision had its roots in the realization that increased farmer incomes were highly fungible and not always invested in livestock.

Initially, the project model was based on the collection of milk from farmers in 15 villages and selling it to private dairies in Lahore. The project provided price guarantees and assurances to buy all milk offered for sale by farmers. However, difficulties in selling milk to private dairies, especially during the flush season, underscored the need for creating processing capacity. The Pattoki milk processing plant was established in 1987 to help address the milk marketing problem, and with it the organization – *Idara-e-Kissan* – was also created as a means of developing a private enterprise that would generate its own funds, be financially self-sustaining, and involve members in the decision-making process of milk processing and marketing. *Idara-e-Kissan* was registered under the Pakistan Society Act in June 1989. In 1992, PLPP terminated and IK's own administration has been running the organization since then.

Initial Investment Costs

The initial investment in IK, from 1984 to 1992, was Rs 200 million. The German government's contribution was Rs 180 million, which included Rs 100 million in local expenditures for the establishment of the Pattoki milk processing plant, vehicles, equipment and other hardware.

Growth of Operations

The original IK model was developed in areas around Pattoki, in the milk belt along the left bank of the Ravi between Balloki and Gugera-Saddar/Akbar Chawk. This area consists of the western parts of the

[21] Pattoki is a town in Punjab province located 75 kilometers from Lahore on the Lahore-Multan Road. Also see section 6.1.2 on growth of operation for geographic areas of operation.

[22] Discussions with CEO, Idara-e-Kissan.

administrative districts Kasur and Okara. In the *Idara-e-Kissan* lexicon, this is IK-1. Now the IK model has been extended to more areas, as shown below:

- IK-1: Kasur, Okara
- IK-2 Syedwala (on right bank of Ravi), Sheikhupura
- IK-3 Arifwala, Hujra Shah Muqeem
- IK-4 Sargodah, Layyah

IK-4 is the newest area. The historical evolution of IK operations is summarized in the table below:

Table-6: Evolution of IK Operations

Years =>	**1992**	**1996**	**2000**	**2004**
Villages Under IK Operations	87	139	351	519
Farmer Members	1,817	7,143	10,753	20,164
Milk Collected –6% Fat (million liters)	4.66	9.62	37.65	47.10

Source: Information provided by IK

Demand for UHT treated packed milk is limited due to modest income levels in Pakistan and its real price has fallen consistently over the years. IK evolved a new strategy focusing on lower cost segments of the marketing, involving cheaper packaging to market affordable products such as unpacked pasteurized milk. This has helped the bottom line.

Flush season milk has always been difficult to sell (IK faced the same problem as other dairies). To deal with strong seasonality, IK started a powdered milk plant (in 2001) with production capacity of 1 ton per hour. This plant works during the September-April period, i.e. 8 months a year.

Despite increasing the scale and scope of operations, and greater geographic dispersion of its activities, IK operates under the same basic model. This model is described below.

The Idara-e-Kissan Model

Any livestock keeper in a target village can become a member if he/she owned one buffalo or one cow and is able to supply 300 liters of milk during a six-month period. Members are entitled to members' services during the next six months. A village with 15 members can form a Village Committee (VC) and elect a '*nomainda*' or representative at the village level for a five-year

term. The villages in the Union Council elect Council members who form the Governing Body. The Governing Body meets quarterly and makes policy decisions. In addition there is an Executive Committee (EC) for operational decisions. The members of the EC are nominated. The Governing Body must approve any decisions made by the EC.

Milk Collection System

From a milk collection perspective, each operational village (i.e. where IK collects milk) has a village milk collection point, where farmers deliver milk. A village milk collector (VMC) is present in the mornings and the evenings to receive milk, which is tested for fat content in the farmer's presence and both the quantity of raw milk and its fat percentage are recorded. The price farmers receive depends on the fat percentage and payments are made weekly.

From here on, the responsibility for storing and transporting milk shifts to the VMC, who is a self-employed person and operates under the close supervision of the village council and can be dismissed by them. Unlike the traditional *dodhi*, the VMC does not have price-setting power. The base price of milk (containing 6% fat) is announced by the IK and the VMC gets a commission for collecting, storing, and transporting the milk from the village to the collection center. The VMC in Village Vander received Rs 1.50 per liter for collecting milk and delivering it to the IK center at Hala.[23] Upon delivery at the center, milk is again tested for fat content and quality. If the delivered milk is rejected by the center, the financial liability is of the VMC and not of the farmers.

Each center can receive milk from 35-60 villages. The milk collection centers are equipped with chillers and PHE systems for cooling milk. The chilled milk is transported in truck-mounted insulated containers to processing plants. The transporters receive a commission for transporting milk. For instance, the commission for transporting milk from Hala Center to the Pattoki processing plant was Rs 0.35 per liter.

Package of Development Services

Apart from the participatory nature of the organization, what distinguishes IK operations from those of the other commercial milk processing firms is the package of veterinary and other services offered to its members. Because IK is registered under the Pakistan Society Act, the

[23] This amount can be higher if road infrastructure is inadequate and the distance from the village to the collection center is greater.

members cannot receive income from the organization's activities. The profits from commercial milk processing and marketing operations are used to finance a range of development services. These include services directly related to livestock activities as well as social services aimed particularly at rural women.

IK staff members, some of whom are self-employed and stationed in villages, provide these services. This creates an incentive structure vastly different than the one facing the salaried staff at government veterinary and extension agencies. Professional staff hired by the IK supervises service delivery. The package of services is described below.

- Artificial insemination (AI) – These services are provided, free of charge to members, by IK technicians for the purpose of bringing about genetic improvement in herds and boosting their fertility. IK also maintains semen production at the Chuchak center to provide fresh insemination services.

- Animal Vaccination – farmers' livestock is protected against diseases by vaccination programs administered by the veterinary staff of IK. Vaccination is free of charge for members

- Animal Health Treatment – These services are provided at a nominal charge and part of the cost of medication is reimbursed to farmers after they have supplied 300 liters of milk during the 6-month period (as stipulated in their membership conditions). In practice, in Village Vander, the VMC collected the medication bill immediately and later offset it against the members' milk supply. An important aspect of this program is access to treatment services in case of an emergency. At such times, a veterinarian or needed IK staff is rushed to the farmers at their call. This solves some of the farmers' most serious problems, i.e. non-responsiveness of government veterinary staff and high cost of private treatment.

- Feed Improvement – To improve productivity, IK procures quality concentrates such as cottonseed cake and supplies them to farmers at cost. It also produces balanced rations (known as '*vanda')* and a mineral mix at its feed production unit located at Chuchak. IK makes efforts to provide quality fodder seed to farmers to raise productivity and to ensure adequate availability during the lean season. Towards the latter objective, farmers are also encouraged to grow non-traditional varieties of fodder. The improved seed for

hybrid sorghum and *barseem* is obtained from Sargodah, and that of maize from Yusufwala.

- Extension Services – The aim of this program is to educate farmers about animal health, fodder, and feeding practices. Also demonstration plots for fodder are set up. The cost of seed and other inputs for these is borne by the farmer but fertilizer is supplied free by IK. The organization helps farmers procure quality seed from seed multiplication agencies in the private sector.

- Social Services – The IK operates a women's program, which is aimed at supporting their role in rural households and involving them in a services package. The program has family planning, mother and child health, adult literacy, health education components, as well as a goat distribution component for poor women.

The Table below provides information on delivery of selected services.

Table-7: IK Service Provision Levels (selected services)

Service	1992	1996	2000	2004
Veterinary Cases	10,125	42,826	73,757	127,144
Animals Vaccinated	90,513	219,180	249,802	363,014
Artificial Insemination Cases	4,513	8,063	14,202	15,707
Target Group Meetings	811	2,637	3,425	6,486
Mother & Child Care Cases	720	10,333	19,080	21,674
Health & Livestock Meetings (Women)	134	1,540	2,623	3,240

Source: Information provided by *Idara-e-Kissan*

Cost of Development Services

Idara-e-Kissan is a non-profit organization. Profits from its commercial operations are used to finance development services for its members.

Table-8: Costs of Deveopment Services

Year	Cost of Development Services (Rs million)	Turnover (Rs million)	Services Cost as %age of Turnover
1998	28.54	395.49	7.2 %

Year	Cost of Development Services (Rs million)	Turnover (Rs million)	Services Cost as %age of Turnover
1999	27.32	516.12	5.3 %
2000	31.29	731.76	4.3 %
2001	40.61	697.23	5.8 %
2002	58.10	658.51	8.8 %
2003	53.80	793.77	6.8 %
2004	61.91	922.48	6.7 %

Source: Information provided by *Idara-e-Kissan*

From 1998 to 2004, the cost of development services has ranged from 4.3% to 8.8% of *Idara-e-Kissan*'s turnover. The average for this period is 6.4%. The outlay on services was about Rs 62 million in 2004. A more detailed breakup of costs is not available, but Table 7 indicates that development services include some social services as well, although this does not appear to dominate livestock related services.

Constraints

Transportation infrastructure is very important for collecting and transporting milk. In the Punjab, the farm-to-market road network has gradually expanded. But roads constructed many years ago are now in need of repair.

The power supply is not reliable causing difficulty in the operations of the milk chilling unit. Sometimes the electricity supply is not available for as along as two days. Generators are used when the power supply is cut off, but they are very expensive. Even obtaining a new electricity connection is difficult, which makes expanding into new areas (by setting up chilling units) very challenging.

The law and order situation is not satisfactory, especially in areas near the rivers. There have been incidents where IK staff motorcycles were stolen. This makes operations difficult because it interferes with the movement of cash to collection centers and VMCs. The staff at the Chuchak Center said it is sometimes difficult for the doctor to make emergency calls for the treatment of animals after-hours because of the law and order situation. The doctor on these occasions travels with an armed escort provided by the farmer requesting the service. This raises the transactions costs and makes the task of receiving emergency animal treatment more difficult for farmers.

