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Corruption, Endogenous Fertility, and Growth

Matthias Cinyabuguma*

Abstract

While much research in economic development has pointed out the negative impact of corruption on growth, less research has been devoted to studying the relationship between corruption and demographic transition. This theme is developed into an overlapping generation model in which corruption affects fertility decisions through its negative impact on physical capital formation and its productivity. The analysis indicates that, when the level of corruption is high, the productivity of capital is low and fertility is excessively high because of the relatively low cost of raising children. Theoretical and empirical results show that, in both developed and developing countries, corruption creates distortions and leads to low-equilibrium traps. Introducing child quality into the model accelerates the pace of demographic transition and produces effects similar to reducing the level of corruption. Empirical estimates confirm the predictions of the model and support the proposition that fertility declines in less corrupt countries.

Keywords: Endogenous fertility, corruption, productivity of physical capital, economic growth.

JEL Classification: J13, 016, 012, F43.

1. Introduction

Since the work of Shleifer and Vishny (1993) and Mauro (1995), the relationship between corruption and economic development has become a central question in both economic theory and empirical work. Many authors have studied the concept of corruption in terms of bad policies or inefficient institutions (see, for instance, Djankov, LaPorta, Lopez-de-Silanes, & Shleifer, 2002). Their work indicates that corruption negatively affects economic growth by causing various economic inefficiencies and by discouraging the accumulation of both physical and human capital. For example, in many cases, corruption has slowed down economic growth through the misallocation of resources and talents (Murphy, Shleifer, & Vishny, 1991, 1993). A number of other authors conclude that corruption leads to lower economic growth by decreasing

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government revenue, which is needed to finance productive spending (see, for instance, Tanzi & Davoodi, 1997).

Thus, much research in economic development has pointed out the negative impact of corruption on growth, but less research has been devoted to studying the relationship between corruption and demographic transition. In this article, we develop an overlapping-generations model in which corruption affects fertility decisions through its impact on physical capital accumulation and its productivity. When the level of corruption is high, the marginal productivities of capital and labor fall, and fertility is excessively high because of low childbearing costs relative to the costs of capital accumulation. Our results show that, in both developed and developing countries, corruption creates distortions and leads to low-equilibrium traps. While an economic structure with limited corruption encourages savings by citizens—and, hence, the accumulation of physical capital—countries mired in corruption are trapped in poverty with excessively high fertility. This view suggests that corruption affects economic development by deterring investments and making them less productive (da Silva, Garcia, & Bandeira, 2000).

As noted above, there is a large body of literature studying the effects of government spending on economic growth. Most early theoretical work was motivated by the empirical work of Aschauer (1989), among others, and argued that public investment had a substantial positive effect on growth. Starting with Barro (1990), public spending was introduced into the production function to account for its impact on long-run growth. Shleifer and Vishny (1993), among others, have studied the relationship between corruption and economic growth in the presence of weak institutions, and argued strongly that corruption will be stronger where institutions are weak.[1] In particular, Rose-Ackerman (1978) has emphasized the very nature of bureaucratic and legal institutions that are tainted by bribery and corruption.

One of the most striking aspects of economic development has been the demographic transition. Underlying this is the idea that, as an economy goes through the advanced stages of its development process, parents trade off child quantity for child quality. Existing theoretical studies attribute this outcome to particular features of economic

[1] A contrary strand in economic literature suggests that corruption may, in some instances, improve economic welfare (Huntington, 1968, p. 386; Leff, 1964, p. 11). In this regard, corruption induces the more efficient provision of public services, and serves as a bridge for entrepreneurs to bypass inefficient regulations. This article, however, emphasizes the adverse effects of corruption on the provision of public services.

development, such as reduced child mortality (Kalemli-Ozcan, 2003; Soares, 2005); reduced income inequality (de la Croix & Doepke, 2003); increased demand for human capital (Galor & Weil, 2000); improved health (Murtin, 2009); and decreased need for child labor (Hazan & Berdugo, 2002). A number of authors provide further empirical support for these arguments (Becker, Cinnirella, & Woessmann, 2010; Black, Devereux, & Salvanes, 2005; Bleakley & Lange, 2009; Hanushek, 1992; Rosenzweig & Wolpin, 1980); and some place institutions at the center of the demographic transition (Basso & Vilalta, 2011; Wang, 2005).

Although economic historians use institutions to analyze demographic transitions, this article is, to the best of the author's knowledge, the first to directly relate public institutions (public spending), corruption, and the demographic transition. Its core finding is that, during any transition to sustained economic growth, reductions in corruption are instrumental to the onset of demographic transition.

The rest of the article is organized as follows. Section 2 presents the basic features of an overlapping generation economy and its expected performance results. Section 3 reports the model's empirical estimates, and Section 4 concludes the article.

2. The Basic Structure of the Model

2.1. Environment

We begin by positing a closed economy with overlapping generations in which economic activity extends over infinite, discrete periods of time. Each generation consists of homogeneous agents who work in the first period while being retired in the second. In other words, there are two generations—young and old—at each point in time. In the first period, individuals decide what quantity of market goods and education to invest in their children, and thus determine what number of children to have and what portion of income to save for consumption during their own retirement.

We allow for a quadratic child-rearing cost in net income to reflect the fact that time and/or parental resources devoted to raising and educating children could have been allocated to market work or leisure (Birdsall, 1988). Unlike standard models in economic development in which child-rearing time is modeled as forgone earnings, the quadratic time-cost of child rearing reflects the idea that it becomes relatively more expensive for individuals with higher incomes and greater skills. In particular, Becker, Murphy, and Tamura (1990), and Galor and Weil (1996) indicate that increases in parental human capital can increase the opportunity cost of parental time and lower fertility by raising the time cost of rearing a child. Each child born at time t costs z_t evaluated in terms of his parent's income net of government taxes τ_t, with $z_t = b((1-\tau_t)h_t w_t)^2$. [2] h_t is the level of human capital for an adult parent of period t, and w_t is the wage per effective labor.

People enjoy parenthood, and children are thought of as consumption goods (Becker & Barro, 1988). The economic viability of fertility decisions, as reflected by individual choices and the accumulation of capital, depends on the level of corruption, which affects the marginal productivity of capital and the opportunity cost of raising children. In this setting, the cost of raising a child increases when corruption decreases, and falls when corruption rises. Since corruption affects the productivity of physical capital, we conclude that the cost of raising a child will be related not only to the stock of existing physical capital, but also to its effective use.

Following Feng, Kugler, and Zak (2000) and Cinyabuguma (2011), we construct a simple household decision model in which fertility is endogenous and influenced by the opportunity cost of raising children, a parent's level of education, and the use of time and savings related to productive activities. We model corruption very simply as to affect the productivity of capital and, hence, the opportunity cost of raising children. Similar to Feng et al. (2000), the government in this model uses tax revenue to promote policies and institutions that enhance growth. However, its ability to build pro-growth institutions is adversely affected by corruption among public officials. Consequently, fewer resources are spent on public goods that support production and this, in turn, reduces the productivity of physical capital and hampers economic growth.

Since the time-cost of child rearing is defined in terms of missed opportunities, countries with lower capital productivity will have a lower opportunity cost for the time spent raising children and, hence, higher fertility. For simplicity's sake, we assume the proceeds from corruption to be deadweight loss for the economy as a whole.

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[2] The cost of child-rearing imposes an upper limit on the maximum feasible number of children an individual can bear. For example, by making savings equal zero, the maximum number of children a parent can bear is given by $(x)^{max} = 1/b(1-\tau_t)w_t h_t$. To avoid non convexity problems that might arise when making fertility decisions, we neglect integer restrictions on x_t.

The next section formalizes these insights into a dynamic model in which corruption and fertility interact in the process of development.

2.2. Individuals' Preferences

Individuals derive utility in youth from the number of children they have, and in old age from consumption. This can be summarized by the following utility function:

$$U = ln x_t + \beta ln c_{t+1} \tag{2.2.1}$$

Where x_t is the effective number of children born (preferences are shaped by the level of corruption); β is the parameter for time preference; and, c_{t+1} is the old age consumption for a member of generation t. We assume that there is no consumption in the first period of life, and that individuals consume only during their second period of life, i.e. when retired.[3] We further, assume that all goods are perishable, and that the only means of transferring value across periods of life is capital markets. As it will become apparent in this model, corruption affects fertility and savings decisions through the productivity of physical capital.

2.3. Individual Budget Constraints

Since individuals do not generate utility from consumption in their first period of life, their income is divided between the cost of raising x_t children and saving for future consumption. As an adult, a member of generation t faces the following budget condition:

$$s_t = (1 - \tau_t) w_t h_t - x_t z_t \tag{2.3.1}$$

Where s_t accounts for savings per capita in period t, $z_t = b((1 - \tau_t) w_t h_t)^2$ is the per-child spending, and $b \in (0,\ 1/(1 - \tau_t) w_t h_t)$. Unlike standard neoclassical growth models in which the fraction of time (income) devoted to child rearing is exogenous, here, the latter—the fraction of a parent's income devoted to child production, including material goods and education—is endogenous to the process of development.[4] As it will

[3] We could have incorporated consumption in period *t* into the utility function without affecting the qualitative results of this analysis. In fact, if individuals have logarithmic preferences with respect to consumption in the two periods of life, the fraction of output saved in period *t* to be consumed in period *t* + 1 would be constant. Thus, the dynamical equation that governs the evolution of the economy would be altered only by a multiplicative constant. Notice that our formulation is similar to that of Galor and Weil (1996) in that they too assume zero consumption in the first period of life.
[4] In Raut and Srinivasan (1994), and Cinyabuguma (2011) the cost of raising a child varies over time.

become clear, the child-rearing cost, $b(1-\tau_t)w(k_t)h_t$, is proportional to the capital labor ratio. Individuals are homogeneous, and each is endowed with one unit of time-labor which is inelastically supplied on the labor market. The cost of raising a child, z_t, can also be seen as a transfer of goods or value (or a subtraction from the time available for, and in lieu of purchases of market goods from income earned at work) from parents to children.

On reaching old age (period $t+1$), as member of generation t, an individual consumes his/her savings with any accrued interest; i.e.,

$$c_{t+1} = R_{t+1}s_t \tag{2.3.2}$$

Where $R_{t+1} = 1 + r_{t+1} - \delta$, and $\delta = 1$ for simplicity. By combining (2.3.1 and 2.3.2), we derive a lifetime budget constraint which equates the value of all resources to the value of all expenditures. This budget is expressed as

$$R_{t+1}z_t x_t + c_{t+1} = R_{t+1}(1-\tau_t)w_t h_t \tag{2.3.3}$$

The right-hand side of (2.3.3) is the potential income available for old-age consumption if the individual were to save all his/her first-period income. The left-hand side is the opportunity cost of raising x_t children plus all spending on-old age consumption.

*2.4. Individual*s' *Optimization*

Each parent chooses his fertility x_t, which implies his consumption c_{t+1} in old-age, anticipating that there is a corruption tax on capital productivity. A parents' optimization problem can be articulated as

$$Max\ U = lnx_t + \beta lnc_{t+1} \tag{2.4.1}$$

Subject to

$$\begin{cases} s_t = (1-\tau_t)w_t h_t[1 - b(1-\tau_t)w_t h_t x_t], \\ c_{t+1} = R_{t+1}s_t \\ (s_t > 0, x_t > 0, c_{t+1} > 0 \end{cases}$$

Where, as noted above, $b(1-\tau_t)w_t h_t$ is the time cost of raising a child. As in Galor and Weil's (1996) setting, the only decision a parent makes at time t in this model is to choose how many children x_t to have. The individual's optimization problem is then regarded as a x_t that maximizes

$$lnx_t + \beta \ln[R_{t+1}(1-\tau_t)w_t h_t(1 - b(1-\tau_t)w_t h_t x_t)] \tag{2.4.2}$$

The first-order condition for an interior solution amounts to:

$$c_{t+1} = R_{t+1}\beta b((1-\tau_t)w_t h_t)^2 x_t \tag{2.4.3}$$

This yields an equilibrium condition that equates the marginal utility of having an additional child to the opportunity lost from such a decision. Equation (2.4.3) indicates that increases in the opportunity cost of raising children could motivate parents to substitute more of their resources toward savings. However, if corruption rises, the above opportunity cost falls—by a substitution effect, a parent will want to raise more children relative to savings. On solving (2.4.2), and combining (2.4.3) and (2.3.3), we derive the following demand functions for fertility and savings:

$$x_t = \frac{1}{(1+\beta)(1-\tau_t)w_t h_t} \tag{2.4.4}$$

and

$$s_t = \frac{\beta}{(1+\beta)}(1-\tau_t)w_t h_t \tag{2.4.5}$$

It is important to note that corruption matters for decisions about both savings and fertility; it affects (i) an individual's choices through price distortions, and (ii) investment through increased uncertainty and reduced productivity. If the level of corruption is high, the productivity of capital will be low and parents will choose high fertility. Likewise, the savings function depends on corruption through the productivity of capital. If the level of corruption is high, people will save less and, ultimately, the level of output will be low.

2.5. The Government Problem

The government receives tax revenue, $\tau_t w_t h_t L_t$. A fraction $(1-\pi_t) \epsilon (0,1)$ evaporates through corruption, and only a fraction π_t is spent on policies and institutions, i.e., property rights and enforcement of contracts, to support production and enhance growth. Therefore, the amount of resources available for productive activities in the next period will be reduced by corruption, and will equal

$$G_{t+1} = \pi_{t+1}\tau_t w_t h_t L_t \tag{2.5.1}$$

2.6. The Technology

The basic framework we use in this study is a variant of the Barro (1990) and Barro and Sala-i-Martin (1992) models, which we modify to account for corruption. Following empirical evidence from Silva et al. (2000), we assume that corruption reduces the amount of resources available for proactive policies and institutions, and, hence, reduces the productivity of capital.[5]

A single final good is produced by two factors of production: (i) human capital, supplied by young adults, and (ii) physical capital, supplied by older adults. The productivity of physical capital depends on the amount of resources available in the economy for public spending G_t . The final good produced in period t may be (i) consumed in period t, (ii) invested in the production of physical capital that becomes available in period $t+1$, or (iii) utilized to promote proactive policies and productive institutions. The economy at date t consists of L_{t-1} elderly persons and L_t young adults. Since all people are alike, there are $L_t = x_{t-1}L_{t-1}$ units of labor or working adults at each date $t \geq 0$.

The technology of the final good sector satisfies standard neoclassical properties. So we define the total production function as

$$Y_t = F(\pi_t, K_t, H_t) = [G(\pi_t)K_t]^{\alpha} H_t^{1-\alpha} \tag{2.6.1}$$

Where $G(\pi_t) = \pi_t \tau_{t-1} w_{t-1} h_{t-1} L_{t-1}$. Using the production function above and the equilibrium wage below, $G(\pi_t)$ can be written as $\pi_t \tau_{t-1}(1-\alpha)\bar{Y}$; with $(1-\alpha)\bar{Y} \equiv w_{t-1}h_{t-1}L_{t-1}$. Equation (2.6.1) exhibits constant returns to scale with respect to K_t and L_t. K_t denotes the aggregate domestic supply of physical capital owned by elderly agents, $\alpha \in (0,1)$ is the share of income that goes to capital earnings, $H_t = e_t^{\varphi} L_t$; e_t denotes on-the-job experience or the extent of "learning by doing" human capital transmission, G_t represents government spending on productive institutions such as property rights and the enforcement of contracts, and $\pi_t > 0$ is the index for absence of corruption; implying that less corruption boosts the productivity of physical capital.[6]

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[5] As noted earlier, corruption modifies the productivity of physical capital. For instance, two economies with the same amounts of all productive factors and government spending, but with different levels of corruption, will end up with different volumes of production. Less corrupt countries will have greater production, since their capital is more productive. Countries with higher corruption will be less productive.

[6] Silva et al. (2000) estimate the value of α in a Cobb-Douglas technology function and suggested that corruption is a phenomenon that affects economic development only through the productivity of capital.

Let

$$y_t = f(G(\pi_t),\ k_t) \tag{2.6.2}$$

Where, $k_t \equiv \frac{K_t}{H_t}$, $y_t \equiv \frac{Y_t}{H_t}$, and $f(G(\pi),\ k_t)\ is\ C^2$ and satisfies

$$\frac{\partial f\,(G(\pi_t), k_t)}{\partial k_t} > 0 > \frac{\partial^2 f\,(G(\pi_t), k_t)}{\partial k_t^2}, \text{and } f(0) = 0$$

As noted earlier, π_t corresponds to absence of corruption. Consequently, we should expect a positive relationship between π_t and y_t, i.e., $\frac{\partial f\,(G(\pi_t), k_t)}{\partial \pi_t} > 0 > \frac{\partial^2 f\,(G(\pi_t), k_t)}{\partial \pi_t^2}$

We write the intensive production function as

$$y_t = \mathrm{P}(\pi_t k_t)^{\alpha}, \text{where } \mathrm{P} \equiv (\tau_{t-1}(1-\alpha)\bar{Y})^{\alpha} \tag{2.6.3}$$

The factor markets in this model are competitive, and the factor rewards for physical capital and labor (all equal to their marginal products) are paid in terms of the final good. Given the structure of the production technology, the factors' marginal products are

$$R_t = \frac{\partial f\,(\pi_t,k_t)}{\partial k_t} = \alpha P \pi_t^{\alpha} k_t^{\alpha-1} \tag{2.6.4}$$

$$w_t = f(\pi_t, k_t) - \frac{k_t \partial(\pi_t, k_t)}{\partial k_t} = (1-\alpha)P\pi_t^{\alpha} k_t^{\alpha} \equiv w(\pi_t, k_t) \tag{2.6.5}$$

So far, we have evaluated the impact of corruption on individual choices through the marginal productivity of capital. Following (2.6.4) and (2.6.5), the demand functions given by (2.4.4) and (2.4.5) are also affected by corruption through factor prices, and become

$$x_t = \frac{1}{(1+\beta)b(1-\alpha)(1-\tau_t)P\pi_t^{\alpha} k_t^{\alpha} h_t} \tag{2.6.6}$$

and

$$s_t = \left(\frac{\beta}{(1+\beta)}\right)(1-\alpha)(1-\tau_t)P\pi_t^{\alpha} k_t^{\alpha} h_t \tag{2.6.7}$$

Clearly, $\frac{\partial x_t}{\partial \pi_t} < 0$; $\frac{\partial s_t}{\partial \pi_t} > 0$. A country with less corruption will have a lower fertility rate and more savings than a country with a high level of corruption. Notice that in (2.6.6), fertility depends negatively on the time-dependent capital stock, k_t. The negative relationship between fertility and physical capital is instrumental to the onset of demographic transition during sustained economic development.

2.7. Accumulation of Factors of Production

Following (2.6.7), the stock of capital at time *t + 1* is determined by the aggregate supply of savings at time *t*:

$$K_{t+1} = L_t s_t \tag{2.7.1}$$

The equation of motion for working people at time *t*+1 is represented by

$$H_{t+1} = h_{t+1} L_{t+1} = e_{t+1}^{\varphi} L_t x_t \tag{2.7.2}$$

Where e_{t+1} is the level of knowledge acquired through learning by doing or experience. The accumulation of knowledge is proportional to the level of the parent's human capital, h_t, and the number of children, x_t, as below:[7]

$$e_{t+1} = \left(\frac{\omega h_t}{x_t^{\mu}}\right)^{1/\varphi}$$

Where $\frac{\partial e_{t+1}}{\partial \pi_t} > 0$, $\frac{\partial e_{t+1}}{\partial x_t} < 0$

This structure allows for the intergenerational transmission of human capital through workplace skills' transmission; no mention is made of the process linking formal education to human capital.[8]

Following Feng et al. (2000), ω is the maximum rate of intergenerational human capital transmission, and μ is the dilution effect that results from multiple siblings who are competing for their parents' time. In some traditional or poor countries, it is common for families to share child-rearing costs among parents, aunts, grandparents, and other family members, in which case, parents feel the intensity of child

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[7] We ignore any issues of child quality in this analysis, focusing only on the quantity of children. Notice that adding another trade-off through the quality of children will only increase the speed of the demographic transition without altering the main conclusion of the model.

[8] Details on the technology of human capital can be found in Feng et al. (2000). Hanushek (1992) and Downey (1995) indicate that an adult's income and ability to transmit human capital to his or her children is inversely related to the number of children.

competition less. However, in rich countries where such practices are almost nonexistent, the competition for parenting time is severely felt by parents and makes having children even more expensive. Consequently, μ will be high in developed countries and low in developing countries.

We consider that in developing countries $\mu \in \left(0, \frac{1-2\alpha}{\alpha}\right)$ and that in developed countries $\mu > \frac{1-2\alpha}{\alpha}$. We will individually cover the case where $\mu = \frac{1-2\alpha}{\alpha}$. Thus when family size is small, parents will provide more nurturing per child and the adult productivity will be enhanced. Globally speaking, we capture the structure of the human capital of each child h_{t+1} by relating parental human capital h_t and the number of children in the household x_t as follows:

$$h_{t+1} = \left(\frac{\omega h_t}{x_t^{\mu}}\right)$$

As follows from (2.6.6) and (2.7.1), physical capital per effective unit of labor can now be defined as

$$k_{t+1} = \left(\frac{s_t}{e_{t+1}^{\varphi} x_t}\right) \tag{2.7.3}$$

Where from (2.6.6) and (2.6.7), (2.7.3) becomes

$$k_{t+1} = \left(\frac{\beta b\left((1-\alpha)(1-\tau_t)P\pi_t^{\alpha}\right)^2 k_t^{2\alpha} h_t^2}{e_{t+1}^{\varphi}}\right) \tag{2.7.4}$$

Since $e_{t+1}^{\varphi} = \frac{\omega h_t}{[(1+\beta)b(1-\alpha)(1-\tau_t)P\pi_t^{\alpha} k_t^{\alpha} h_t]^{\mu}}$ we have to rewrite (2.7.4) as:

$$k_{t+1} = \Omega_t k_t^{\alpha(2+\mu)} \equiv \phi(k_t) \tag{2.7.5}$$

with $\Omega_t = \left(\frac{\beta}{\omega}\right)(1+\beta)^{\mu}(bh_t)^{1+\mu}\left((1-\alpha)(1-\tau_t)P\pi_t^{\alpha}\right)^{2+\mu}$

$\phi'(k_t) > 0,\ \forall\mu > 0,$ and $\mathrm{P} = (\tau_{t-1}(1-\alpha)\bar{Y})^{\alpha}$ [9]

[9] An increase in parent's human capital or a decrease in corruption helps the accumulation of physical capital of the next generation.

2.7.1. Dynamic Equilibrium

The dynamic system is governed by the evolution of per-unit-of-effective labor physical capital from a historical given initial stock k_0. Instances in which 0 is the only feasible capital stock may occur in this model when the slope of $\phi(k_t)$ is less than one, that is: $\phi'(k_t) < 1$. Assuming the long-run, and $\forall k > 0$, this equation yields the following condition:[10]

$$\pi \leq \left(\frac{\omega k^{1-\alpha(2+\mu)}}{\alpha(2+\mu)\beta(1+\beta)^{\mu}(bh)^{1+\mu}\left((1-\alpha)(1-\tau_t)(\tau_{t-1}(1-\alpha)\bar{Y})^{\alpha}\right)^{2+\mu}}\right)^{\frac{1}{\alpha(2+\mu)}} \equiv \bar{\pi} \quad (2.7.6)$$

Thus, $\bar{\pi}$ is the threshold level of absence of corruption below which 0 is the only feasible steady state for capital stock. With a logarithmic utility function, a Cobb-Douglas production function, endogenous fertility, and a positive dilution, μ, any study of the steady state should discuss the concavity of ϕ:

$$\Phi''(k_t) = \alpha(2+\mu)(\alpha(2+\mu)-1)\Omega_t k_t^{\alpha(2+\mu)-2} \quad (2.7.7)$$

When $\mu \in \left(0, \frac{1-2\alpha}{\alpha}\right)$ and $\pi > \bar{\pi}$, we have $\phi''(k_t) < 0$ and $\phi(k_t)$ is strictly concave. Moreover $\phi(0) = 0$, and 0 becomes an unstable corner solution. However, when $\pi \leq \bar{\pi}$, 0 is a globally stable corner solution. In each case where $\pi > \bar{\pi}$, and for any $k_0 > 0$, there exists a unique, globally stable state given by:

$$k_t^* = \left(\frac{\beta(1+\beta)^{\mu}(bh_t)^{1+\mu}}{\omega\left(\pi_t^{\alpha}(1-\alpha)(1-\tau_t)(\tau_{t-1}(1-\alpha)\bar{Y})^{\alpha}\right)^{-(2+\mu)}}\right)^{\frac{1}{1-\alpha(2+\mu)}} \quad (2.7.8)$$

Assuming that condition 2.7.6 does not hold, the function $\phi(k, \pi_1)$ in Figure 1 depicts the path of an economy beset by severe corruption. In the same Figure 1, when $\pi > \bar{\pi}$, $\phi(k, \pi_2)$ and $\phi(k, \pi_3)$ represent paths for moderate and low corruption, respectively.