In the past, *Idara-e-Kissan* did not get direct support from the government but was a user of government R&D and production in various fields. For instance, the IK obtains vaccines from the government but these are not always available. Last year they could not obtain them. Moreover, the government does not provide good breeds of animals to ordinary farmers in good numbers. One key informant, talking about livestock raised on government farms said, "*Their animals are only meant for the Horse and Cattle Show.*"[24]

Recently, the government has decided to collaborate with the IK to provide 80 milk chillers at market prices. The cost would be paid back in installments. In Sargodah district, the government will provide a soft loan to the IK for setting up a milk collection program that includes collection, chillers, training and extension.[25] Moreover, in Layyah District, the Government of Punjab is planning a joint venture with IK. This would involve setting up of a processing unit. The Government of Punjab would invest in the development activities of IK.[26]

VII. Economic Analysis

This analysis is based on a structured survey that covered 36 dairy farmers, equally divided between IK members and non-members (control group). The sample was chosen from smaller dairy farms having 3-5 animals.

[24] Horse and Cattle Show is a government sponsored event held every spring in Lahore. Among other attractions, cattle and horses of good breeds are displayed on this occasion. The stark contrast between these animals and the non-descript breeds found on typical farms in the Punjab seems to have prompted this comment.

25 Discussions with the General Manager (Development), and Deputy General Manager (Development), Hala/IK, Pattoki Dairy Plant.

[26] Discussions with Director General Livestock, Government of Punjab, Lahore.

Table-9: Basic Information about IK Member and Non-Members Farms

	IK Member Farm	Non-Member Farm
Animal Units Per Farm	6.83	6.84
Animal Units Per Buffalo	1.50	1.50
No. Milk Buffalo Per Farm	1.70	1.56
Milk-Buff Animal Units Per Farm	2.55	2.34

Source: Survey Data (2005)

The IK member farms and the farms in the non-member control groups are identical in terms of average herd size, both owning between six to seven animal units. The average number of milk buffaloes in IK farms was marginally higher at 1.70 compared to 1.56 in the control group farms.

Enterprise Budgets

This section presents enterprise budgets for one buffalo both for IK member farmers (see Table-10 below) and the control group of non-members (see Table-11 below).

Table-10: Budget (Per Milk Buffalo) for IK Member Dairy Farmer

	Unit	Quantity	Rate (Rs)	Cash (Rs)	Cost Per Animal Unit (Rs)
Milk	Head	2,003.36	14.58	29,209	
Calf-Female	Head	0.397	3,500.00	1,390	
Calf-Male	Head	0.397	2,500.00	993	
Total Value of Production				**31,591**	
Input Costs					
Rabi Fodder Costs					
Barseem	Acre	1.15	22,285	25,628	3,752.23
Oats	Acre	0.08	10,000	800	117.13
Kharif Fodder Costs					-
Sorghum Fodder	Acre	1.25	5,738	7,173	1,050.15
Sadabahar Fodder	Acre	0.06	6,400	384	56.22
Maize Fodder	Acre	0.33	6,060	2,000	292.80
Other Kharif Fodder	Acre	0.16	6,066	971	142.10
Cottonseed Cake	Bag	13.07	454	5,935	2,327.33
Mineral Mix	Bag	0.66	14	9	5.44
Wheat Straw	Mds	59.00	112	6,608	967.50
Choker	Kg	4.40	6	24	3.54
Gur	Kg	15.33	27	411	60.15
Wheat Grain	Kg	29.35	10	301	44.05
Oils	Kg	3.30	139	459	67.16
Masalas		-	1	90	13.18
Health Treatment (Net of Reimbursement)	Total Rs			340	49.78
Vaccination	Total Rs			3	0.44
De-Worming	Total Rs			25	3.66
Breeding Costs	Total Rs			21	3.07
Total					**8,956**
Cost Per Milk-Buffalo					**13,434**
Net Returns Per Milk Buffalo					**18,157**

Source: Survey Data (2005)

Table-11: Budget (Per Mil Buffalo) for Non-IK Member Farmers

	Unit	Quantity	Rate (Rs)	Cash (Rs)	Cost Per Animal Unit (Rs)
Milk	Lit	1,599.04	12.85	20,548	
Calf-Female	Hd	0.397	3,500.00	1,390	
Calf-Male	Hd	0.397	2,500.00	993	
Adult-Male	Hd				
Total Output				22,930	
Input Costs					
Rabi Fodder Costs					
Barseem	Acer	1.00	18,377	18,377	2,686.70
Oats	Acer	0.03	5,000	150	21.93
Lucerne	Acer	0.13	25,000	3,250	475.15
Kharif Fodder Costs					-
Sorghum	Acer	1.16	4,162	4,828	705.84
Sadabahar	Acre	-	6,400	-	-
Maize Fodder	Acer	0.50	6,909	3,455	505.04
Other Kharif Fodder	Acer	0.06	5,824	349	51.08
Cottonseed Cake	Bag	3.90	440	1,716	733.33
Mineral Mix	Bag	-	14	-	-
Wheat Straw	Md	58.00	63	3,654	534.21
Choker	Kg	28.00	6	175	25.58
Gur	Kg	16.00	22	352	51.46
Wheat Grain	Kg	2.50	10	26	3.75
Oils	Kg	0.67	123	82	12.05
Masalas		-	1	60	8.77
Health Treatment (Net of Reimbursement)	Total Rs			283	41.37
Vaccination	Total Rs			30	4.39
De-Worming	Total Rs			7	1.02
Breeding Costs	Total Rs			22	3.22
Total				49,089	5,865.00
Cost per Milk-Buffalo					**8,797.00**
Net Return					14,132.00

Source: Survey Data (2005)

IK Members

The IK member farmer produces on an average 2003 liters of milk per buffalo per year and earns gross revenue of Rs 29,209 from milk sales to the IK.

The cost of inputs is presented in the table on a per animal unit basis. The IK farmers' major input costs are Rs 5,410 for fodder or 60% of total input cost per animal unit. On an average the farmers had 1.23 acres of land under *Rabi* fodder, mostly *barseem* but also some oats. The acreage allocation to *Kharif* fodder was 1.8 acres, which was mainly sorghum but some farmers also planted maize fodder. Very few farmers used non-traditional fodders such as motgrass and *sadabahar*.

The second most important input cost is that of concentrates and supplements. Together these costs add up to Rs 3,488 per year or 39% of total input cost per animal unit. About two-thirds of this expenditure is the cost of cottonseed cake, which is fed to lactating buffaloes to increase their milk productivity.

The animal health costs (Rs 57) is small partly because IK subsidizes animal health treatment and vaccination. But this should not obscure the importance of these costs. Because the figures presented in the budget are averaged over all the farmers, including those whose animals do not fall sick, the average cost appears small. But in reality, the farmer whose animal falls sick bears the full cost of treatment, which is substantial.

On a per buffalo basis, the average cost for IK farmers is Rs 13,434 and net returns are Rs 18,157.

Non-Member Farmers

The budget for dairy farmers who were not IK members is presented in Table-11. The average milk yield per animal for this group comes to 1,599 liters per year. These farmers received on an average Rs 20,548 by selling the milk to the traditional *dodhi.*

The main input cost for non-IK farmers was also the cost of fodder, which was Rs 4,445/animal unit per annum, accounting for 75.8% of input costs. The area allocated to *Rabi* fodder was 1.16 acres, which was mostly under *barseem*. The area under fodder in the *Kharif* season was 1.72 acres out of which 1.16 acres were for sorghum fodder and an additional 0.5 acres were planted as maize fodder.

The cost of feeding concentrates and supplements to milk animals was Rs 1,369. The share of cottonseed cake in this was 54% while wheat straw accounted for another 39% of this cost. Medical costs were small (Rs 50) but as mentioned earlier, averaging these costs over all farmers – including those whose animals do not fall sick – results in a smaller expected value in an *ex-ante*, probabilistic sense. The farmers whose animals actually fall sick pay much more, *ex-post*.

The non-IK farmers had a total cost of Rs 8,797 per milk buffalo and they earned a net return of Rs 14,132.

Comparison between IK-Member and Non-Members

A brief comparison of productivity related variables for both IK members and non-members is presented below in Table-12.

Table-12: Comparative Productivity Levels -- IK Members *vs.* Non-Members

	Difference (IK Over Non-IK)
Net Returns Per Milk Buffalo (Rs/Year)	+ 28.5%
Milk Prices Received (Rs/Litre)	+ 13.5%
Milk Yield Per Buffalo (litre/year)	+ 25.3%
Number of 'Wet' Milk Buffaloes	+ 8.97%
Number of 'Dry' Milk Buffaloes	- 6.00%

Source: Survey Data (2005)

Table-12 above shows that IK member farmers enjoy 28.5% higher net returns per milk buffalo compared to non-members. This is a result of 13.5% higher prices received based on the fat test. Note that the base price offered by IK for 6% fat milk was Rs 13.50/liter. Therefore, the average price received of Rs 14.58/ per liter indicates that milk produced by IK members had more than 6% fat. Because the non-members sold to the traditional *dodhi*, no fat test was conducted on the milk they supplied. *Dodhis*, however, have lots of experience and reasonably good idea of milk quality (including fat content). So apart from the *dodhi*'s own margin, possibly lower fat content of their milk (as judged by the *dodhi*), could be another factor explaining the lower prices they received. Moreover, by eliminating the middleman and consolidating milk collection operations to a scale larger than that of the typical *dodhi*, IK may be able to achieve economies of scale in transportation and handling,

some of which may be passed on to the farmers.[27] Finally, IK members had 9% more milk buffaloes and 6% fewer dry buffaloes.

Sources of Productivity Differences

Having established that productivity at the IK members' dairy farms is higher compared to farms operated by non-members, we now try to trace the sources of these differentials. These can be divided into two groups --- (a) access to services and (b) usage levels of inputs

Table-13: Sources of Productivity Difference

Service/Input	Access to Services (%)		Usage Levels*	
	IK Members	Non-Members	IK Members	Non-Members
Artificial Insemination	28	6	-	-
Vaccination	83	72	2.3	1.5
Animal Health Treatment	44	44	4.4	1.9
LS extension workers' visit	56	0	2.9	0
Loans / Advances	78	39	Rs 3,264	Rs 2,285
Cottonseed Cake (Mds)			13.1	3.9
Wheat Straw (Mds)			59.0	58.0
Rabi Fodder (Acres)			1.23	1.16
Kharif Fodder (Acres)			1.80	1.72

*Note: Unless otherwise stated, the figures refer to average number of times the service was used by farmer

Source: Survey Data (2005)

In terms of access to services, the IK members seem to enjoy a clear advantage in artificial insemination, vaccination and number of visits by livestock extension workers. The percentage of farmers having access to animal health treatments is about the same in both groups but this does not imply equal access, because service usage levels are greatly different. The IK farmers get between 4-5 animal treatments per year on an average while non-members average only about 2 treatments during the same period. Despite similar service coverage, the IK members' usage rate is almost twice that of the non-members. The same pattern is seen in the number of

[27] The author is thankful to an anonymous referee for this point.

vaccinations. The IK members' animals on an average get between 2-3 vaccinations during the year while non-members' can manage only between 1-2 vaccinations for their herds. This means that IK members protect their animals against more diseases compared to non-members.