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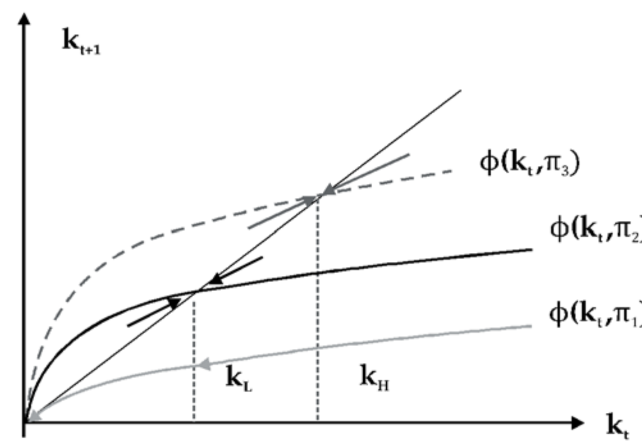
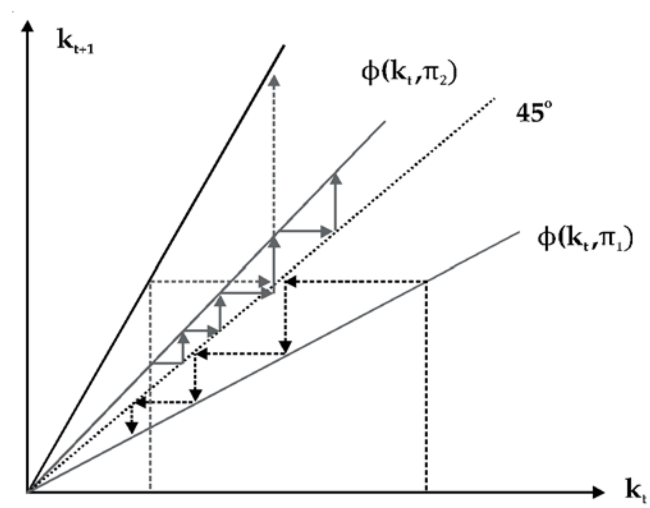
[10] For simplicity's sake, I will drop the time subscript on π whenever writing condition (2.7.6).

Figure 1: A time path of an economy with $\boldsymbol{\mu} \in \left(\mathbf{0}, \frac{\mathbf{1-2\alpha}}{\boldsymbol{\alpha}}\right)$



When $\mu = \frac{1-2\alpha}{\alpha}$, and $\pi > \bar{\pi}$, we have an AK model, i.e., $\phi(k_t)$ is a linear function, and $\phi''(k_t) = 0$. When $\pi \leq \bar{\pi}$, $\phi(0)= 0$ is the only steady state (0 is a globally stable steady state). Figure 2 below depicts three different paths, $\phi(k, \pi_1)$, $\phi(k, \pi_2)$, and $\phi(k, \pi_3)$, corresponding to three different levels of corruption, namely: $\pi_1 < \pi_2 < \pi_3$.

Figure 2: A time path of an economy with $\boldsymbol{\mu} = \frac{\mathbf{1-2\alpha}}{\boldsymbol{\alpha}}$

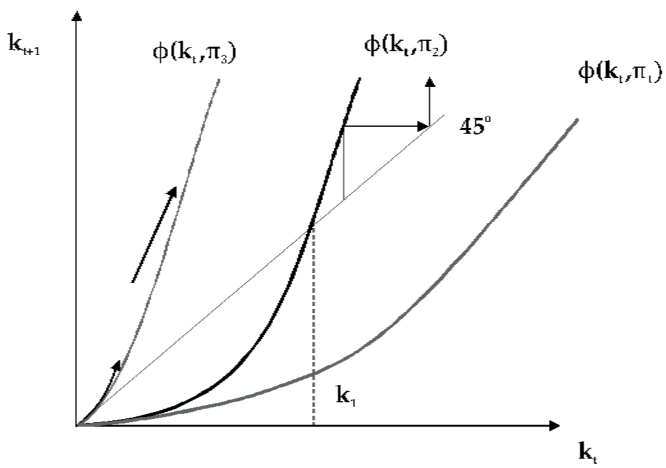


When $\mu > \frac{1-2\alpha}{\alpha}$, and $\pi > \bar{\pi}$, we have $\phi''(k_t) > 0$ and $\phi(k_t)$ is strictly convex. Moreover $\phi(0) = 0$, and 0 is a locally unstable corner solution. 0 becomes a globally stable solution when $\pi \leq \bar{\pi}$. In addition, for each level of $\pi: \pi > \bar{\pi}$, there is an unstable non zero steady state given by

$$k_t^* = \left(\frac{\omega(\pi_t^\alpha(1-\alpha)(1-\tau_t)(\tau_{t-1}(1-\alpha)\bar{Y})^\alpha \quad)^{-(2+\mu)}}{\beta(1-\beta)^\mu(bh_t)^{1+\mu}}\right)^{\frac{1}{\alpha(2+\mu)-1}} \tag{2.7.9}$$

In the "$\phi(k, \pi_3)$" case, where $\pi \geq \bar{\pi}_3$, the zero steady state is not possible provided that the initial capital stock sufficiently high, i.e., $k_o > 0$; (See Figure 3 below). Therefore, at higher levels of π, $\pi \geq \bar{\pi}_3$, the economy is no longer trapped in low-growth, low-investment equilibrium. Instead, it enters the modern growth regime under which income per capita rises and fertility declines. This feature of the model is consistent with historical evidence associated with most industrialized countries, such as the UK, France, Sweden, and Germany (McEvedy and Jones, 1978).

Figure 3: A time path of an economy with $\mu > \frac{1-2\alpha}{\alpha}$



To summarize:

Lemma 1: Given the production function in (2.6.1) and assuming that $\pi > \bar{\pi}$, an increase in π_t has the following effects:

The steady state level of k_t increases when $\mu \in \left(0, \frac{1-2\alpha}{\alpha}\right)$

The steady state level of k_t decreases when $\mu > \frac{1-2\alpha}{\alpha}$

Proof: The proof of lemma 1 follows from equations (2.7.8) and (2.7.9) by taking their derivatives with respect to π_t.

When $\mu > \frac{1-2\alpha}{\alpha}$ we obtain an unstable steady state that yields the threshold level of physical capital above which rich economies would enter a modern growth regime. A fall in this threshold suggests that, in rich countries, less corruption reduces the risk of falling into-low level equilibrium. Consequently, changes in π_t affect steady states levels of y_t.

Proposition 2: Given the results of **Lemma 1** and assuming that $\pi > \overline{\pi}$, an increase in π_t affects the growth rate of output per effective labor.

Proof: In the steady-state, the growth rate of output per effective unit of γ_y, depends solely on π_t. Letting y_t be the level of output per effective labor and $y_t = P\pi_t^\alpha k_t^\alpha$; and assuming the steady state, we obtain

$$\gamma_y = \left(\frac{dP/dt}{P}\right) + \alpha\left(\frac{d\pi_t/dt}{\pi_t}\right) + \alpha\left(\frac{dk_t/dt}{k_t}\right) = \alpha\sigma$$

Where

$$\sigma = \frac{d\pi_t/d_t}{\pi_t}, \text{and } \frac{dk_t/dt}{k_t} = \frac{dP/dt}{P} = 0$$

This proposition implies that, in the long run, even when the stock of capital per effective unit of labor does not change, output per effective unit of labor grows or shrinks at the rate of change in the level of corruption. In fact, an economy with less corruption will grow faster because it will attract more investment, induce lower fertility, allow for greater human capital transmission, and permit a high level of physical capital accumulation.

2.7.2 Fertility and Development Trajectory

In the steady state, and as noted above from (2.4.4), (2.6.6) and (2.7.8) or (2.7.9), k_t^* determines uniquely a stationary fertility rate:

$$x(k_t^*) = \frac{1}{(1+\beta)b(1-\alpha)(1-\tau_t)P\pi_t^\alpha k_t^{*\alpha} h_t},\ P \equiv (\tau_{t-1}(1-\alpha)\bar{Y})^\alpha$$

The demographic transition can be linked to reductions in corruption through capital productivity. Along the development path and during the transition to balanced growth, fertility depends on k_t; and as corruption decreases, existing capital becomes more productive, the opportunity cost of raising children increases, and fertility declines. Following (2.4.4), (2.6.5), and (2.7.5), and taking the derivative of (2.6.6) with respect to k_t, we obtain that:

$$\frac{\partial x_t}{\partial k_t} = \left(\frac{-\alpha}{(1+\beta)b(1-\alpha)(1-\tau_t)P\pi_t^{\alpha}k_t^{\alpha}h_t k_t}\right) < 0 \qquad (2.7.10)$$

The above equation indicates that during the transition to balanced growth, fertility depends negatively on both π_t and k_t. Thus, this model does capture the demographic transition.

To summarize:

Proposition 3: During the transition from low-level equilibrium to sustained economic growth, reductions in corruption followed by increases in marginal productivity of capital are instrumental to the onset of demographic transition.

Proof: The proof of this result follows from equation (2.7.10) and **Lemma 1**.

3. Empirical Analysis

In our model, long-run growth and demographic transition are viewed as outcomes of decreases in corruption, followed by increases in capital productivity. This phenomenon is reinforced by incorporating endogenous child-rearing costs in the model. Understanding how fertility responds to changes in corruption becomes crucial to the study of long-run growth and the demographic transition. Therefore, our empirical strategy emphasizes the model's implications for fertility.

As noted above and following (2.6.6), this model predicts that (i) fertility falls when corruption rises, (ii) the amount of physical capital grows, and (iii) parents' level of education increases. Our regression model is derived from (2.6.6) by applying the log transformation on both sides of the equation as

$$\ln x_t = ln\left(\frac{1}{(1+\beta)b(1-\alpha)(1-\tau_t)P\pi_t^{\alpha}k_t^{\alpha}h_t}\right)$$

or equivalently,

$$\ln x_{it} = \alpha_0 + \alpha_1 ln\pi_{it} + \alpha_2 \ln k_{it} + \varphi \ln e_{it} + u_{it}$$

Where $\alpha_0 \equiv ln\big((1+\beta)b(1-\alpha)(1-\tau_t)P\big)$, and $h_t = e_t^{\varphi}$ [11]

[11] In this particular regression equation where fertility is the endogenous variable, α_1 and α_2 do not need to be equal.

We use fixed effects models to properly address any unobserved heterogeneity that might be correlated with our independent variables:

$$\ln x_{it} = \alpha_0 + \alpha_1 ln\pi_{it} + \alpha_2 \ln k_{it} + \varphi \ln e_{it} + Z_i + \eta_i + u_{it} \qquad (3.0.1)$$

Where lnx_{it} is the log of total fertility rate observed for country i at time t, $ln\pi_{it}$ is the log of absence of corruption, lnk_{it} is the log of physical capital per effective labor, lne_{it} is the log of completed secondary education, Z_i is a vector of time invariant-variables, η_i is the unobserved country effect, X_{it} is the time variant regressor, and u_{it} is the error term. η_i is associated with sociocultural and historical factors. We assume that η_i is not independent of X_{it}, Z_i.[12]

To get rid of country effects η_i, a within transformation is applied to the data, and α_1, α_2, and φ are then estimated using ordinary least squares.

Our data covers the period 1960–2000 for about 94 countries. We organize all data on fertility rates and other variables for which measures are available into eight half-decade observation periods for 1965–69, 1970–74, etc., to account for any missing observations for some sub-periods. This gives us between five and eight observations for most countries.

Data and sources used are: Gross Domestic Product per capita (GDPpc), Total Fertility Rate, the percentage of the population that belongs to the Catholic faith (Catholic), the percentage of the population that belongs to the Muslim faith (Muslim), the percentage of the population that belongs to the Protestant faith (Protestant), Latitude, British Legal Origin (Leg_British), and French Legal Origin (Leg_French) are from the World Bank (WDI, 2010). Data on schooling ((Schooling), Average years of schooling for those 25 years old and over) were from Barro and Lee (2000). Data on corruption is based on the Corruption Perception Index (CPI) from Transparency International, and is available from 1995. We used a five-year average from 1995-2000. (http://www.transparency.org/policy_research/surveys_indices/cpi.)

In Tables 1 and 2, we use the log of the total fertility rate as our dependent variable, and a set of independent variables that includes

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[12] For simplicity's sake, the empirical model will use log of GDP per capita as a proxy for log of physical capital stock, k_{it}. Because of data limitation on literacy rate, we use completed secondary education to proxy for human capital. In this very particular case, literacy rate would have been the best proxy for human capital acquired through experience and learning by doing. However, both years of education and literacy rate are correlated, and literacy rate is included in the years of education since it measures the proportion of the population that has achieved a given minimum level of education.

measures of education, GDP per capita, corruption, and a number of income dummies. The model also includes a dummy variable for sub-Saharan countries. We control for religious factors (the proportion of population that is Catholic, Muslim, or Protestant). Religion and countries' legal origins play key roles in explaining heterogeneous fertility trends across countries and over time (Bloom & Humair, 2010). Following tests to determine endogeneity and over-identification (see Table 2), legal origins are best used as an instrument for corruption. The first-stage results (Table A1 in Appendix 1) suggest that legal origins affect fertility through corruption. Table 1 reports the fixed effects results of a panel data analysis of equation (3.0.1).

Turning to the estimates, the coefficients of ln(GDPpc) and ln(Schooling) are always significant and have the expected signs across all regressions. A 1-percent rise in GDPpc leads to a fall of about 0.27 percent in the fertility rate; likewise, a 1-percent rise in the level of an adult parent's human capital in period *t* causes the fertility rate to fall by about 0.04 percent. Measures of corruption were included in columns 1–4 of Table 1, and appeared statistically significant in all columns but the fourth, even after controlling for various other determinants suggested in this article, such as per-capita income and religious factors.

We included dummy variables for low-, middle-, and high-income countries as well as for sub-Saharan countries to test that our results were not due to missing-variable bias.[13] The dummy for low-income countries carried a positive sign but was not statistically significant. Dummies for middle-income and sub-Saharan countries were all statistically significant ($p < 0.05$) with positive signs, suggesting that fertility is likely to be high both in middle-income and sub-Saharan countries.

Of particular interest is the dummy variable for high-income countries in the fourth column. While this variable is statistically significant, it has an unexpected negative sign, and whenever it is accounted for in the model, the coefficient of the corruption variable becomes negative and insignificant. This phenomenon suggests that the dummy variable reflects other variables that might affect fertility in high-income countries.

We used slope dummy variables in which corruption interacted with each of the three dummies for income levels (low, middle, and high).

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[13] Using World Bank values, we classify countries as low-, middle-, or high-income. The World Bank's criteria classify countries with per capita income (in 1997 figures) (i) below USD785 as low-income, (ii) USD785–9,655 as middle-income, and (ii) equal to or above USD9,655 as high-income.

Table 1: Fixed Effects (within) Regression with Level and Slope Dummies

Dependent variable = log (total fertility rate)

Indep't variable	1	2	3	4	5	6
InGDPpc[a]	-0.293***	-0.289***	-0.287***	-0.213***	-0.281 ***	-0.251 ***
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.016)
InSchooling[b]	-0.039***	-0.037***	-0.059***	-0.043***	-0.023***	-0.039***
	(0.012)	(0.013)	(0.013)	(0.011)	(0.013)	(0.012)
InCorruption[c]	0.095***	0.097***	0.040*	-0.0006	0.101***	
	(0.022)	(0.023)	(0.024)	(0.022)	(0.022)	
Catholic[a]	0.0032***	0.0032***	0.0028***	0.0021 ***	0.0033***	0.0023***
	(0.0003)	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0003)
Muslim[a]	0.0046***	0.0046***	0.0041***	0.0034***	0.0047***	0.0033***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Protestant[a]	0.0043***	0.0043***	0.0036***	0.003***	0.004***	0.002***
	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0005)
DLowInc		0.0166				
		(0.0351)				
DMdlInc			0.125***			
			(0.023)			
DHighInc				-0.358***		
				(0.036)		
SSA					0.087***	
					(0.032)	
CorXLowInc[c]						0.026***
						(0.006)
CorXMdlInc[c]						0.028***
						(0.005)
CorXHighInc[c]						-0.033***
						(0.009)
Constant	3.437***	3.401 ***	3.474***	3.119***	3.282***	3.223***
	(0.1686)	(0.1850)	(0.1654)	(0.1610)	(0.1770)	(0.1370)
No. of observations	689	689	689	689	689	713
R overall	0.72	0.72	0.74	0.74	0.72	0.74
F (*k*, n)	308.16	263	278	314	267.6	184.4
P-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: The table presents fixed effect estimates of model's coefficients via within (between) regression model. Standard errors are given in parentheses. Asterisks *, **, and *** indicate significance at 10, 5, and 1 percent levels, respectively.

Sources: Data used to calculate variables is from: a = the World Bank (2010); b = Barro and Lee (2000) for average number of years of schooling for those aged 25 or over; c = corruption perception index from Transparency International (available from 1995; we used a five-year average for the period 1995–2000).

The results presented in column 5 of Table 1 indicate that fertility increases with corruption in low- and middle-income countries, and decreases when corruption rises in high-income countries. This last result might relate to the fact that high-income countries' fertility rates have dropped below the replacement level. We were concerned by a possible endogeneity bias between fertility and corruption. A reverse causality between fertility and corruption may run through income inequality. In fact, high fertility rates foster income inequality within and across countries, and income inequality, in turn, increases corruption (You & Khagram, 2005).

Table 2 reports the estimates of a set of two-stage least-squares (2SLS) regression models in which latitude and legal origins are used as instruments to predict corruption, assuring that all our results pass the tests for endogeneity of the latter variables and for over-identifying restrictions.[14]

There are good reasons to expect legal origin and latitude to perform well as instruments for corruption in a regression involving fertility. There is a strong affinity between a country's legal origins and the historical presence of a colonizing power. Consistent with this, corruption was much higher in countries with French legal origins than in those with British legal origins (in fact, countries tend to inherit their colonizers' institutions).[15] Likewise, latitude was found significantly related to productivity growth, which, in turn, is shaped by the quality of existing institutions, including the level of corruption. For example, Mauro (1995), La Porta, Lopez-de-Silanes, Shleifer, and Vishny (1998), and Hall and Jones (1999), among others, have suggested that distance from the equator (*latitude*) can be used as an instrument for corruption in income-inequality regressions.

[14] We use the Wu-Hausman and Durban-Wu-Hausman tests of endogeneity to assess that the instruments successfully predict the relevant endogenous variable. We use the Sargan and Basmann tests of over-identifying restrictions to ensure that the instruments can be excluded from the 2SLS regression.

[15] Fredriksson and Svensson (2002) use the legal origins of a country as an instrument for corruption: They claim that the legal system of the country affects the way property rights are set and this, in turn, affects corruption.

Table 2: 2SLS Regressions for IV Models

Dependent variable = log (Total Fertility rate)

Indep't variable	1	2	3	4	5
InGDPpc[a]	-0.148***	-0.148***	-0.147***	-0.149***	-0.148***
	(0.033)	(0.037)	(0.038)	(0.032)	(0.034)
InSchooling[b]	-0.078***	-0.078***	-0.076***	-0.077***	-0.078***
	(0.014)	(0.015)	(0.016)	(0.015)	(0.015)
InCorruption[c]	0.374***	0.372***	0.378***	0.393***	0.375***
	(0.058)	(0.062)	(0.087)	(0.102)	(0.058)
Catholic[a]	0.0023***	0.0023***	0.0024***	0.0025***	0.0023***
	(0.0004)	(0.0004)	(0.0004)	(0.0005)	(0.0005)
Muslim[a]	0.0041***	0.0041***	0.0041***	0.0042***	0.0041***
	(0.0005)	(0.0005)	(0.0005)	(0.0006)	(0.0005)
Protestant[a]	0.0083***	0.0083***	0.0083***	0.0086***	0.0083***
	(0.001)	(0.0001)	(0.0013)	(0.002)	(0.001)
DLowInc		-0.002			
		(0.043)			
DMdlInc			0.0077		
			(0.044)		
DHighInc				-0.032***	
				(0.087)	
SSA					-0.007
					(0.038)
Constant	1.856***	1.870***	1.853***	1.828***	1.860***
	(0.347)	(0.389)	(0.429)	(0.416)	(0.355)
No. of observations	689	689	689	689	689
Adjusted E′′	0.64	0.64	0.64	0.763	0.64
Sargan (X^2)	6.08 (0.11)	6.1 (0.11)	6.13 (0.11)	5.98 (0.11)	6.19 (0.10)
Basmann (X^2)	6.05 (0.11)	6.05 (0.11)	6.08 (0.11)	5.94 (0.11)	6.14 (0.10)
WH (X''^2)	57.9 (0.00)	53.1 (0.00)	34.12 (0.00)	29.69 (0.00)	58.75 (0.00)
DWH (F)	54.0 (0.00)	49.9 (0.00)	32.92 (0.00)	28.82 (0.00)	54.79 (0.00)
Instruments[a]	Latitude Latitude sq. LegalBritish LegalFrench	Latitude Latitude sq. LegalBritish LegalFrench	Latitude Latitude sq. LegalBritish LegalFrench	Latitude Latitude sq. LegalBritish LegalFrench	Latitude Latitude sq. LegalBritish LegalFrench

Notes: Over-identifying restrictions are conducted through the Sargan (χ^2) and Basmann (χ^2) tests; endogeneity tests are conducted through the Wu-Hausman f-test (F) and Durbin-Wu-Hausman (χ^2) test. P-values are given in parentheses. Asterisks *, **, and *** indicate significance at 10, 5, and 1 percent levels, respectively.

Sources: Data used to calculate variables is from: a = the World Bank (2010); b = Barro and Lee (2000) for average number of years of schooling for those aged 25 or over; c = corruption perception index from Transparency International (available from 1995; we used a five-year average for the period 1995–2000).

Overall, the 2SLS results in Table 2 are far better than the fixed effects results in Table 1. The coefficients of all corruption variables were much larger and remained statistically significant at 1 percent in all five regressions in which they were included, even after controlling for income per capita, religion-related variables, legal origins, and various dummy variables. Likewise, the coefficients of schooling were much larger and remained significant at 1 percent with the predicted signs. The coefficients of ln(GDPpc) shrank by about 50 percent but remained statistically significant at 1 percent and carried the expected sign. The dummy for high income was also significant at 1 percent but carried a negative sign, suggesting that fertility decreases in high-income countries. However, unlike the results in column 4 of Table 1, here the coefficient of corruption remained highly statistically significant with the expected sign. Other dummies for low- and middle-income countries were only significant in the first-stage regressions.

The results presented in Tables 1 and 2 support the main prediction of our model, i.e., that decreases in corruption reduce fertility and stimulate economic growth. Our findings provide additional insights into the effects of corruption on fertility in developing versus developed countries.[16]

4. Conclusion

In this article, we wanted to show that reduction in corruption is one of the major driving forces behind economic growth and demographic transition. We constructed a simple theoretical model in which corruption (i) modifies the productivity of physical capital by reducing the amount of resources available for proactive policies and productive economic activities, and (ii) affects the opportunity cost of raising children. Unlike standard growth models in which child-rearing costs are exogenous, we endogenized the opportunity cost of raising children to properly account for parents' trade-off between working and raising children. Both our theoretical and empirical results suggest that, during the transition from a low-level equilibrium to sustained economic growth, reductions in corruption, followed by increases in the marginal productivity of capital, are instrumental to the onset of demographic transition. Results based on fixed effects and 2SLS regressions indicate that corruption is highly predictive of fertility, even after controlling for GDP per capita, education, and religious and historical factors, such as legal origins.

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[16] In all Tables, we were concerned with a possible endogeneity between y_t and fertility rate. We tested this by replacing y_t with its lags and we find the regression results did not change.

In addition, our results indicate that fertility increases in both middle-income and sub-Saharan African countries, while it decreases in high-income countries. The effect of corruption on fertility remains statistically significant and positive in both low- and middle-income countries, but negative and statistically significant in high-income countries. Further research will extend this model to endogenize corruption and to account for the three regimes of demographic transition: the Malthusian Regime, the Post-Malthusian Regime, and the Modern Growth Regime.

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Appendix

Table A1: First-Stage Regressions for IV Models

Dependent variable = In corruption

Independent Variable	1	2	3	4	5
InGDPpc	-0.352***	-0.374***	-0.322***	-0.212***	-0.357***
	(0.029)	(0.030)	(0.028)	(0.032)	(0.029)
InSchooling	0.0076	-0.009	-0.035*	-0.017	-0.0002
	(0.018)	(0.019)	(0.019)	(0.018)	(0.020)
Catholic	0.0019***	0.0018***	0.0011*	0.0009	0.0018***
	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0006)
Muslim	0.0006	0.0005	0.0004	0.0001	0.0006
	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Protestant	-0.005***	-0.006***	0.0075***	0.0083***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Latitude	1.811 ***	1.748***	1.649***	1.719***	1.789***
	(0.513)	(0.324)	(0.315)	(0.310)	(0.325)
Latitude sq.	-4.658***	-4.4 73***	-3.847***	-3.710***	-4.637***
	(0.513)	(0.515)	(0.510)	(0.502)	(0.514)
LegalBritish	-0.0169	-0.0188	-0.035	-0.046	-0.015
	(0.066)	(0.065)	(0.063)	(0.063)	(0.065)
LegalFrench	0.149	0.145	0.076	0.017	0.015
	(0.075)	(0.074)	(0.073)	(0.073)	(0.074)
DLowInc		-0.145***			
		(0.053)			
DMdlInc			0.263***		
			(0.028)		
DHighInc				-0.528***	
				(0.063)	
DSSA					-0.055
					(0.049)
Constant	4.335***	4.580***	4.099***	3.494***	4.406***
	(0.218)	(0.235)	(0.214)	(0.231)	(0.228)
No. of observations	689	689	689	689	689
Adjusted R	0.76	0.76	0.77	0.78	0.76

Notes: The table presents estimates of model's coefficients via first-stage IV regression model. Standard errors are given in parentheses. Asterisks *, **, and *** indicate significance at 10, 5, and 1 percent levels, respectively.