A comparison of input usage levels is presented in the lower panel of Table-13. In both the *Rabi* and *Kharif* seasons, the area allocated to fodder is somewhat higher on IK members' farms, but the difference is not very significant. The same is true of wheat straw. From amongst the inputs, the single most important contribution to productivity seems to come from cottonseed cake. The IK members reported using 13 Mds of cottonseed cake whereas non-members used only about 4 Mds. Although the number of milk buffalos is higher on IK members' farms (1.7) compared to non-members farms (1.56) the difference in cottonseed cake usage is far more to be explained just by differences in herd composition.

Service Quality and Productivity

Not all productivity differences can be attributed to quantitative aspects of services delivered. Service quality is also a very important factor in explaining productivity difference between members and non-members. The survey collected information on service quality that is presented below.

Error! Reference source not found.Error! Reference source not found. Error! Reference source not found. shows satisfaction levels of IK members with animal health services delivered by IK staff versus the satisfaction levels reported by non-members for services delivered by the private sector and government veterinary staff. It is clear that the distribution of IK members' satisfaction ratings is skewed towards high satisfaction, while that of the non-members is centered almost symmetrically at the medium satisfaction level. Farmers reported during the field survey that even the government veterinary staff engages in private practice and charges fees just like the private sector. So given that these services are delivered mostly on a payment basis to non-members, higher satisfaction levels reported for IK delivered services is all the more significant.

Figure 2: Service Quality and Productivity - Animal Health Treatment

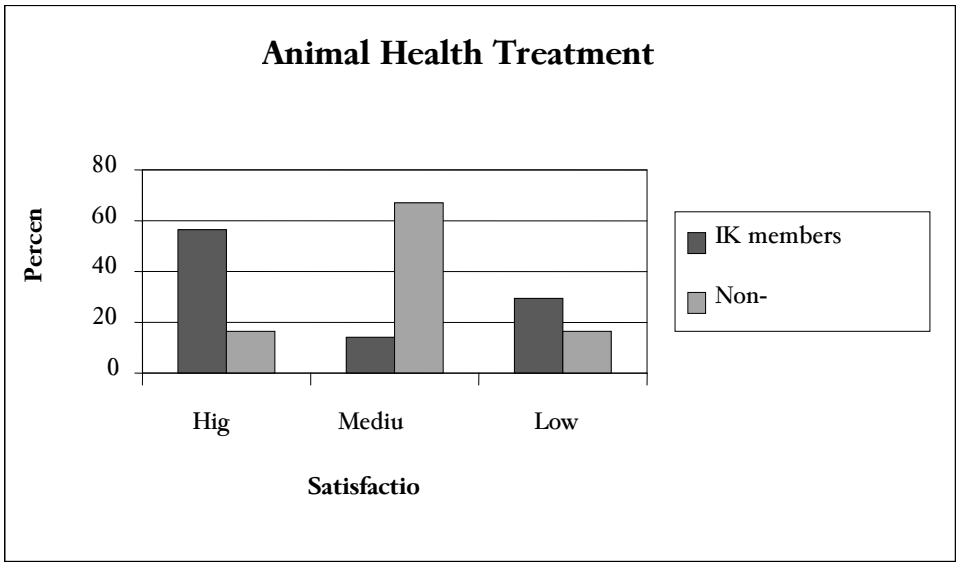


Figure 3: Service Quality and Productivity Vaccination Service

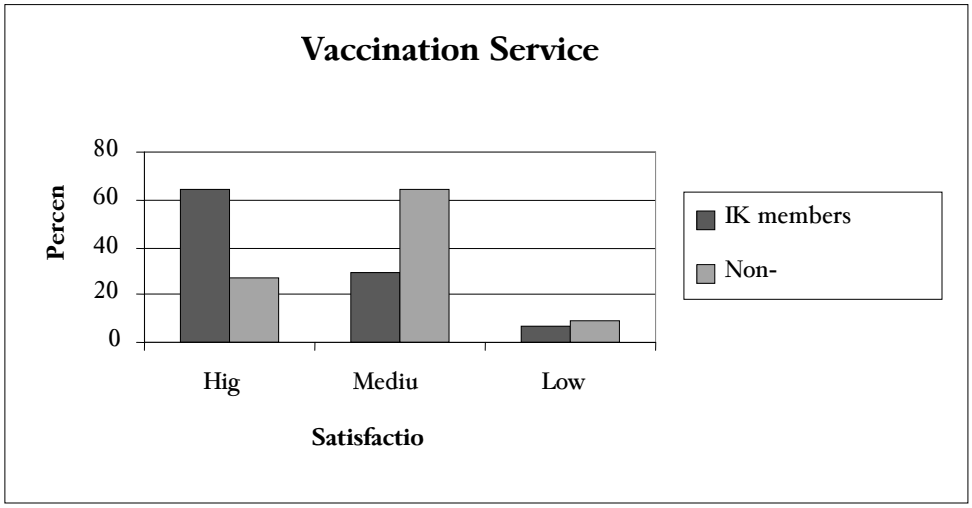


Figure 3 above also shows the same pattern as the previous figure. The majority of IK members (above 60%) express a high level of satisfaction with the free vaccination services provided by the IK staff. The fact that IK Village Veterinary Assistants (VVAs) are self-employed, with income coming from commissions on delivery of veterinary and vaccination services, partly explains the better quality of services delivered and higher farmer satisfaction levels.

Compared to this, an almost equal proportion (above 60%) of non-members express only medium level of satisfaction with services obtained from non-IK sources, and only 25% or so expressed high satisfaction with service delivery. It may be pointed out that fewer numbers of vaccinations for herds of non-members (see Table-13) may be explained by the difficulty they face in obtaining quality, hassle-free, services.

VIII. What Works and What Doesn't

Idara-e-Kissan is a vertically integrated dairy cooperative. Unlike traditional cooperatives that own dairy farms, IK collects milk from thousands of geographically dispersed farmers, who are also its members. The cooperative delivers a package of veterinary and livestock extension services that are financed by profits from commercial operations. The milk procured from members is priced on the basis of fat content. Members tend to obtain better prices for milk compared to those offered by the traditional *dhodhi*.

The returns of IK members are 28.5% better than those obtained by non-members, who follow a low-input/low-productivity strategy. Apart from the approximately 13% higher price received for milk, this gap is also due to 25% higher productivity on IK members' dairy farms.

To support productivity, IK provides members with a range of services that include vaccinations, subsidized animal health treatments with partial or full reimbursement of medication costs, feed supplements and mineral mix and balanced feed rations. Members also get access to livestock extension. IK procures quality fodder seed from seed producing farms in the private sector for its members and sets up demonstration plots.

A greater proportion of IK members are covered by animal health treatment services and have more herd vaccinations as compared to non-members. Moreover, members' satisfaction with these services is higher compared to satisfaction levels reported by non-members from services provided by government agencies and the private sector.

On the other hand, some limitations of the approach were also noted from the analysis of data and discussions with farmers in the field.

First, although farmers used cottonseed cake, it was privately supplied by VMC and there is no guarantee if it was the same high quality cake that IK procures for its members.

Second, no IK member reported using *vanda* – a balanced feed ration, which IK produces at its feed production facility at Chuchak. It seems that farmers try to concentrate on milk fat-enhancing cottonseed cake instead of using more balanced ration *vanda* ration because the IK pricing policy is based on milk fat content whereas the benefits of including *vanda* in the feed in terms of improved animal health and productivity are less immediate. Also cotton seed cake is a more traditional ingredient of animal feed than *vanda* and, therefore, some resistance to changing traditional practices may also be involved.

Third, no IK member reported using improved fodder seed supplied by IK. Moreover, no members planted any non-traditional fodders such as motgrass or *sadabahar*.

Fourth, artificial insemination was used by a greater percentage of IK members compared to the control group. But the majority of farmers still used natural services from the bulls available in the village. Unless concerted breed improvement efforts are made, milk yields from non-descript breeds available to the farmers is likely to remain low.

Fifth, IK extension service effectiveness is limited as indicated by the failure of farmers to adopt balanced feed rations and non-traditional fodder varieties. But another area of weakness is herd management. While vaccination helped control some diseases, other diseases that depend on better herd management, such as mastitis, are still common. Farmers do not adopt hygienic practices required to control such diseases, again indicating less than fully effective extension.

IX. Conclusion

The *Idara-e-Kissan* case underscores the scope for enhanced productivity and income growth in the dairy sector through the formation of a vertically integrated cooperative. However, unlike the typical cooperative that takes profits and distributes them back to members, the IK operates as a non-profit organization that uses profits to finance member services. This has increased the productivity and incomes of the members when compared to non-members.

The most successful services have been animal health treatment, vaccination and to a somewhat lesser extent, livestock extension. Improved productivity of IK member farmers is greatly driven by higher use levels of feed concentrates. Evidence of success has been less definitive in the areas of breed improvement, including artificial insemination, and enhancing fodder productivity.

A useful way to characterize the successes and the remaining challenges is the public-private good paradigm. The successes have been in areas where, on the one hand, the benefits were private and could be captured by the individual participating farmers or were largely restricted to IK membership with only small spillovers. On the other hand, the costs of these services were relatively smaller and highly divisible. Benefits of animal health treatment and livestock extension are clearly highly excludable for non-members. Vaccination has spillover benefits beyond IK membership because a significant increase in the proportion of vaccinated animals may limit the incidence of some diseases in the entire livestock population. But, arguably, the spillovers are small because IK operations cover a small proportion of the entire livestock population.

By comparison where the benefits were truly public – breed improvement or development of improved fodder varieties – results were less spectacular. These are also areas where large, lumpy investments are required and project gestation periods are also long. These results are hardly surprising given what is already known from the public goods' literature. A farmers' cooperative may overcome some transaction costs and enhance productivity and members' incomes, it cannot escape the classic under-provision incentives for public goods. This is especially true where the public goods in question require very substantial investments in the production of new knowledge, requisite infrastructure, laboratory facilities, and scientific personnel.

In view of this, the government has two strategies. It could actively pursue the up-scaling of the IK model. This approach would bring limited benefits but would largely amount to doing what the private sector could do reasonably well even on its own. Alternatively, there could be a division of labor between the government and the private sector and cooperatives whereby the government invests in public goods such as the creation of new scientific knowledge and products in areas of livestock breed improvement and fodder variety development as well as dissemination, while the private sector concentrates on overcoming transaction costs, provision of short-term credit to members, expanding membership, and creating a product range to penetrate high end segments of markets so as to increase profits and the members' benefits. The latter approach capitalizes on the comparative advantages of the public and private sectors and is likely to achieve better results.

An important observation during the case study was the use of milk as collateral for short-term credit. But this form of credit is usually extended by the traditional *dhodis* who typically offer a low price for milk.

It was noted that village milk collectors of IK also provided some short-term credit, although outside the framework of the IK agreement with farmers. This suggests that there may be the possibility of developing micro credit products aimed at small dairy farmers.

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Apple Market Integration: Implications for Sustainable Agricultural Development

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Abstract

In a market driven economy, price signals guide and regulate production, consumption and marketing decisions over time, form and place. Identifying the causes of price differences in interregional or spatial markets has therefore become an important economic analytical tool to understand markets better. If markets are not well integrated, price signals are distorted, which leads to an inefficient allocation of resources. Further, it may constrain sustainable agricultural development and aggravate inequitable patterns of income distribution. This paper examines the degree of spatial market integration in the regional apple markets of Pakistan using cointegration analysis and monthly wholesale price data from January, 1996 to December, 2005. Results show that apple markets are perfectly integrated and Quetta is the dominating market. The high degree of market integration observed in this case is consistent with view that apple markets in Pakistan are quite competitive and provide little justification for government intervention designed to improve competitiveness to enhance market efficiency.

JEL Classification: C22, Q13, Q18

Keywords: Market Integration, Cointegration, Apple, Pakistan

1. Introduction

In a market driven economy, the pricing mechanism is expected to transmit orders and directions to determine the flow of marketing activities. Pricing signals guide and regulate production, consumption and marketing decisions over time, form and place (Kohls and Uhl, 1998). Identifying the causes of price differences in interregional or spatial markets has therefore become an important economic analytical tool to understand markets better.

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In developing economies, there are several impediments to the efficient functioning of markets, particularly agricultural commodity markets. These include insufficient transportation infrastructure, difficulties in accessing market information, government-imposed restrictions on the movement of goods between regions, government monopoly over the marketing and distribution system, and poor enforcement of anti-trust regulations that result in price fixing and oligopolistic market structures. If markets are not well-integrated, then price signals could be distorted which leads to an inefficient allocation of resources, and the marketable surplus generated by the farmers could result in depressed farm prices and diminishing income (Tahir and Riaz, 1997).

Market integration is an alternative approach to stabilize prices, allocate resources and rectify market imperfections like entrenched monopolies or monopsonies and inadequate and costly information transmission. The rectification of market imperfections smoothes the way to attain market efficiency, which in turn facilitates the attainment of agricultural development and equal distribution of income. If markets are well integrated then government can stabilize the price in one key market and rely on commercialization to produce a similar outcome in other markets. This reduces the cost of stabilization considerably. Further, farmers will not be constrained by local demand conditions.

Spatial market integration refers to co-movements or a long run relationship of prices. It is defined as the smooth transmission of price signals and information across spatially separated markets (Golleti, *et al.*, 1995). Two trading markets are assumed integrated if price changes in one market are manifested in an identical price response in the other market (Barrett, 1996). Market integration can also be defined as a measure of the extent to which demand and supply in one location are transmitted to another (Negassa *et al.*, 2003). To illustrate integration in two markets, consider two markets A and B. Suppose market A experiences a bad harvest while market B does not. Due to the bad harvest the price will suddenly increase in market A. In the absence of communication flows between the two markets, the price in the market B will not change. Thus markets A and B are completely separated and prices of the same commodity are not related. On the other hand if markets A and B are integrated, the commodity will flow from B to A and prices in market A will come down. However, the price in market B will rise because of less availability of supply in B.

In the case of widely spatially dispersed regional markets in developing countries, the nature and extent of market integration is of particular

importance. The nature of optimal policies depends on the dynamics of market integration and the cost of incorrect policies can be massive (Ravallion, 1986). Much emphasis is given to area and production of apples in Pakistan, while relatively little is known about how price transmission takes place in the domestic apple market. Such information is important for apple producers and other players in the apple value chain since it affects their marketing decisions (buying and selling), which in turn affects decisions related to logistical matters and eventually profits realized. In this context, the present study aims at empirically estimating the degree of integration in apple markets of Pakistan. The paper is organized as follows: Section 2 discusses the empirical approach; Section 3 discusses the data and results; while Section 4 concludes.

2. Empirical Methodology

We begin by testing for the presence of unit roots in the individual time series of each model using the augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1981), both with and without a deterministic trend. The number of lags in the ADF-equation is chosen to ensure that serial correlation is absent using the Breusch-Godfrey statistic (Greene, 2000, p. 541). The ADF equation required for estimation by OLS is the following:

$$\Delta Y_t = \alpha_3 + \beta_3 t + (\phi_3 - 1)Y_{t-1} + \sum_{i=1}^{k} \theta_i \Delta Y_{t-i} + u_t \qquad (1)$$

where Y_t is the series under investigation, t is a time trend[1] and u_t are white noise residuals. We do not know that how many lagged values of the dependent variable to include on the right-hand side of (1). There are several approaches but we use the Lagrange Multiplier (LM) test (Holden and Perman, 1994, p. 62).

If two series are integrated of the same order, Johansen's (1988) procedure can then be used to test for a long run relationship between them. The procedure is based on maximum likelihood estimation of the vector error correction model (VECM):

$$\Delta z_t = \delta + \Gamma_1 \Delta z_{t-1} + \Gamma_2 \Delta z_{t-2} + \cdots + \Gamma_{p-1} \Delta z_{t-p+1} + \pi z_{t-p} + \Psi x_t + u_t \qquad (2)$$

where z_t is a vector of I(1) endogenous variables, $\Delta z_t = z_t - z_{t-1}$, x_t is vector of I(0) exogenous variables, and π and Γ_i are (n×n) matrices of parameters with

[1] The rationale for having a trend variable in the model is that most of the series are trended over time. So it is important to test the series for unit roots having a stochastic trend against the alternative of trend stationarity.

Γ_i=-(I-A_1-A_2-…-A_i), (i=1,…,k-1), and π=I-π_1-π_2-…-π_k. This specification provides information about the short-run and long-run adjustments to the changes in z_t through the estimates of $\hat{\Gamma}_i$ and $\hat{\pi}$ respectively. The term πz_{t-k} provides information about the long-run equilibrium relationship between the variables in z_t. Information about the number of cointegrating relationships among the variables in z_t is given by the rank of the π-matrix: if π is of reduced rank, the model is subject to a unit root; and if 0<r<n, where r is the rank of π, π can be decomposed into two (n×r) matrices α and β, such that $\pi=\alpha\beta'$ where $\beta' z_t$ is stationary. Here, α is the error correction term and measures the speed of adjustment in Δz_t and β contains r distinct cointegrating vectors, that is the cointegrating relationships between the non-stationary variables. Johansen (1988) uses the reduced rank regression procedure to estimate the α- and β-matrices and the trace test statistic is used to test the null hypothesis of at most r cointegrating vectors against the alternative that it is greater than r.

3. Data and Results

Monthly wholesale price (Rs. 40/ kgs) data from January, 1996 to December, 2005 of apples (120 observations) for the post-liberalization period in logarithmic form will be used. The study analyzes price transmission in nine selected apple markets in Pakistan. The markets included in this study are Quetta, Peshawar, Lahore, Faisalabad, Multan, Sargodha, Gujranwala, Karachi, and Hyderabad. The criterion for selecting these markets is based on net market positions (surplus or deficit area), geographical distribution, data availability and the volume of trade or the importance of the market to the national apple trade flow.

Table-1 reports the unit root results using ADF tests both with and without a linear trend. The null hypothesis is that the variable observed has a unit root against the alternative that it does not. Both models indicate that of a null of unit root cannot be rejected for all price series, as the absolute values of the ADF statistics are well below the 95% critical value of the test statistics. Thus we conclude that all the price series are non-stationary.

Table-1: Unit Root Tests Results

Prices	Non-Trended Model	Trended Model
Quetta	-2.20	-3.06
Karachi	-2.10	-3.15
Hyderabad	-2.41	-3.22
Peshawar	-2.43	-3.19
Lahore	-2.74	-3.40
Faisalabad	-1.47	-2.48
Multan	-1.54	-2.64
Sargodha	-1.15	-2.52
Gujranwala	-1.43	-3.10
CV (95% Confidence Level)	-2.88	-3.45

After testing for a unit root, the next step is to test for cointegration. Johansen's procedure has been applied to apple prices. The first step in Johansen's procedure is the selection of the order of the Vector Auto Regression (VAR) model. We use the LR-statistic[2], adjusted for small samples (Sims, 1980), to test the null hypothesis that the order of the VAR is k against the alternative that it is four where k=0,1,…,4 and for all cases, k=1. The second step in the Johansen procedure is to test for the presence and number of cointegrating vectors among the series in each model. Table-2 presents Johansen's cointegration results. The trace test results show there are seven cointegrating vectors and two common trends at the 95% confidence level because first seven statistical values of trace statistics (445.489, 338.524, 250.985, 168.785, 104.359, 65.768, 37.674) are greater than their respective 95% critical values (203.96, 166.12, 132.45, 102.56, 75.98, 53.48, 34.87) whereas the remaining two statistical values of trace statistics (14.992, 2.208) are less than their respective 95% critical values i.e. 20.18, 9.16. The trace test results suggest that these nine price series are strongly cointegrated and converge to long run equilibrium in the sense that the Pakistani apple market system is stationary in seven directions and non-stationary in two directions. In other words, seven prices can be expressed in terms of the other two prices, meaning that prices in nine apple markets are fully cointegrated as the law of one price (LOP) holds.