Appendix

Definition of Variables used in the empirical model:

1. lnGDPpc = log GDP per capita.
2. lnSchooling = log completed secondary schooling.
3. Catholic = percentage of people who are Catholic.
4. Muslim = percentage of people who are Muslim.
5. Protestant = percentage of people who are Protestant.
6. LegalFrench = French legal origin.
7. LegalBritish = British legal origin.
8. DLowInc = dummy variable for low-income countries.
9. DMdlInc = dummy variable for middle-income countries.
10. DHighInc = dummy variable for high-income countries.
11. CorXLowInc = corruption times dummy variable for low-income countries.
12. CorXMdlInc = corruption times dummy variable for middle-income countries.
13. CorXHighInc = corruption times dummy variable for high-income countries.
14. DSSA = dummy variable for sub-Saharan African countries.
15. lnCorruption = log of corruption.
16. Latitude = latitude.
17. Latitude sq. = latitude squared.

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Tariffs, Trade and Economic Growth in a Model with Institutional Quality

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Abstract

This article shows how institutional quality can affect the relationship between trade and growth. Our model looks at an economy in which the export sector is a high-innovation sector. In this economy, a government that is politically threatened by innovation can use its tariff policy to block innovation and increase domestic revenues. In this case, higher tariffs reduce economic growth and the government faces a tradeoff: It can either (i) raise tariffs, collect greater rents, and increase stability; or (ii) it can reduce tariffs and increase long-run growth and instability. When the quality of a country's institutions are reflected in the costs of increasing tariffs, it can be shown that countries with strong institutions gain more (in terms of growth) from trade than countries with weak institutions, due to the effect of institutions on trade policy. It is also possible to show that the quality of institutions in one country can spill over into another by affecting its trading partner's growth rate of income. However, these results are reversed in the case where a country has a highly innovative domestic sector—this explains the tariff-growth paradox in which countries experience higher growth with higher tariffs in earlier stages of development, but higher growth with lower tariffs in later stages of development.

Keywords: Economic growth, institutions, trade, tariffs.

JEL Classification: O41, O43, E1, F13.

1. Introduction

This study provides a new link between institutions, tariffs, and growth. More specifically, it shows how the quality of a country's institutions helps determine the tariff level set in the economy. This tariff level, in turn, influences the economy's rate of growth. Though institutions can sometimes be used for very specific aspects of an economy, we use the general definition of institutions provided by North (1990):

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> Institutions are the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction. In consequence they structure human incentives in human exchange, whether political, social or economic.

Thus, institutional quality will measure (i) the quality of formal rules (such as property rights, the legal system, etc.) and informal rules (such as trust and conventions) in an economy; and (ii) the impact of these rules on determining trade policy.

Economists such as North (1990) have discussed the effect of institutional quality on a country's growth rate, and many others have established the empirical link (see Acemoglu, Johnson, & Robinson, 2001; Barro, 1997; Knack & Keefer, 1995), but the effect of institutions on tariff policy has been relatively neglected. Some economists have analyzed the relationship from a political perspective: Hillman (1982) discusses political support-maximizing protectionist responses for declining industries. Another well-known analysis is by Grossman and Helpman (1994), who model the structure of trade protection to reflect the outcome of a competition for political favors.

Though these models focus on the political reasons for the level of protection set by a country's government, they can also be viewed as specific institutional explanations for a government's trade policy formulation. Thus, the size, influence, or contributions from lobbying are just one piece of the entire institutional puzzle that explains why governments raise or lower tariffs.

What makes our model different is that institutional quality plays a key role in determining the level of tariffs that are set in an economy. More specifically, a country with stronger institutions bears higher "costs" of tariffs than a country with weaker institutions. These costs can be seen in two ways: (i) a country with strong institutions might have a more efficient direct tax collection and enforcement mechanism, which makes the relative cost of tariff collection higher; or (ii) the costs of imposing tariffs can be seen as political costs, in which a government with better institutions is more apt to respond to domestic and foreign pressures for free trade. In this paper, no matter which interpretation is used, we expect countries with better institutions to have lower tariff levels.

Graphical evidence of this relationship is shown in Figure 1 (Appendix B), which plots the relationship between the effective tariff rate (taken from the Sachs & Warner, 1995, dataset) and institutional quality (taken from the International Country Risk Guide's corruption index) across countries. The figure suggests that there may be a negative relationship between tariffs and institutions—the correlation coefficient between the two variables is -0.57; if one excludes India (which has very high tariffs) as an outlier, then the correlation coefficient rises to -0.70.

However, it is important to note that this correlation does not automatically prove causation: a better functioning legal system may improve tax collection, which could lead to lower tariff rates. Similarly, lower tariff rates may lead to greater competition, in turn leading to improved institutions. In actuality, both channels exist, and separating the impact of the two is an interesting exercise. But the scope of this article is limited to looking at how improved institutional quality affects a government's determination of tax policy, which, in turn, impacts innovation and economic growth.

The second economic relationship modeled in this study is that between tariffs and growth. The oft-quoted Sachs-Warner (1995) results imply that openness (or lower protection) affects growth positively, but this has come under some scrutiny by Rodriguez and Rodrik (1999). Since then, Clemens and Williamson (2001) have weighed in on the side of Sachs and Warner, and found that the relationship between tariffs and growth was negative for the last three decades. But their findings—preceded by similar results by O'Rourke (2000)—present another problem: While, in recent times, higher tariffs may have been accompanied by lower growth, higher tariffs were accompanied by higher growth in the late 19th and early 20th centuries. This is illustrated in Figure 2 (Appendix B). What is the difference now as compared to the past?

Our model explains this "tariff-growth paradox" as follows. What higher tariffs basically do is reallocate labor from the export sector to the domestic production sector. Now, if the export sector was predominantly made up of agricultural or basic manufactured goods, then a reallocation of labor out of the export sector would lead to more labor going into high productivity research in the domestic sector. This, in turn, would lead to more innovations and higher growth. Thus, if higher tariffs reallocate labor from a low-innovation export sector to a higher-innovation domestic sector, then higher tariffs will lead to higher growth.

On the other hand, if the export sector was the higher-innovation sector, then higher tariffs would lead to labor moving out of the high-innovation sector and into the low-innovation sector, thus reducing growth. One explanation for the "tariff growth paradox" could therefore be that, in the late 19th century, higher tariffs led to labor being pushed into higher-innovation domestic industries. But in the late 20th century, with greater trade links, the export sector had become the higher-innovation sector. Thus, growth would be reduced if tariffs were raised. This idea is supported by Broadberry (1998), who finds that the shift of resources out of agriculture can account for significant productivity growth in countries such as Germany, the UK, and the US in the late 19th century.

Thus, institutions help determine tariffs and, in turn, tariffs help determine growth. But there is one more aspect to the model: Tariffs not only generate revenue for the government, they can also be viewed as political tools for reducing political instability. Recent work by Chaudhry and Garner (2006, 2007) and earlier work by Dinopoulos and Syropoulos (1999) has focused on how innovation is capable of politically destabilizing a government.

The model we present here yields a way in which tariffs can be used to (i) block innovation, and (ii) increase political stability. The first can be achieved by reducing the amount of competition faced by the domestic sector, reducing the need for these sectors to innovate. The second, political stability, can be brought about by protecting the interest of economic elites, which would increase the chances for reelection (see Grossman & Helpman, 1994). Thus, higher tariffs can either increase political stability either by blocking innovation or by increasing the chances of reelection. The model shows how institutional quality and tariffs affect a country's growth rate, and presents an interesting idea of institutional spillovers in which institutions influence a country's tariff policy, which in turn affects the growth rates of its trading partners.

Section 2 explains the model in question, Section 3 presents its results, and Section 4 concludes the article.

2. The Model

Our model is an extension of the ''tariffs and Schumpeterian growth'' model of Dinopoulos and Syropoulos (1997),[1] and presents a dynamic two-country and three-commodity model of Schumpeterian

[1] Dinopoulos and Segerstrom (1999) present a similar model.

growth (see also Aghion & Howitt, 1992, 1999), trade, and tariffs. Section 2.1 describes the basic Dinopoulos and Syropoulos model, while Section 2.2 extends this basic model by adding to it a government "welfare function" through which the tariff rate set on imports is endogenously determined. We go on to examine the effect of tariff reductions on long-run growth rates, and then compare these changes in growth rates across countries with differing qualities of institutions.

2.1. The Basic Dinopoulos and Syropoulos (1997) Model

The basic model contains two countries, denoted by superscripts $i = 1, 2$. Each country comprises three sectors, denoted by subscripts $j = 0, 1, 2$, each producing one good: (i) a nontraded good, denoted by the subscript $j = 0$, in which there are endogenous process innovations due to research and development (R&D); (ii) a traded good, 1, denoted by subscript $j = 1$, for which endogenous process innovations due to R&D occur only in country 1 and not in country 2—thus, only country 1 produces that good; and (iii) a traded good, denoted by subscript $j = 2$, for which endogenous process innovations due to R&D occur only in country 2 and not in country 1—thus, only country 2 produces that good.

The assumptions above imply that country 1 has a comparative advantage in the production of good 1, whereas country 2 has a comparative advantage in the production of good 2. Additionally, we assume that there are no technological spillovers from country 1 to country 2 in sector 1 (or from country 2 to 1 in sector 2).[2]

Comparative advantage would dictate that each country should eventually specialize in the production of the good in which it has a comparative advantage. Even if country i imposed a tariff on imports of good j (to protect its inefficient j sector), eventually foreign innovations would push the tariff-inclusive price of the imported good below the price of the good produced domestically. Thus, the assumption of complete specialization is made with country 1 producing the world output of good 1 and country 2 producing the world output of good 2.

The pattern of trade in this model is that country 1 produces good 0 domestically and consumes the final output; it also produces good 1 domestically, consumes a certain amount, and exports the rest to country 2.

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[2] The model's results would remain the same if one were to assume that country i was not at the frontier of technology in the production of good j, which would mean that it was at least one innovation behind country j in the good j sector.

The only primary factor of production in the model is labor, which, in each country, can be used to produce final output and provide R&D services. The latter result in random discoveries of better production methods that improve the productivity of the labor used to produce final goods.

For simplicity, the model is set up for country 1 (represented by the superscript 1). Analogous setup, market-clearing conditions, and steady state solutions can be obtained for country 2. The inter-temporal utility function of the representative consumer in country 1 is

$$U^1 = \int_0^\infty e^{-\rho t} ln\big(u^1(t)\big)dt \qquad (1)$$

The term $\rho > 0$ is a constant discount rate, and $ln(u^1(t))$ is the consumer's instantaneous utility. Additionally,

$$u^1(t) = \prod_{j=0}^{2}\left[d_j^1(t)\right]^{\alpha_j} \qquad (2)$$

Here $\alpha_j>0$, $\sum_{j=0}^{2}\alpha_j=1$ and $d_j^1(t)$ is the quantity of good *j* demanded by the representative consumer in country 1 at time *t*.

At time *t*, the instantaneous expenditure per consumer in country 1 across all goods is $E^1(t)E$. Solving the consumer's static optimization problem, we obtain

$$d_j^1(t) = \alpha_j E^1(t)/p_j^1(t) \qquad \forall j = 0, 1, 2 \qquad (3)$$

$p_j^1(t)$ is the price of good *j* in country 1 at time *t*.

If the labor force in country 1 is equal to L^1, the aggregate demand for good *j* in country 1 is:

$$D_j^1(t) = L^i d_j^{1i}(t).$$

Consumers maximize their expected discounted lifetime utility, so solving their inter-temporal optimization problem yields

$$\dot{E}/_{E^1(t)} = r^1(t) - \rho \qquad (4)$$

where $r^1(t)$ is the instantaneous interest rate of country 1.