[2] We also tried the Schwarz Bayesian Criterion (SBC) and Akaike information Criterion (AIC). Both SBC and AIC selects lag length one and three respectively. To avoid over-parameterization, we choose one as the lag length (Pesaran and Pesaran, 1987).

Table-2: Cointegration Results - Trace Statistics

Equation Tested	Null	Alternative	Statistics	95% C V
Quetta, Karachi, Lahore, Hyderabad, Peshawar, Faisalabad, Multan, Sargodha, Gujranwala	r= 0	r=1	445.489	203.96
	r<=1	r=2	338.524	166.12
	r<=2	r=3	250.985	132.45
	r<=3	r=4	168.785	102.56
	r<=4	r=5	104.359	75.98
	r<=5	r=6	65.768	53.48
	r<=6	r=7	37.674	34.87
	r<=7	r=8	14.992	20.18
	r<=8	r=9	2.208	9.16

It suggests that even though the regional markets are geographically dispersed and spatially segmented, spatial pricing relationships reveal that the prices are linked together indicating that all the apple exchange locations are in the same economic market. First, the relationship among all nine markets has been checked. Next, the pair-wise relationship between the markets will be analyzed. We take the Quetta market as a main apple market and check the relationship of all other markets with it. Table-3 reports the pair-wise cointegrating relationships between the markets. The results of pair-wise cointegrating relationships indicates that the Karachi, Hyderabad, Peshawar, Lahore, Faisalabad and Multan markets are strongly integrated with the Quetta apple market, in the sense that these markets have two cointegrating vectors as their estimated trace statistics are greater than the 95% critical values while the Sargodha and Gujranwala markets were integrated but not strongly with the Quetta market as they have one cointegrating vector.

Table-3: Pair-wise Cointegration Results --- Trace Statistics

Equation Tested	Null	Alternative	Statistics
Quetta - Karachi	r=0	r≥1	24.48 (20.18)
	r≤1	r≥2	12.68 (9.16)
Quetta - Hyderabad	r=0	r≥1	72.08 (20.18)
	r≤1	r≥2	18.58 (9.16)
Quetta - Peshawar	r=0	r≥1	35.17 (20.18)
	r≤1	r≥2	10.92 (9.16)
Quetta - Lahore	r=0	r≥1	51.42 (20.18)
	r≤1	r≥2	12.82 (9.16)
Quetta - Faisalabad	r=0	r≥1	39.54 (20.18)
	r≤1	r≥2	11.30 (9.16)
Quetta - Multan	r=0	r≥1	57.19 (20.18)
	r≤1	r≥2	11.23 (9.16)
Quetta - Sargodha	r=0	r≥1	23.36 (20.18)
	r≤1	r≥2	1.81 (9.16)
Quetta - Gujranwala	r=0	r≥1	25.01 (20.18)
	r≤1	r≥2	2.67 (9.16)

Note: Critical values (95% Confidence Level) in parentheses.

Even if one demonstrates market integration through cointegration, there could be disequilibrium in the short-run i.e., price adjustment across markets may not happen instantaneously. In may take some time for spatial price adjustments. An error correction model takes into account the adjustment of short-run and long-run disequilibrium in the markets and the time needed to eliminate disequilibria. Table-4 shows that 37 to 53 percent of disequilibrium is removed each period, i.e. one month, in Pakistan's major apple markets. This implies that economic agents take between 2 to 3 months to adjust back to the long run equilibrium. For example, in the Karachi apple market, 47 percent of the disequilibrium is removed in each period i.e., one month, while 37 percent of the disequilibrium is removed in the Peshawar apple market. However, the coefficient for the Hyderabad market suggests that 204 percent of the disequilibrium is removed in each period, which is difficult to justify. Other apple markets follow the same pattern of adjustment to shocks except the Sargodha and Gujranwala apple markets which show non-significant results.

Table-4: Adjustment Vectors

Price Relationship: Quetta	Coefficient	T-Value	P-Value
Karachi	-0.47028	-3.4913	0.001
Hyderabad	-2.0401	-7.9565	0.001
Peshawar	-0.37743	-2.9185	0.004
Lahore	-0.53390	-3.2153	0.002
Faisalabad	-0.53.39	-3.2381	0.002
Multan	-0.50900	-3.0496	0.003
Sargodha	-0.15338	-1.3407	0.183
Gujranwala	0.16632	1.1776	0.241

4. Summary and Conclusions

This paper has examined the degree of spatial market integration in the regional apple markets of Pakistan using cointegration analysis and monthly wholesale prices data from January, 1996 to December, 2005. The results indicated that these apple markets are strongly cointegrated and converge to long run equilibrium in the sense that Pakistan's apple market system is stationary in seven directions and non-stationary in two directions. In other words, seven prices can be expressed in terms of the other two prices means that prices in nine apple markets are fully cointegrated as the law of one price (LOP) holds. The pair-wise cointegration results indicate the markets are well integrated, with Quetta being the dominant market.

The study also revealed that 37 to 53 percent of the disequilibrium is removed each period in apple markets of Pakistan. This implies that following a shock to the market which causes disequilibrium, economic agents takes between 2 to 3 months to adjust back to equilibrium.

The study confirmed that market price linkages and the inter-relationships among spatial markets are important in economic analysis. Inter-market price linkages and the speed of adjustment to shocks show that transaction costs have a significant impact in determining the degree of market integration in the apple markets of Pakistan. The high degree of market integration observed in this case is consistent with view that apple markets in Pakistan are quite competitive and provide little justification for government intervention designed to improve competitiveness or to enhance market efficiency.

The results of the research show that certain markets are not well integrated with each other, and in order to achieve the goal of integration government should promote information and develop communication within markets. To accomplish better integration and integration among the markets, infrastructural facilities should be provided by the government to the targeted markets.

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The Determinants of Capital Structure of the Chemical Industry in Pakistan

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Abstract

This study is an attempt to determine the capital structure of listed firms in the chemical industry of Pakistan. The study finds that by studying a specific industry's capital structure, one can ascertain unique attributes, which are usually not apparent in the combined analysis of many sectors as done by Shah and Hijazi (2004). This study analyzed 26 of 39 firms in the chemical sector, listed at the Karachi Stack Exchange for the period 1993-2004 using pooled regression in a panel data analysis. Six regressors i.e. firm size, tangibility of assets, profitability, income variation, non-debt tax shield (NDTS) and growth were employed to examine their effects on leverage. The results show that these six independent variables explain 90% of variation in the dependent variable and, except for firm tangibility, results were found to be highly significant. The study has policy implications of importance for researchers, investors, analysts and managers.

JEL Classification: C13, C23, C51, L65

Keywords: Chemical, Panel Data, Karachi Stock Exchange, Pakistan

1. Introduction

A firm can combine different proportions of debt and equity in an attempt to increase the market value of the firm and is recognized as capital structure of the firm. Firms differ with respect to capital structure which has given birth to different capital structure theories in an attempt by researchers to explain variation in capital structure over time or across regions.

Modigliani and Miller (1958) demonstrated that the market value of a firm is determined by its earning power and the risk of its underlying assets,

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and is independent of the way it chooses to finance its investments or distributes dividends. Moreover, a firm can choose between three methods of financing: issuing shares, borrowing or spending profits (as opposed to disbursing them to shareholders as dividends). The theorem gets much more complicated, but the basic idea is that under certain assumptions, it makes no difference whether a firm finances itself with debt or equity.

Although this theory is based on many unrealistic assumptions, it provides the basic theoretical background for further research. After Modigliani and Miller, a lot of research was done on optimal capital structure and the determinants of capital structure. During this period, among others, three main theories emerged to explain the behavior of the firm in choosing its capital structure. These are Static Tradeoff Theory, Pecking Order Theory and the Signaling Theory.

In Pakistan, the first thorough study with regards to the determinants of capital structure of stock exchange-listed, non-financial firms of Pakistan was conducted by Shah and Hijazi (2004). Their work is considered a good start, considering the neglect of Financial Economics topics by researchers in Pakistan. However, it has been pointed out that the study is based on only six years of data, and by updating the data set and using a longer data set, results can be improved. Besides this, the inclusion of some important explanatory variables, which are important for corporate decision making, may make the study more valuable. Moreover, the empirical evidence suggests that there is significant industry influence on capital structure. So, analyzing sectors individually may produce better results.

The present study has been designed to address these shortcomings and to find out industry-specific determinants of capital structure by taking the chemical sector as a case study. Furthermore, an attempt has also been made to elucidate the policy implications of the model and to make suggestions for analysts, managers, investors, and researchers. Here, it must be stressed that it is a pioneering work in the field of the non-financial sector in Pakistan.

2. Theoretical Framework

2.1 Static Trade-Off Theory

Static Trade-Off Theory (STT) explicates that a firm follows a target debt-equity ratio and then behaves accordingly. The benefits and costs

linked with the debt option sets this target ratio. These include taxes, cost of financial distress and agency costs.

2.2 Pecking Order Theory

Pecking Order Theory (POT) theory was put forward by Myers and Majluf (1984). It postulates that firms follow a hierarchy of financial decisions when establishing its capital structure.

Initially, firms prefer to finance their projects through internal financing, i.e. retained earnings. In case they need external financing, first they apply for a bank loan then for public debt. As a last resort, the firm will issue equity to finance a project. Thus, according to POT, profitable firms are less likely to incur debt for new projects because they have the available internal funds for this purpose. The reason firms are reluctant to issue equity is because of asymmetric information between management and new stockholders. Myers and Majluf (1984) pointed out that under-pricing would be the result of less information held by potential investors vis-à-vis management with respect to the expected cash flows from the firm's assets, both current and future. Considering these information asymmetries, investors would infer that the management would issue stock only when it is overpriced. Thus the newly issued equity might be sold at a discount. This would be regarded as a wealth transfer from existing investors to the new ones. This problem could be avoided if the firms use internally generated resources, such as retained earnings.

Moreover, Pecking Order Theory has a more important effect on capital structure for firms that are managed in the interests of equity holders, rather than the combined interests of debt and equity holders.

However, when financial distress costs are high, equity-maximizing and value-maximizing firms make similar capital structure choices (Titman and Tsyplakov, 2005).

Myers (1977) suggests that firms acting to maximize the interests of equity holders will be reluctant to issue equity because of the wealth transfer to debt holders, while Myers and Majluf (1984) propose that firms are reluctant to issue equity because of an adverse selection problem. Titman (2005) and Stultz (1990) suggest that firms may be reluctant to issue equity because of the costs associated with being scrutinized. Finally issuing equity involves substantial transaction costs. Tong and Green (2005) have provided empirical evidence which support the pecking order hypotheses.

Moreover, Delcoure (2007) have also provided fresh evidence in support of pecking order theory.

These theories are not mutually exclusive. Firms can choose target ratios that reflect the benefits and costs of debt financing put forth in the trade-off literature, but may deviate from their targets for the reasons described in the pecking order literature.

2.3 Signaling Theory

The Signaling Theory (ST) approach, originally developed by Ross (1977), explains that debt is considered a way to highlight investors' trust in the company; that is, if a company issues the debt it provides a signal to the markets that the firm is expecting positive cash flows in the future, as the principal and interest payments on debt are a fixed contractual obligation which a firm has to pay out of its cash flows. Thus the higher level of debt shows the manager's confidence in future cash flows.

Another impact of the signaling factor, as we have already discussed it in the Pecking Order Theory, is the problem of the under-pricing of equity, If a firm issues equity instead of debt for financing its new projects, investors will interpret the signal negatively; since managers have superior information about the firm than investors, they might issue equity when it is overpriced.

Among other explanations about a firm's behavior in choosing its capital structure is agency theory. Jensen and Meckling (1976) identify the possible conflict between shareholders and a manager's interests because the manager's share is less than 100% in the firm. Furthermore, acting as an agent to shareholders, the manager tries to appropriate wealth from bondholders to shareholders by incurring more debt and investing in risky projects.

This is consistent with the work of Myers (1977) who argues that, due to information asymmetries, companies with high gearing would have a tendency to pass up positive NPV (net present value) investment opportunities (under-investment problems). Myers therefore argues that companies with large amounts of investment opportunities (also known as growth options) would tend to have low gearing ratios.

A manager having a less than 100% stake in the business may try to use these free cash flows sub-optimally or use it to their own advantage rather than use it to increase the value of the firm. Jensen (1986) suggests

that this problem can be somehow controlled by increasing the stake of the manager in the business or by increasing debt in the capital structure, thereby reducing the amount of "free" cash available to managers to engage in their own pursuits (Jensen, 1986; Stultz, 1990). Here the reduction in the cash flow because of debt financing is considered to be a benefit.

Stultz (1990) suggests that the agency problem can be solved to some extent if the management stake is increased or the proportion of debt in the capital structure is increased.

3. Methodology

This section provides information about the source of data, sample size, measurement of the variables and discussion of different measures of the variables.

3.1 Sources of Data

The study has made use of twelve years data published by the State Bank of Pakistan, "Balance Sheet Analysis of Joint Stock Companies Listed on The Karachi Stock Exchange Volume-II 1993-1999" and "Balance Sheet Analysis of Joint Stock Companies Listed on The Karachi Stock Exchange Volume-II 1999-2004."

3.2 Sample

This study has focused on the Chemical Sector, and initially all the 39 firms (which are listed on the Karachi Stock Exchange) in the chemical sector (whose published data was available) were selected. After screening the data, firms with incomplete data were dropped and the remaining 26 firms were selected for panel data analysis.

3.3 Dependent and Independent Variables

The study used profitability (PF), tangibility of assets (TG), size of the firm (SZ), growth (GT), income variation (IV) and non-tax debt shield (NDTS) as explanatory variables to determine the degree of leverage (LG) (the response variable). This section presents the description of these variables, how they are measured and what empirical evidence was found by previous studies. The choice regarding the included explanatory variables has been made based on a review of the relevant literature.

3.3.1 Leverage (LG) (Dependent Variable)

Leverage refers to the percentage of assets financed by debt. Previous research studies have used different measures of leverage. Frank and Goyal (2003) state that the difference between a debt ratio based on market value and one based on book values is that the former tends to regard the firm's future situation whereas the latter reflects the past situation. Fama and French (2000) point out some inconsistencies arising from the use of two different debt ratios. According to them, both theories (Pecking Order and Static Tradeoff) apply to the debt book value, and there are doubts if the predictions may be extended to the debt market value.

Consistent with a previous study on non-financial Pakistani listed firms by Shah and Hijazi (2004), this study has used the book value measure of leverage. The main benefit of debt is that the interest payments are tax-deductible and thus provides cash savings. These tax shield benefits are not changed by the market value of the debt once it is issued (Banerjee et. al., 2000). So the market value of the debt is irrelevant for this study.

On the other hand, the primary cost of borrowing is the increased chance of bankruptcy. If a firm falls in financial distress and goes into bankruptcy, then the relevant value of the debt is the book value of the debt, not the market value of the debt (Shah and Hijazi, 2004).

Another consideration when deciding on the appropriate measure of leverage is to take total debt or only long term debt as a percentage of total assets. Though capital structure theories consider long term debt as a proxy for financial leverage, this study has used the measure of total debt because in Pakistan, firms have mostly short term financing, as the average firm size is small. This makes access to the capital market difficult in terms of cost and technical difficulties (Shah and Hijazi, 2004). In Pakistan, firms usually prefer short term borrowing, the reason being that commercial banks are the major lenders and they do not encourage long term loans. Up until 1994, firms did not rely on market based debt; in mid 1994 the government amended the Company Law to permit companies to raise debt directly from the market in the form of TFCs (Term Finance Certificates).

Booth et. al. (1999) also pointed out in their study on determinants of capital structure in developing countries (including Pakistan) that the use of short term financing is greater than long term financing in developing countries.

3.4 Independent Variables

3.4.1 Profitability (PF)

Profitability is a strong point of dissent between the two theories i.e. Pecking Order Theory (POT) and Static Tradeoff Theory (STT). For STT, the higher the profitability of the firm, the more reasons it will have to issue debt, reducing its tax burden. On the other hand, the POT presupposes that larger earnings lead to the increase of the main source firms choose to cover their financial deficit: retained earnings. Therefore, the STT expects a positive relationship between profitability and leverage, whereas the POT expects exactly the opposite.

In previous studies, the measure of profitability used was operating earnings before interest payments and income tax (EBIT). But following Shah and Hijazi (2004) and Tariq and Hijazi (2006), this study measures profitability (PF) as the ratio of net income before taxes divided by total assets because the data taken from the State Bank of Pakistan publication does not permit us to calculate EBIT (Shah and Hijazi, 2004; Tariq and Hijazi, 2006).

Thus the first hypothesis is that firms with higher profitability will have less leverage.

Tong and Green (2005) has also provided empirical evidence regarding this relationship.

3.4.2 Tangibility of Assets (TG)

Firms having a large amount of fixed assets can easily raise debt at cheaper rates because of the collateral value of those fixed assets. The companies with a higher ratio of tangible assets have an incentive to borrow more because loans are available to them at relatively cheaper rates. Therefore this study expects a positive relationship between tangibility of assets and leverage.

According to the static tradeoff approach, firms with a higher ratio of fixed assets serve as collateral for new loans, favoring debt. However, Pecking Order Theory is of the view, as argued by Harris and Raviv (1990), that firms with low levels of fixed assets would have more problems of asymmetric information, making them issue more debt, since equity issues would only be possible by under-pricing them. On the other hand, firms with higher levels of asset tangibility are generally larger firms that can issue

equity at fair prices, so they do not need to issue debt to finance new investment. According to them, the expected relationship between asset tangibility and debt should then be negative.

Tangibility of assets is measured in this study as the ratio of fixed assets to total assets, taking the total gross amount of fixed assets as the numerator. Using total gross fixed assets rather than net depreciated value of assets makes sense as different firms may possibly use different depreciation methods that may create unevenness in the data.

A firm can pledge an asset having a market value even if it has been fully depreciated. Calculating tangibility this way, the ratio was above one in some cases suggesting that total gross fixed assets were more than total assets (Shah and Hijazi, 2004).

Therefore the second hypothesis is that firms with a higher percentage of fixed assets will have higher debt ratios.

3.4.3 Size (SZ)

With respect to the Pecking Order Theory, Frank and Goyal (2003) and Rajan and Zingales (1995) argued that this relationship could be negative. There is less asymmetric information about the larger firms, reducing the chances of the undervaluation of new equity issues, encouraging large firms to use equity financing. This means that there should be a negative relationship between size and leverage of the firm.

For the Static Tradeoff approach, the larger the firm, the greater the possibility it has of issuing debt, resulting in a positive relationship between debt and size. One of the reasons for this is that the larger the firm, the lower is the risk of bankruptcy. Large firms do not consider the direct bankruptcy costs as an active variable in deciding the level of leverage as these costs are fixed by the Constitution and constitute a smaller proportion of the total firm's value and also because larger firms, being more diversified, face a lower probability of bankruptcy (Titman and Wessels, 1988).

Shah and Hijazi (2004) also found a positive relationship between size and leverage of the firm, so this study expects positive relation between size and leverage of the firm.

Size (SZ) of the firm is measured by the taking the natural log of the sales to smoothen the variation over the periods considered.

Therefore the third hypothesis is that there is a positive relationship between size and leverage of firms.

3.4.4 Growth (GT)

Rajan and Zingales (1995) suggest that one would expect a negative relationship between growth opportunities and the level of gearing. This is consistent with the theoretical predictions of Jensen and Mekling (1976) based on agency theory, and the work of Myers (1977) who argues that, due to information asymmetries, companies with high gearing would have a tendency to pass up positive NPV (net present value) investment opportunities. Myers therefore argues that companies with large amounts of investment opportunities (also known as growth options) would tend to have low gearing ratios.

Moreover, as growth opportunities do not yet provide revenue, companies may be reluctant to take on large amounts of contractual liabilities at this stage. Similarly, as growth opportunities are largely intangible, they may provide limited collateral value or liquidation value (in a similar spirit to the discussion of tangibility below).