Let $q_j(t)$ denote the world price of good j at time t, and $T_j^1(t)$ denote the ad-valorem tariff levied by country 1 on its imports. At this point, we make the assumption that neither country's government levies any tariffs or taxes on its own nontraded good or exported good. The domestic price of country 1's imported good is

$$p_j^1(t) = T_j^1(t)\, q_j(t), \text{ where } T_j^1(t) = (1 + \tau_j^1(t))$$

Defining $Y_j^1(t)$ as country 1's expenditure on good j, and $Y_j(t) = \sum_{\epsilon N} Y_j^i(t)$ as the world's expenditure on good j as a whole (both measured in world prices), we can use Equation (3) to obtain

$$q_j(t) D_j^1(t) = \alpha_j L^1 E^1(t)/T_j^1(t) = Y_j^1(t) \qquad \forall_j = 0, 1, 2 \tag{5a}$$

$$q_j(t)\left[\sum_{h\epsilon N} D_j^h(t)\right] = Y_j(t) \tag{5b}$$

An important feature of the model is that it assumes Bertrand competition, which results in limit-pricing strategies—the monopolist does not charge monopoly prices, but instead a price just low enough to drive out holders of less quality intermediates. Let X_j^1 denote the output of good j in country 1, and $v(1, j) \in \{0, 1, 2\ldots\}$ denote the number of innovations that have occurred in sector j of country 1. If $\gamma_j > 1$ represents the increment in labor productivity per innovation in sector j, and L_j^1 represents the labor allocated to manufacturing in sector j in country 1, the following are the production functions for the final goods:

$$X_j^1 = \begin{cases} \gamma_j^{1+v(1,j)} L_j^1 & if\ j = 0, 1 \\ L_j^1 & if\ j \neq 0, 1 \quad \text{where } \gamma_j^{1+v(1,j)} > 0 \end{cases} \tag{6}$$

This equation implies that country 1 could utilize one unit of labor to produce $\gamma_0^{1+v(1,0)}$ units of the nontraded good (0), or $\gamma_1^{1+v(1,1)}$ units of the exported good (1). The country could also use one unit of labor to produce one unit of good 2. This implies that country 1 has a comparative advantage in producing good 1 for all time periods.

From this we can determine the profits of country 1's monopolists in the nontraded good (0) and the export good (1).

$$\pi_0^1 = \left[p_0^1 - \omega^1/\gamma_0^{1+v(1,0)}\right] D_0^1 \tag{7a}$$

$$\pi_1^1 = \left[q_1(t) - \omega^1/\gamma_1^{1+\upsilon(1,1)}\right]\left[\sum_{h\epsilon N} D_1^h\right] \quad (7b)$$

Given that $p_0^1 = \omega^1/\gamma_0^{1+\upsilon(1,0)}$ and $q_1\ (t) = \omega^1/\gamma_1^{1+\upsilon(1,1)}$, we can use Equations (5) and (7) to rewrite the profit functions as

$$\pi_0^1 = [1 - 1/\gamma_0]p_0^1 D_0^1 = [1 - 1/\gamma_0]Y_0^1 \quad (8a)$$

$$\pi_1^1 = [1 - 1/\gamma_1]q_1\left[\sum_{h\epsilon N} D_1^h\right] = [1 - 1/\gamma_1]Y_1 \quad (8b)$$

In addition to devoting labor to final production, each country devotes labor to R&D to improve labor productivity. The model assumes that there is free entry into the R&D race, or that workers are employed in R&D up until its expected gains equal its expected costs. In country 1, the *k*th firm producing good j devotes n_{jk}^1 units of labor to R&D, with the sector-wide quantity of labor devoted to R&D equal to $n_j^1 = \sum_k n_{jk}^1$. Each unit of labor devoted to R&D has a constant productivity of λ, which does not vary across goods. It is important to note that the expected instantaneous profits are not dependent on either time or the number of innovations in that sector. Thus, each firm in country 1, producing good *j*, devotes R_{jk}^1 units of R&D services, where

$$R_{jk}^1 = \lambda n_{jk}^1 \quad (9a)$$

$$R_j^1 = \sum_k R_{jk}^1 \quad (9b)$$

Note that the second equation above is the total quantity of labor services devoted to R&D for the production of good *j* in country 1.

If the arrival of innovations in each sector follows a Poisson process, the instantaneous probability of successful innovation occurring in sector *j* (of country 1) will be equal to $R_j^1 dt$. Similarly, the instantaneous probability of firm k discovering a state-of-the-art innovation is $R_{jk}^1 dt$. Based on this, the expected profit of a firm participating in the R&D race in sector *j* of country 1 is

$$\left[\frac{\pi_j^1}{r^1 + R_j^1}\right]\left[R_{jk}^1\, dt\right] - w^1\left[n_{jk}^1\right]dt \quad (10)$$

This reduces to:

$$\left[\frac{\pi_j^1}{r^1 + R_j^1}\right] = \frac{w^1}{\lambda} \quad (11)$$

Combining Equations (11) and (8) yields the following expressions for the quantity of labor devoted to R&D in each sector (*j*) of country 1:

$$n_0^1 = R_0^1/\lambda = [1 - 1/\gamma_0][Y_0^1/w^1] - \rho/\lambda \tag{12a}$$

$$n_1^1 = R_1^1/\lambda = [1 - 1/\gamma_1][Y_1/w^1] - \rho/\lambda \tag{12b}$$

where n_0^1 is the amount of labor devoted to R&D for the production of good 0 by country 1, and n_1^1 is the amount of labor devoted to R&D for the production of good 1 by country 1. Recall that there is no R&D investment for the production of good 2 by country 1 (or n_2^1 = 0).

Each country has perfectly competitive labor markets, ensuring that the wage rate adjusts to equate labor supply to labor demand. It can be shown that, in country 1, the amounts of labor devoted to the final production of the nontraded good (0) and the exported good (*i*) are equal to $L_0^1 = [1/\gamma_0][Y_0^1/w^1]$ and $L_1^1 = [1/\gamma_1][Y_1^1/w^1]$ respectively. Thus, full employment in country 1's labor market dictates that

$$n_0^1 + n_1^1 + [1/\gamma_0][Y_0^1/w^1] + [1/\gamma_1][Y_1/w^1] = L^1 \tag{13}$$

Substituting Equations (12) into (13), we obtain

$$[Y_0^1/w^1] + [Y_1/w^1] = L^1 + 2\rho/\lambda \tag{14}$$

In steady state, $r_i(t) = \rho$ in Equation (4). We assume that each country's trade account is balanced at every point in time. This implies that

$$\textstyle\sum_{h=0,1}\left(q_1 D_1^h\right) = \left(q_2 D_2^1\right) \tag{15}$$

By adding $q_1 D_1^1$ to each side and substituting in Equations (5), this can be transformed into

$$\sum_{h\epsilon N}\left(q_1 D_1^h\right) = \sum_{j\neq 0}\left(q_j D_j^1\right), \text{ which implies that:}$$

$$Y_1 = \textstyle\sum_{j\neq 0} Y_j^1 \tag{16}$$

This states that world expenditure on country 1's exported good is equal to country 1's expenditure on all traded goods.

Using the first line in Equation (5a), Equation (16) can be rewritten as

$$Y_0^1/w^1 = [\varphi^1/\alpha_0][Y_1/w^1] \text{ where } \varphi^1 = \sum_{j\neq 0} \alpha_j/T_j \tag{17}$$

In the equation above, φ^1 can be interpreted as the degree of trade liberalization in country 1. If $\varphi^1 > \varphi^2$, this implies that country 1 has lower tariffs—and a more liberal trade regime—than country 2.

Solving Equations (14) and (17) simultaneously, we obtain

$$Y_0^1/w^1 = [\alpha_0/(\alpha_0 + \varphi^1)][L^1 + 2\rho/\lambda] \tag{18a}$$

$$Y_1/w^1 = [\varphi^1/(\alpha_0 + \varphi^1)][L^1 + 2\rho/\lambda] \tag{18b}$$

The further substitution of Equations (18) into Equations (12) yields

$$R_0^1 = \lambda[1 - 1/\gamma_0][\alpha_0/(\alpha_0 + \varphi^1)][L^1 + 2\rho/\lambda] - \rho \tag{19a}$$

$$R_1^1 = \lambda[1 - 1/\gamma_1][\varphi^1/(\alpha_0 + \varphi^1)][L^1 + 2\rho/\lambda] - \rho \tag{19b}$$

In the steady-state equilibrium described above, total consumption expenditures, R&D investment, and the inter-sectoral allocation of labor remain constant. Sequential R&D races result in the discovery of better R&D techniques. These innovations increase both the productivity of workers in the production of final goods and their output, which is matched by instantaneous reductions in the price of final goods.

For consumers, these reductions in price lead to perpetual increases in their level of instantaneous utility. On the producer side, the discovery of an innovation gives one firm temporary monopoly profits until the next innovation occurs and it is driven out of business.

In the model, a fall in tariffs shifts labor from the nontraded good sector (sector 0 for country 1) to the exported good sector (sector 1 for country 1). In particular, it reduces the amount of labor devoted to R&D services in the nontraded sector and increases the amount of labor devoted to R&D services in the export sector. Similarly, a reduction in the tariff rate leads to a fall in the amount of labor devoted to final output production in the nontraded sector, and increases the amount of labor expended on final output production in the export sector. Finally, a reduction in tariffs also leads to a decrease in steady-state expenditure on country *i*'s nontraded good and leads to an increase in steady-state expenditure on country *i*'s exported good. Thus, by changing the level of tariffs, the government can reallocate labor in the country. The government's decision concerning the optimal level of tariffs to set is explained below.

Determining the Government's Optimal Level of Tariffs

The government in each country i sets the level of tariffs on good j, (where $T = 1 + \tau$) at every time period t. It also keeps a proportion f of tariff revenues and gives the remaining $(1 - f)$ of tariff revenues to consumers as a lump sum. The costs associated with the collection process are βc_t, where β is a constant, $c\ (0) = 0$, $c'\ (0) \geq 0$, $c' \geq 0$, and $c'' \geq 0$. Here, we propose that the costs of collecting tariffs reflect the quality of institutions in that country—countries with better institutions should face higher costs of collecting tariff revenues than those with poor institutions. The government also faces political instability due to the process of innovation. Thus, if the probability of the government being overthrown every time there is an innovation is $(1 - \mu)$, the probability of maintaining power each time an innovation occurs is μ.

The key idea above is that governments may find domestic innovation politically destabilizing. The reasons for this are discussed in Chaudhry and Garner (2007):

> In general, we can think of three ways in which innovation can politically threaten the current government. First, the nature of the innovation itself could be threatening. Information technologies like printing, satellite dishes, and the Internet could spread information that could induce political instability, especially in repressive regimes that attempt to control the population through ideology, etc. This mechanism is appealing, but unfortunately no simple way of modeling it presents itself. Second, innovations in the private sector could also shift economic power to groups that are unfavorable to the current regime. As economic power often translates into political power, these groups could try to replace the current government. Third, there may be vested interests that oppose the adoption of a new innovation.

Given the setup of the model above, it can be shown that country 1's real revenues from tariffs are $[(T-1)/T][\alpha_2/\alpha_0]\, Y_0^1/w^1$, which means that the government's expected wealth in the steady state can be written as

$$E(W_t) = \int_0^{\infty} e^{-\rho t} \left\{ \left[[\frac{f(T-1)}{T}]\ [\frac{\propto_2}{\propto_0}]\, Y_0^1/w^1 - \beta c_t \right] \right\} Pr_v dt$$

Pr_v is the probability of being in power at time t.

If the number of innovations that have occurred up to time t in sector 0 is represented by s, and the number of innovations that have occurred up to time t in sector 1 is represented by v, the expression is rewritten as

$$E(W_t) = \int_0^{\infty} e^{-\rho t}\{\sum_{s=0}^{\infty}\sum_{v=0}^{\infty}\prod(s,t)\prod(v,t)\,[f\tilde{Y}-\beta c_t]\mu^{s+v}\}dt \tag{20}$$

Where $\tilde{Y} = [(T-1)/T][\alpha_2/\alpha_0]\,Y_0^1/w^1$,

$\Pi\,(\mathrm{s,t}) \;= \frac{(\lambda n_0^1 t)^s}{s!} + e^{-\,\lambda n_0^1 t}$ is the probability that there will be exactly s innovations up to time t in sector 0, and $\Pi\,(\mathrm{v,t}) \;= \frac{(\lambda n_1^1 t)^v}{s!} e^{-\,\lambda n_0^1 t}$ is the probability that there will be exactly v innovations up to time t in sector 1.