However, the empirical evidence regarding the relationship between gearing and growth opportunities is rather mixed. Titman and Wessels (1988), Barclay et al. (1995), Rajan and Zingales (1995), and Shah and Hijazi (2004) find a negative correlation, whereas Kester (1986) does not find any support for the predicted negative relationship between growth opportunities and gearing. This is therefore consistent with the hypotheses of Jensen and Meckling (1976) and Myers (1977), and lends weight to the notion that companies with high levels of growth opportunities can be expected to have low levels of gearing.

For the POT there are two possibilities for the sign of this variable; on the one hand, firms with high growth opportunities would tend to keep their debt ratios at low levels so as to preserve their credit capacity when it becomes necessary (negative impact), and on the other hand, this growth requires investments which are usually made with the issue of new debt (positive impact). Fama and French (2000) named these two possibilities as the complex and simple versions of the POT, respectively.

Different studies have used varying measures of growth like market to book value of equity, research expenditure to total sales measure and annual percentage increase in total assets (Titman and Wessels, 1988). Given the structure of data, this study measures growth (GT) as a percentage

increase in total assets, as the data was taken from the State Bank of Pakistan's publication which does not have information on annual stock prices and research expenditure of the listed firms (Shah and Hijazi, 2004).

Thus the study expects a positive coefficient for growth. The fourth hypothesis is that firms with higher growth rates will have higher leverage.

Delcoure (2007) has substantiated the same argument and has provided evidence on a positive relationship between the aforementioned variables.

3.4.5 Income Variation

Income variation is considered to be either the inherent business risk in the operations of a firm or a result of inefficient management practices. In either case, earnings volatility is a proxy for the probability of financial distress and the firm will have to pay a risk premium to outside providers of funds. To reduce the cost of capital, a firm will first use internally generated funds and then outsider funds. This suggests that earnings volatility is negatively related with leverage. This is the combined prediction of trade-off theory and pecking order theory. However, Cools (1993) says that agency theory suggests a positive relationship between earnings volatility and leverage. He says that the problem of underinvestment decreases when the volatility of a firm's returns increases. Following the prediction of trade-off theory and pecking order theory, this study expects negative relationship between income variation (IV) and leverage.

Several measures of volatility are used in different studies, such as the standard deviation of earnings before interest and tax (Booth et al., 2001), standard deviation of the first difference in operating cash flow scaled by total assets (e.g., Bracley et. al., 1995; and Wald, 1999), standard deviation of the percentage change in operating income (e.g., Titman and Wessels, 1988). As standard deviation gives a single value for a given variable, the current study cannot use this measure with panel data. Alternatively, this study uses the value of the deviations from mean of net profit divided by total number of years for each firm in the given year as a proxy for earnings volatility.

Thus the fifth hypothesis is that income variation (IV) is negatively related to leverage.

3.4.6 Non-Debt Tax Shields

Non-debt tax shields (NDTS) include depreciation and investment tax credits. DeAngelo and Masulis (1980) say that non-debt tax shields can be substitutes for the tax benefits of debt financing and a firm with larger non-debt tax shields is expected to use less debt. The study therefore expects a negative relationship between NDTS and leverage. Wald (1999) uses the ratio of depreciation to total assets and Chaplinsky and Niehaus (1993) employ the ratio of depreciation expense plus investment tax credits to total assets to measure NDTS. Both studies find that leverage is negatively correlated with NDTS. In this study, annual depreciation charges divided by total assets to calculate non-debt tax shields is used.

Our sixth hypothesis is that NDTSs are negatively related to leverage.

3.5 Analytical Technique

This study uses panel regression analysis. Panel data analysis facilitates analysis of cross-sectional and time series data. The study uses the pooled regression type of panel data analysis. Pooled regression, also called the Constant Coefficients model, is one where both intercepts and slopes are assumed constant. The cross-sectional company data and time series data are pooled together in a single column assuming that there is no significant cross-sectional or inter-temporal effects. Many other studies on this subject matter have used the same analytical technique. Other studies (for example Shah and Hijazi, 2004; and Hall, Hutchinson and Michaelas, 2004) have employed the same analytical technique.

Therefore the equation for our regression model will be:

$$LG = \beta_0 + \beta_1 (TG) + \beta_2 (SZ) + \beta_3 (GT) + \beta_4 (PF) + \beta_5 (IV) + \beta_6 (NDTS) + e$$

Where

LG = Leverage
TG = Tangibility of assets
SZ = Firm Size measure by log of sales
GT = Growth
PF = Profitability
IV = Income variation
NDTS= Non-debt tax shield
e = Error term

4. Analysis and Results

Checking for multicollinearity among predictor variables, Spearman's Correlation among them is checked, which is given in Table-1.

Table-1: Correlations Among Independent Variables (A Check for Multicollinearity)

	Growth	Tangibility	Size	NDTS	Profitability	Income Variation
Growth	1	.004	.001	−.037	−.189	−.577
Tangibility	.004	1	.035	−.253	.006	.039
Size	.001	.035	1	.121	−.441	.350
NDTS	−.037	−.253	.121	1	−.059	.170
Profitability	−.189	.006	−.441	−.059	1	−.164
Income Variation	−.577	.039	.350	.170	−.164	1

From Table-1 it can be seen that: the highest correlation value between two variables is −0.577 which shows that a multicollinearity problem is unlikely among the selected independent variables.

Regression Analysis Results

Table-2: Regression Coefficients and Significance

	Coefficients	Standard Error	t	Sig.
Constant	−.111	.161	−.688	.492
Profitability	−1.147	.237	−4.834	.000
Size	0.06313	.023	2.754	.006
NDTS	3.532	1.337	2.642	.009
Tangibility	0.06108	.081	.756	.450
Income Variation	18.250	.635	28.754	.000
Growth	0.04545	.003	14.818	.000

R^2= 0.908
Adjusted R^2=0.906
F-Statistic=457

Table-2 shows the results of the regression analysis. The value of R-squared (R^2=0.908) shows that the six variables i.e. growth, size, income variation, profitability, non-debt tax shield (NDTS) and tangibility explain about 90% of variation in the dependent variable, leverage. This means that

the choice of capital structure is mainly defined by these six variables in the chemical sector. From the value of the F-statistic it can be seen that the model is significant.

Table-3: Expected and Observed Relationships

Determinant	Measure	Expected Relationship with Leverage	Observed Relation
Profitability	EBT/Total Assets	Negative	Negative
Size	Log of Sales	Positive	Positive
NDTS	Annual Depreciation/Total Assets	Negative	Positive
Tangibility	Total Gross Fixed Assets/Total Assets	Positive	Positive
Income Variation	|Average-Value| /Number of Years	Negative	Positive
Growth	Annual %age Change in Total Assets	Positive	Positive

All results are statistically significant other than tangibility.

Profitability is negatively correlated with leverage. This suggests that profitable firms in the Pakistani chemical sector use more equity and less debt. Thus the conclusion might be that higher profitability keeps firms away from debt instead of encouraging it, exactly as foreseen by the POT. Therefore first hypothesis is accepted. The same results were observed by Shah and Hijazi (2004) and Tariq and Hijazi (2006).

Results show that asset tangibility is positively correlated with leverage. However, evidence was not found that this relationship is statistically significant. Though the positive sign confirms earlier hypotheses about tangibility of assets, the lack of statistical insignificance does not confirm the hypothesis. Thus second hypothesis cannot be accepted. The results thus do not conform to Jensen and Meckling's (1976) and Myers' (1977) version of trade-off theory that debt level should increase with more fixed assets. Shah and Hijazi (2004) observed the same results.

Size is positively correlated with leverage. This suggests that large firms in Pakistan borrow more and small firms are fearful of more debt. This confirms the earlier hypothesis about the size of the firm: that large firms will have a higher level of leverage. This also lends support to the bankruptcy cost theory on leverage; that the fixed direct costs of bankruptcy constitute a smaller portion of the total value of the firm, and thus larger

firms do not hesitate to take more debt because of fear of bankruptcy. At the same time, the results contradict the Rajan and Zingales (1995) view of less asymmetric information about large firms, suggesting that new equity issue will not be under-priced and thus large firms will issue more equity.

Growth was found to be positively correlated with leverage. This suggests that growing firms in the Pakistani chemical industry use more debt than equity to finance the new projects. One possible reason for this is that in order to grow in the chemical sector, huge cash flows are needed, which a growing firm may not be able to meet through internal sources and therefore they have to rely on debt. This confirms earlier hypotheses about growth opportunities. Tariq and Hijazi (2006) observed a positive relationship between growth and leverage. On the other hand, Shah and Hijazi (2004) found a negative relationship.

The results do not support the simple version of the Pecking Order Theory that suggests growing firms will resort first to internally generated funds to fulfill their financing needs. But it supports the extended version of the Pecking Order Theory that internally generated funds may not be sufficient for growing firms and the next option for such a firm would be to use debt financing.

Income variation was found to be positively correlated with leverage. In Table 1 (independent variable correlations), size is positively correlated with income variation which suggests that large firms in the chemical sector have more income variability than small firms. Bankruptcy cost theory suggests that the fixed direct costs of bankruptcy constitute a smaller portion of the total value of the firm thus larger firms do not hesitate to take more debt. Other reasons can be that the bankruptcy process is slow and inefficient in Pakistan and firms face no or low bankruptcy costs. Furthermore, according to Shah and Hijazi (2004) Pakistani firms have mostly short-term financing as the average firm size is small, which makes access to the capital market difficult in terms of cost and technical difficulties. The main source of debt in Pakistan has been commercial banks, which do not encourage long-term loans (Shah and Hijazi, 2005). So another reason for the positive relationship between income variation and leverage can be that when a firm in the chemical sector faces some loss, then in order to fulfill its requirements it opts for debt financing which is mostly short-term. However, when firms have adequate profits, then it does not finance its operations by debt, as it was observed earlier that leverage is negatively related to profit. The positive relation contradicts earlier hypotheses that income variation is negatively related to leverage. However Cools (1993) says that agency theory suggests a positive relationship between

earnings volatility and leverage. He says that the problem of underinvestment decreases when the volatility of a firm's returns increases.

Non-debt tax shield (NDTS) is found to be positively related to leverage. The positive relationship between leverage and NDTS is not supported by theory. Literature on capital structure suggests that non-debt tax shields like depreciation reduce the need for debt to stop net income from going to a higher tax bracket, and thus debt should be negatively related to leverage. The most appropriate explanation for the positive relationship of depreciation to debt level can be given from the relevance of NTDS to the capital structure in the Pakistani environment. The corporate tax rate in Pakistan does not vary with the level of income. There are three straight rates; one applicable to public limited companies the second to commercial organizations in government ownership and a third to organizations in the financial sector. Companies in a given group thus face a constant rate of taxation. Depreciation thus does not work as a substitute to debt to stop net income from going into a higher tax bracket. Hence, the positive relationship is only a matter of chance. The positive relationship of NTDS with leverage is not in conformity with earlier hypotheses about NTDS but it supports Bradley et al (1984) that NDTS is positively related to leverage.

5. Policy Implication and Importance of the Model

5.1 Importance for Researchers

When we look at the data, some firms have more assets than others do and some firms are more profitable than others, so further research can be done by dividing the firms into local and multinational firms and the results could be compared with the combined study of the chemical sector.

Results of the study show that a specific industry exhibits unique attributes which is usually not apparent in the combined analysis of many sectors, and so similar studies can be conducted for other sectors of Pakistan.

5.2 Importance for Investors and Analyst

According to the results the model is:

$$LG = -0.111 - 1.147(PF) + 0.06313(SZ) + 3.532(NDTS) + 0.06108(TG) + 18.25(IV) + 0.04545(GT)$$

As this model explains 90% variation in leverage, it can be used in the analysis of company performance.

By putting values in the equation one can make a judgment about the firm as to how it is financing its assets and comparing it to the overall industry.

For example in 2003 we will find the predicted level of leverage for Colgate Palmolive and than compare it with its actual capital structure.

The sales, EBT, total assets, fixed assets, depreciation and liabilities of Colgate Palmolive for 2003 are:

Sales	EBT	Total Assets (2003)	Total Assets (2002)	Depreciation	Liabilities	Fixed Assets
3,461.6	270.3	1,020.1	849.6	28.5	551.1	336.7

From the above data, values of profitability, size, NDTS, tangibility, income variation and growth are determined which are:

Profitability	Size	NDTS	Tangibility	Income Variation	Growth
0.265	8.15	0.028	0.33	0.00868	0.2007

Now putting these values in the model

LG = –0.111 –1.147(0.265) + 0.06313(8.15) + 3.532(0.028) + 0.06108(0.33) + 18.25(0.00868) + 0.04545(0.2007)

LG = .3860 = 38.60%

If firms in Chemical Sector of Pakistan have:

Profitability	Size	NDTS	Tangibility	Income Variation	Growth
0.265	8.15	0.028	0.33	0.00868	0.2007

Then according to the model the level of leverage for that firm will be 38.60% with 10% variation.

The actual leverage used by Colgate Palmolive in 2003 was 54.02% as the difference between 38.60% and 54.02% is more than 10%; it means

that the company is not acting in the same way as the chemical sector as a whole and it has taken additional risk by keeping its level of leverage high.

So along with other ratios, investors can use this model to choose among firms to invest their limited resources and analyst can judge a firm's performance.

6. Conclusion

This study has analyzed the determinants of the capital structure by taking the chemical sector of Pakistan as a case study. The study has used a pooled regression model to measure the determinants of capital structure of the firms in the chemical industry.

The motivation for undertaking this study was to address the inadequacies of earlier studies. These studies were based on fewer years of data and less observations. Furthermore, these studies have analyzed the problem using the pooled data for all industries. Based on the empirical results, we conclude that the determinants of capital structure are industry specific. The study also emphasize that more industry specific studies should be undertaken to further explore the problem.

This study has concluded that the relationship between profitability and leverage in the chemical industry of Pakistan follows the pecking order hypotheses.

Besides this, growth which was measured as the annual percentage change in total assets, is positively correlated with leverage. Therefore, we conclude that internally generated funds may not be sufficient for growing firms and debt financing may be the only option for further growth. In addition, the study verifies the positive relationship between variation in income and leverage and non-debt tax shields and leverage.

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Book Review

Gera, Nina, *Structural Adjustment Programs in Pakistan: A Boon or a Bane?* Lahore School of Economics Press, Lahore, 2007, pp 169, Price PKR 300.

Underdeveloped countries such as Pakistan have been suffering from problems like deficits in the balance of payments, budget deficits, inflation, etc. These countries have been receiving foreign grants and concessional loans, yet the problems were not solved. This continued for about thirty years. Starting from 1980, International Financial Institutions such as the International Monetary Fund (IMF) and World Bank started to consider interventions in these economies and tied their foreign aid to certain structural reforms.

The Government of Pakistan began implementing structural adjustment programs as part of the conditions for obtaining loans from the World Bank and the IMF. This led to reductions in the fiscal deficit and balance of payments deficit to a certain extent, but also resulted in increasing poverty. The book by Gera gives a detailed analysis of poverty trends in the country and its underlying causes.

The book presents a historical overview based on data collected by Pakistani agencies and institutes supplemented with World Bank data. The study finds that macro stability is correlated with economic growth but poverty reduction and social sector development have not shown favorable trends. The author therefore highlights the need for a pattern of growth that is also poverty reducing.

The author has made an important contribution by bringing together in one place a diverse literature on poverty, food insecurity and social outcomes from investment in health and education. The analysis of the determinants of poverty in Pakistan has added substantially to the meager empirical literature on Pakistan.

The book is divided into nine chapters. Chapter one gives an introduction to the topic and explains the two hypotheses to be tested. Chapter two reviews the international literature as well as Pakistan-specific literature. Chapter three gives an historical overview of structural adjustment programs in Pakistan. Table-1 shows that the deficit as a percentage of GDP has fallen from 7.1 in 1982-83 to 4.6 in 2002-03. Table 2 shows that tax revenue as a per cent of GDP has remained the same from

14.3 in 1988-89 to 13.8 in 2002-03. Chapter four analyzes the impact of structural adjustment programs on overall social welfare in Pakistan. Table 4.2 shows the performance of structural indicators comparing the pre- and post-1988 averages. There was a fall in the GDP growth rate from 6.4% to 4.5%, growth in the agricultural sector fell from 4.0% to 3.6%, growth in manufacturing fell from 8.9% to 5.0% and total debt servicing as a per cent of GDP increased from 4.1% to 7.1%. Table 4.3 shows inequality measures. The Gini coefficient in Pakistan increased from 0.34 to 0.38 showing an increase in inequality. Table 4.4 shows poverty estimates in Pakistan in terms of headcount. The poverty incidence increased from 23.5 in 1988 to 29.7 in 1999 showing an increase of 26%.

Chapter five deals with food security under structural adjustment. Pakistan imported wheat throughout the 1990s depending on the harvest from year to year. Loans received under the structural adjustment program did not contribute to an increase in wheat production. In fact, wheat imports increased during this period.

The next chapter deals with social sector expenditures in Punjab- the largest province in Pakistan. Despite persisting pockets of poverty, the Punjab province is the most developed of Pakistan's four provinces. And given its considerable size in the overall economy, it is small wonder that trends in this province determine the direction and pace in the country. Table 6.2 compares poverty levels in the four provinces. In FY 93, the highest poverty level was in the NWFP (35.5), then Balochistan (28.6), and the lowest was in Sindh (24.1). In Punjab, it was 25.2 comparing with Pakistan overall at 26.6.

Then follows an analysis of the causes of poverty in Pakistan. The list includes political, economic and social determinants. Political causes include poor governance, political instability, and inadequate access to justice. The economic factors include investment, fiscal policy, lack of subsidies, unemployment, inflation, and falling remittances. The social determinants include the land tenure system, and the low level human development.

Chapter eight tests the hypotheses by regression analysis. The author has used both time series and cross sectional data. The results of time series are not satisfactory. Hence the author used the *Pakistan Integrated Household Survey* (PIHS) 2001-02. As the dependent variable is binary, the author has applied the Logit model. The results show that the probability that a household is poor declines with the education of the head of household, skill levels and a host of infrastructure related household characteristics. It can be concluded from the analysis that government

investment in education, skill enhancement, and health have a direct effect in extricating households from poverty.

Pakistan is poised at an extremely critical moment in time when the right choices, priorities and appropriate strategies in education and health can enable it to progress on a sustainable, pro-poor and just development path. Gera states that the government should also focus on providing safety nets for the poor in the form of welfare programs that supplement the assets of the poor and increase direct income and consumption.

The concluding chapter of the book presents some interesting and useful recommendations. The author suggests that the country needs to follow a set of fiscal, technological, credit and trade policies that are aimed at stimulating the investment climate in favor of employment intensive activities and sectors. Such policies will help to improve the private incomes of the poor. These need to be supplemented by greater emphasis on social sector expenditures and improving social sector service delivery. This will improve the human capital of the country with desirable consequences for poverty reduction. In the short run, there must be a proper system of safety nets for the poor.

All told, we need to learn from our past mistakes and the new government could benefit vastly from a reading of an analysis such as this. It is also a must read for scholars and those in academia in the sphere of development.

COMSATS
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Editors' Note

In Memory of Dr. A.R. Kemal

On 24th March 2008, the nation lost one of its leading economists, Dr. Abdul Razzaq Kemal. Not only was he an authority on the Pakistani economy and on economic policy making, he had an unassuming, sensitive personality, and was humble and modest to the core.

Born on April 14, 1946 in Amritsar, India, Dr. Kemal had a PhD in economics from Manchester University, UK and a Masters degree in economics from Stanford University, USA. He was the co-author and co-editor of 12 books and had 186 research articles published in both national and international journals and books.

He was Director of the Pakistan Institute of Development Economics, Islamabad from 1999 to 2006. Prior to this assignment, he was Chief Economist of the Planning Commission, Government of Pakistan and Economic Advisor, Ministry of Finance. He served on several government committees, task forces and commissions.

He also represented Pakistan at numerous international forums and was a consultant at various points in time to international organizations such as the World Bank, Asian Development Bank, UNDP, UNICEF, ESCAP and the ILO. In addition, he was a member of the restructuring committee of the Islamic Research and Training Institute, Islamic Development Bank. Apart from the Lahore Journal, he was also a member of the editorial boards of several other international and national journals. Before his sad demise, he was teaching economics at the Islamic University, Islamabad.

As an active member of the Lahore Journal's Editorial Advisory Board, he was always available despite his hectic schedule, and at the most needed a single reminder before sending us his insightful reviews. He will be greatly missed.

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