The above expression reduces to

$$E(W_t) = \frac{f\tilde{Y}-\beta c_t}{\rho-(\mu-1)(\lambda n_0^1+\lambda n_1^1)} \tag{21}$$

A. Determination of the Government's Optimal Level of Tariffs

The government chooses that level of tariffs that optimizes its rent collection. The maximization problem it solves is

$$Max_T \frac{f\tilde{Y}-\beta c_t}{\rho-(\mu-1)(\lambda n_0^1+\lambda n_1^1)}$$

After plugging in from Equation (19), this simplifies to

$$Max_T \frac{f\left[\frac{\alpha_2(T-1)}{(\alpha_0+\alpha_1)T+\alpha_2}\right][L^1+2\rho/\lambda]-\beta c_t}{\rho-(\mu-1)(\lambda n_0^1+\lambda n_1^1)} \tag{22}$$

The first-order condition we obtain is

$$f\tilde{Y}' - \beta c'_t + \frac{(f\tilde{Y}-\beta c_t)(\mu-1)[\lambda(\partial n_0^1/\partial T)+\lambda(\partial n_1^1/\partial T)]}{\rho-(\mu-1)(\lambda n_0^1+\lambda n_1^1)} \tag{23}$$

It is useful to analyze this equation in greater detail. The first term $f\tilde{Y}'$ is the expected marginal benefit of raising the tariff rate on tariff revenues. It can be shown that this term is positive. The second term is the expected marginal cost of raising the tariff rate, and is negative by assumption. The sign of the third term is dependent on the sign of $\lambda(\partial n_0^1/\partial T)+\lambda(\partial n_1^1/\partial T)$. By differentiating Equations (19) with respect to T, it can be shown that an increase in the tariff rate leads to an increase in the R&D labor in sector 0 ($\partial n_0^1/\partial T > 0$) and a decrease in the amount of R&D labor in sector 1 ($\partial n_1^1/\partial T < 0$) .

If one assumes that the export sector j is characterized by larger innovations, or $\gamma_i > \gamma_0$, it can be shown that $[\lambda(\partial n_0^1/\partial T) + \lambda(\partial n_1^1/\partial T)] < 0$. Based on this assumption, the third term is positive, which means that the government gains an extra benefit from raising tariffs.

Given the first-order equation, we can define F as

$$= f\widetilde{Y}' - \beta c'_t + \frac{(f\widetilde{Y} - \beta c_t)(\mu - 1)[\lambda(\partial n_0^1/\partial T) + \lambda(\partial n_1^1/\partial T)]}{\rho - (\mu - 1)(\lambda n_0^1 + \lambda n_1^1)} \quad (24)$$

From this we can obtain the optimal tariff level that the government sets, T^*, which implicitly solves $F = 0$ in Equation (24).

3. Results

3.1 Setting Optimal Tariffs

Equation (24) gives rise to the following proposition.

Proposition 1: Given that an interior solution to the government's maximization problem exists:

The greater the threat of political instability by innovation, the greater the tariff rate set by the government. ($\partial T^*/\partial \mu < 0$)

The greater the costs associated with the collection of tariffs, the lower the tariff rate set by the government. ($\partial T^*/\partial \beta < 0$)

See Appendix A for the formal proof.

Part (a) of the proposition provides an interesting interpretation of the role of tariffs in an economy. As in other models, a tariff is used as a rent-extracting device, but unlike in other models, it is also used to block innovation by shifting labor from the sector with a larger level of innovations (the export sector) to the sector with a smaller level of innovations (the nontraded sector). Thus, when faced with a greater risk of losing power (due to levels of innovation), a government will tend to block innovation by collecting greater rents (raising the tariff rate). A government that is not as politically threatened by innovation will keep the tariff rate lower and allow a greater degree of innovation.

Part (b) of the proposition should be intuitive. If the costs of collecting tariff revenues increase, then the government will decrease the tariff rate it sets. It is important to note that the exact tariff rate, T^*, that is set depends on all the parameters above. So, if the costs associated with collecting tariffs are high enough, even an unstable government may choose to set lower tariffs. Since the costs of collecting tariffs reflect the quality of that country's institutions, countries with better institutions should decrease their tariff rate.

3.2 Steady-State Growth

To calculate the growth rate of country i, we define its long-run growth rate as the change in country 1's expected steady-state instantaneous utility, $ln(u^1)$. Following Dinopoulos and Syropoulos, this is given by

$$G = \alpha_0 \lambda^1 n_0^1 ln(\gamma_0) + \alpha_1 \lambda^1 n_1^1 ln(\gamma_1) + \alpha_2 \lambda^2 n_2^2 ln(\gamma_2)$$

$$G = \alpha_0 R_0^1 ln(\gamma_0) + \alpha_1 R_1^1 ln(\gamma_1) + \alpha_2 R_2^2 ln(\gamma_2) \quad (25)$$

Before analyzing the effects of trade liberalization on growth, we define the "growth intensity" Γ_j of sector *j* as

$$\Gamma_j = \alpha_j \lambda \left(1 - 1/\gamma_j\right) ln\left(\gamma_j\right) \qquad \forall j = 0, 1, 2$$

This intensity measures the contribution to growth of each sector *j* in the economy. Sectors with large expenditure shares (α's) and a larger level of innovations have higher growth intensities. Our model assumes that expenditure shares are the same for the nontraded sector (0) and the export sector i, whereas the export sector has a larger level of innovations, $\gamma_i > \gamma_0$. Thus, the export sector's growth intensity is greater than that of the nontraded sector, i.e., $\Gamma_1 > \Gamma_0$.

The main results of the section are given below.

Proposition 2: Given that the share of expenditures on the nontraded good is greater than 0:

(a) If the export sector's growth intensity is greater than that of the nontraded sector, a reduction in the tariff rate of country *i*—due to an improvement in the quality of its institutions—will lead to an increase both in the amount of trade and the growth of country *i*, If the export sector's growth intensity is lower than that of the nontraded sector, a reduction in the tariff rate of country i will lead to a decrease both in the amount of trade and the growth rate of country i, $(\partial G^i / \partial T^i < 0)$

If the export sector's growth intensity is greater than that of the nontraded sector, a reduction in the tariff rate of country j—due to an improvement in the quality of its institutions—will lead to an increase in the growth rate of country i, $(\partial G^i / \partial T^j < 0)$

See Appendix A for the formal proof.

Part (a) of this proposition presents the effects of tariff reductions on a particular country's growth rate. As shown in the manner in which the government determines an optimal tariff rate, different parameters of the model can lead to decreases in the tariff rate set by the government. So, a decrease in the threat of political instability or an increase in the costs of tariff revenue collection can cause a country's government to lower its tariff rate. This redistributes labor from the nontraded sector to the export sector, and results in an increase in country i's quantity of trade. Also, if the export sector is more growth-intensive than the nontraded sector—as is assumed in this model—then the redistribution of labor toward the export sector will raise the economy's growth rate.

At this stage, one should note that this proposition depends on the assumption that the export sector's growth intensity should be greater than that of the domestic nontraded sector. As discussed in the introduction, if the domestic nontraded sector has larger growth intensity—due to greater innovations in the sector—then higher tariffs would lead to lower growth. This could be the relevant case for the late 19th century. While the interpretation of our results has focused on the export sector as the "growth engine," the model is flexible enough to allow for this alternative.

Part (b) of the proposition states that a decrease in the tariff rate of country j leads to an increase in the growth rate of country i. This is because a reduction in country j's tariffs increases R&D investment in country j's export sector (as discussed in Section 2), which in turn reduces the world price of its exported good and leads to an increase in the long-run growth rate of its trading partner. Thus, there exist "institutional spillovers" from one country to another in this model, due to the effect that institutions have on tariffs.

3.3 Trade and Growth

The model presented above also has interesting implications for the relationship between trade and growth in the presence of good and bad institutions. The reason for analyzing the relationship between trade and growth—as opposed to simply concentrating on the relationship between tariffs and growth—is that trade restrictions can take on forms other than simple tariff restrictions. In addition to quota restrictions, the government can also limit imports through mechanisms such as foreign exchange and licensing controls. However, all these methods of controlling imports will affect a country's quantity of trade, which is more easily observed. The aim of this section is to see how institutional quality can affect the relationship between trade and growth.

Two basic results determine the relationship between trade and growth. The first is an obvious extension of the propositions above: If the quality of a country's institutions improves, the government will set a lower tariff rate, which will lead to higher growth rates. Thus, institutional quality has a direct impact on trade and growth—better institutions (and the accompanying lower tariffs) lead to higher trade and higher growth.

The second result focuses on the relationship between trade and growth for countries with either strong or weak institutions. In this section, we keep the level of tariffs fixed because we want to compare how trade affects growth in a country with good institutions as opposed to a country with bad institutions. But since changes in trade will alter the optimal tariff rate set by the government, there may be some confusion as to the effect of trade on growth.

An example may help illustrate the problem: If the quantity of labor in the economy rises, the government will have an incentive to change the tariff rate in the economy. It can be shown that, if the labor supply increases, then the optimal tariff rate set by the government also increases. Thus, while trade by itself leads to higher growth, higher tariffs will reduce the growth rate. To isolate the effect of trade on growth with fixed levels of institutions, we assume in this section that tariffs are fixed. This is achieved by assuming that there are two countries: one with very high institutional quality (a very high cost of tariffs, c), and another with very low levels of institutional quality (a very low cost of tariffs, c). The first country will set its tariff rate close to 0, whereas the second will set its tariff rate close to 1. Then, if the labor supply in the country with good institutions increases, the cost of tariff collection is so high that the level of tariffs does not change.

To observe the effect of higher trade on growth, one has to focus on the equilibrium level of trade. It can be shown that the total trade in country i—which is the sum of domestic expenditure on imports and domestic revenues for exports—is given by

$$\text{Trade} = \frac{2\alpha_2}{T(\alpha_0+\alpha_1)+\alpha_2}\left(L^i + \rho/\theta_0 + \rho/\theta_i\right) \quad (26)$$

As discussed above, one way for the country's total trade to rise would be for it to decrease its tariff rate. Another way to increase trade would be to increase the amount of labor in the economy (L^i). Thus, an economy with more consumers would trade more, for a given level of tariffs.

The next question to ask is how this trade would affect the growth rate. Using the definition of the growth rate given above (in Equation 25), we obtain the following proposition.

Proposition 3: Given that total trade is the sum of domestic expenditure on imports and domestic revenues from exports:

a) For a given level of tariffs, an increase in the quantity of labor in country i will lead to an increase in its total trade and growth rate, $(\partial Trade/\ \partial L^i > 0)$

b) Countries with stronger institutions will experience larger increases in growth than countries with weaker institutions, $(\partial^2 G/\ \partial L^i\, \partial \mathrm{T} > 0)$

Countries with stronger institutions will experience larger increases in growth than countries with weaker institutions

See Appendix A for the formal proof.

Part (a) shows how an increase in one country's labor force stock leads to higher trade and higher growth for all countries. This should be intuitive since an increase in labor stock leads to an increase in the amount of labor in the R&D sectors of the traded and nontraded goods. This, in turn, leads to higher growth. Part (b) discusses how institutional quality influences the relationship between trade and growth, and can be illustrated with an example: Take two countries with different institutional qualities. Both experience increases in their labor stocks and increased trade. From part (a), we know that this will lead to higher growth in both countries, but the incremental growth in the country with better institutions should be higher than the incremental growth in the country with poorer institutions. Thus, the institutional quality of a country affects the increase in growth due to the increase in trade.

The main finding of this section is that higher trade is accompanied by higher growth for all countries, but that countries with better institutions experience greater increases in their growth rates than countries with weaker institutions.

4. Conclusion

This article shows how institutions, innovations, and political stability affect tariffs in an economy and, in turn, affect growth. Good institutions should lead to lower tariffs and tariffs and, in turn, affect growth rates. However, the relationship between tariffs and growth is not as obvious. We find that, if a country has a technologically dynamic export sector (characterized by large innovations), higher tariffs reduce growth by channeling labor away from R&D in the export sector. On the other hand, in a country with a technologically dynamic domestic production sector, higher tariffs may lead to higher growth.

Besides the impact that tariffs have on the domestic growth rate, we show that tariffs should also have an impact on the growth rate of a country's trading partners. In particular, lower tariffs in one country should lead to higher growth rates for its trading partners. This result has important implications for institutional spillovers. If the institutional quality of one country improves, it leads to lower tariffs in that country, which increases the growth rates of its trading partners. But again, this result does not hold if the trading partner has a technologically dynamic domestic production sector.

Finally, we also find that trade should lead to accelerated growth. In particular, while trade leads to higher growth rates in countries that have both good and poor institutions, countries with good institutions should experience more incremental growth than those with poor institutions.

At this stage it is important to note two things. First, in reality, institutions should affect growth through many channels other than tariffs. The aim of our model, however, is not to present tariffs as the only channel through which institutions affect growth, but rather to isolate the impact of institutions on tariffs and economic growth. Second, tariffs are determined by many more factors than just institutions. But again, the link between tariffs and institutions has been ignored in the past and our findings provide a direction for further research in this area.

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Appendix A

Proof of Proposition 1

Part (a): We need to show that, for $T^* > 0$, $\frac{\partial T^*}{\partial \mu} < 0$

From the implicit function theorem (with the appropriate regularity conditions) we know that

$$\frac{\partial T^*}{\partial \mu} = -\frac{\partial F}{\partial \mu} \Big/ \frac{\partial F}{\partial T^*}$$

Here, it is important to note that $\frac{\partial F}{\partial T^*}$ is simply the second-order condition for the government's rent maximization problem. It can be shown that there exists a $\bar{T}$, such that, for any $T > \bar{T}$, $\frac{\partial F}{\partial T} < 0$. Therefore, we need to show that $\frac{\partial F}{\partial \mu} < 0$.

Recalling that $F = f.\partial\tilde{Y}/\partial T - \beta.\partial c_t/\partial T + \frac{(f\tilde{Y}-\beta c_t)(\mu-1)\left[\lambda(\partial n_0/\partial T)+\lambda\left(\partial n_i^i/\partial T\right)\right]}{\rho-(\mu-1)(\lambda n_0+\lambda n_i)}$:

$$\frac{\partial F}{\partial \mu} = \frac{\left(f\tilde{Y} - \beta c_t\right)\left[\lambda(\partial n_0/\partial T) + \lambda\left(\partial n_i^i/\partial T\right)\right]}{\rho - (\mu-1)(\lambda n_0 + \lambda n_i)}$$

$$+ \frac{\left(f\tilde{Y} - \beta c_t\right)(\mu-1)\left[\lambda(\partial n_0/\partial T) + \lambda\left(\partial n_i^i/\partial T\right)\right]\left[\lambda n_0^i + \lambda n_i^i\right]}{[\rho - (\mu-1)(\lambda n_0 + \lambda n_i)]^2}$$

This can be written as:

$$\frac{\partial F}{\partial \mu} = \frac{(f\tilde{Y}-\beta c_t)\left[\lambda\left(\partial n_0^i/\partial T\right)+\lambda\left(\partial n_i^i/\partial T\right)\right]}{\rho-(\mu-1)(\lambda n_0+\lambda n_i)}\left[1 + \frac{(\mu-1)\left[\lambda n_0^i+\lambda n_i^i\right]}{\rho-(\mu-1)(\lambda n_0+\lambda n_i)}\right]$$

This will be less than zero (keeping in mind that$\left[\lambda\left(\partial n_o^i/\partial T\right) +\right.$ *λ∂nii∂T<0 and μ–1<0*) if:

$$\left[1 + \frac{(\mu-1)\left[\lambda n_0^i + \lambda n_i^i\right]}{\rho - (\mu-1)\left(\lambda n_0^i + \lambda n_i^i\right)}\right] > 0$$

$$\Rightarrow \rho - (\mu-1)\left(\lambda n_0^i + \lambda n_i^i\right) + (\mu-1)\left[\lambda n_0^i + \lambda n_i^i\right] > 0$$

$$\Rightarrow \rho > 0,$$

Which is true by assumption.

Part (b) We need to show that for $T^* > 0$, $\frac{\partial T^*}{\partial \beta} < 0$

For $T^* > 0$, we have an interior solution so that $\frac{\partial F}{\partial T} < 0$. Therefore we need to show that

$$\frac{\partial F}{\partial f} < 0.$$

$$\frac{\partial F}{\partial \beta} = -\partial c_t/\partial T - \frac{(c_t)(\mu - 1)\left[\lambda\left(\partial n_o^i/\partial T\right) + \lambda\left(\partial n_i^i/\partial T\right)\right]}{\rho - (\mu - 1)\left(\lambda n_0^i + \lambda n_i^i\right)} < 0.$$

Proof of Proposition 2

Part (i) We need to show that for $T > 0, \frac{\partial G}{\partial T} < 0$.

$$\partial G^i/\partial T^i = (\lambda\alpha_0 ln\gamma_0)(1 - 1/\gamma_0)\left(L^i + 2\rho/\lambda\right)\left(\frac{\alpha_0\alpha_2}{[(\alpha_0 + \alpha_1)T + \alpha_2]^2}\right) - (\lambda\alpha_1 ln\gamma_1)(1 - 1/\gamma_1)\left(L^i + 2\rho/\lambda\right)\left(\frac{\alpha_0\alpha_2}{[(\alpha_0 + \alpha_1)T + \alpha_2]^2}\right)$$

$$\partial G^i/\partial T^i = [(\lambda\alpha_0 ln\gamma_0)(1 - 1/\gamma_0) - (\lambda\alpha_1 ln\gamma_1)(1 - 1/\gamma_1)]\left(\frac{\alpha_0\alpha_2}{[(\alpha_0 + \alpha_1)T + \alpha_2]^2}\right)$$

Recall that the first term is the bracket was defined as the growth intensity, Γ_0, of sector 0, and the second term was defined as the growth intensity, Γ_1, of sector 1. It was assumed that $\Gamma_1 > \Gamma_0$:

$$\partial G/\partial T = \left[\Gamma_0 - \Gamma_1\right]\left(\frac{\alpha_0\alpha_2}{[(\alpha_0+\alpha_1)T+\alpha_2]^2}\right) < 0$$

Part (b) We need to show that $\partial^2 G^i/\partial T^j < 0$.

From Equation (25) we know that:

$$\partial G^i/\partial T^j = \frac{\partial\left(\alpha_2^j ln\gamma_2\left(R_2^j\right)\right)}{\partial T_j} = \alpha_2^j ln\gamma_2 \frac{\partial R_2^j}{\partial T^j}$$

From Part (a) we know that $\frac{\partial R_2^j}{\partial T^j} < 0$, implying that

Which implies that: $\partial^2 G^i/\partial T^j < 0$.

Proof of Proposition 3

Part (a) we need to show that $\partial(Trade)/\partial L^i > 0$

From Equation (26) we know that:

$$Trade = \frac{2\alpha_2}{T(\alpha_0+\alpha_1)+\alpha_2}\left(L^i + 2\rho/\lambda\right)$$

Which implies that: $\frac{\partial(Trade)}{\partial L^i} = \frac{2\alpha_2}{T(\alpha_0+\alpha_1)+\alpha_2} > 0$.

From Equation (25):

$$\frac{\partial G^i}{\partial L^i} = \alpha_0 \frac{\partial R_0^i}{\partial L^i} ln(\gamma_0) + \alpha_i \frac{\partial R_i^i}{\partial L^i} ln(\gamma_i)$$

From the definitions of R_0^1 and R_i^i, it can be shown that $\frac{\partial R_0^i}{\partial L^i} > 0$ and $\frac{\partial R_i^i}{\partial L^i} > 0$.

This implies that: $\frac{\partial G^i}{\partial L^i} > 0$.

Part (b) we need to show that $\frac{\partial^2 G^i}{\partial L^i \partial T} < 0$

In part (a), we showed that:

$$\frac{\partial G^i}{\partial L^i} = \alpha_0 \frac{\partial R_0^i}{\partial L^i} ln(\gamma_0) + \alpha_i \frac{\partial R_i^i}{\partial L^i} ln(\gamma_i)$$

This implies that $\frac{\partial^2 G^i}{\partial L^i \partial T} = \alpha_0 \frac{\partial^2 R_0^i}{\partial L^i \partial T} ln(\gamma_0) + \alpha_i \frac{\partial^2 R_i^i}{\partial L^i \partial T} ln(\gamma_i)$

We can show that $\frac{\partial^2 R_0^i}{\partial L^i \partial T} > 0$ and $\frac{\partial^2 R_i^i}{\partial L^i \partial T} < 0$

Recalling the definition of the growth intensity, Γ_j and the assumption that $\Gamma_1 > \Gamma_0$, the negative growth impact in sector *1* will dominate the positive growth impact in sector 0.

This implies that: $\frac{\partial^2 G^i}{\partial L^i \partial T} < 0$

Appendix B

Figure 1

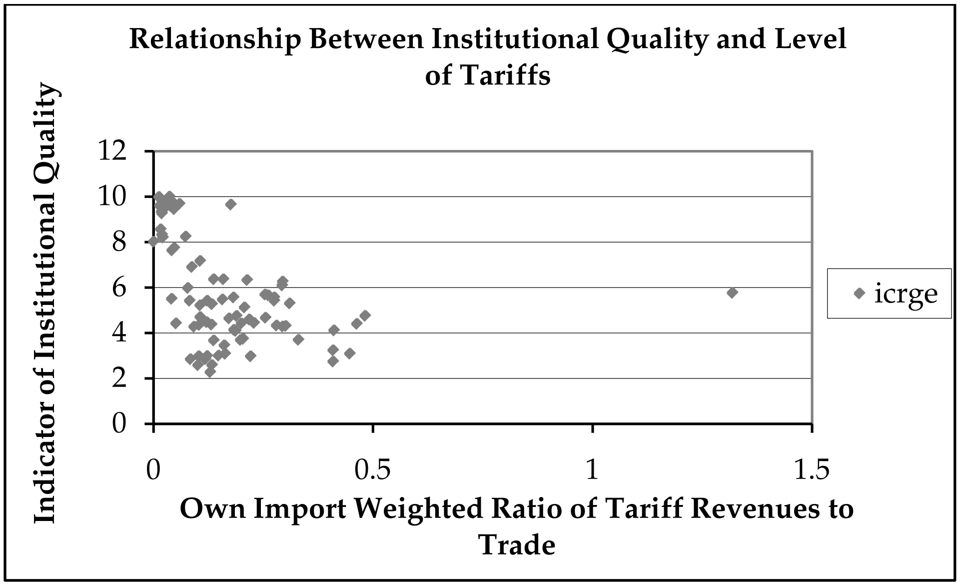
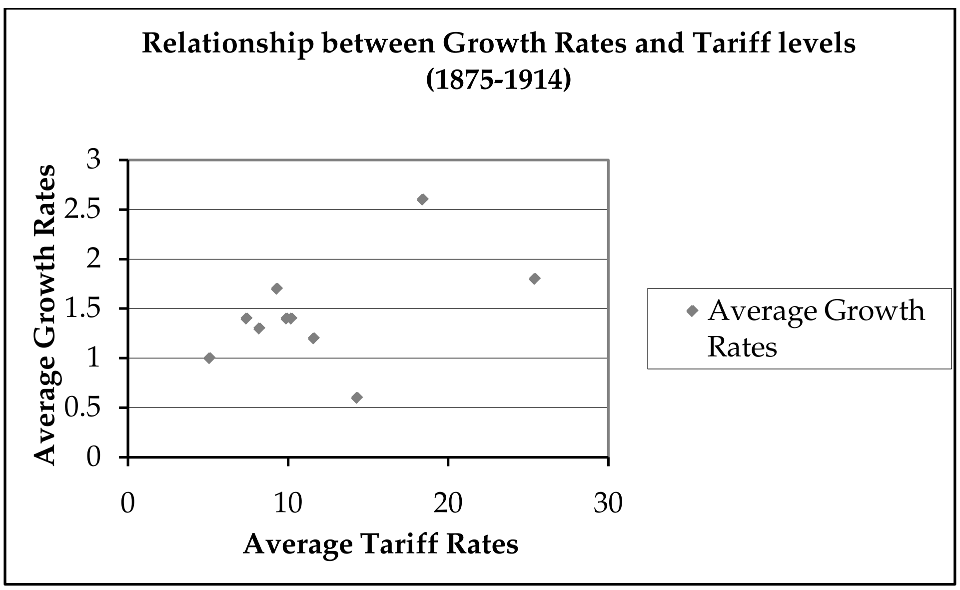


Figure 2



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Trade Openness: New Evidence for Labor-Demand Elasticity in Pakistan's Manufacturing Sector

Bushra Yasmin * and Aliya H. Khan **

Abstract

This study is an attempt to investigate trade–labor market linkages in Pakistan. Our main hypothesis that trade liberalization leads to an increase in labor-demand elasticity is empirically verified using a panel data approach for the period 1970/71–2000/01 for 22 selected manufacturing industries in Pakistan. We use ordinary least squares to estimate models in levels and first-differences, in addition to a fixed effects model. Overall, our findings suggest weak evidence of increased labor-demand elasticity as a result of trade liberalization in Pakistan's manufacturing sector. Nor does the study find support for a positive labor market and trade linkage from an employment point of view—as otherwise suggested by standard trade theory. This may be due to increased capital intensity in the manufacturing sector by time, and the infusion of new technology. It could also be attributed to labor market imperfections preventing trade liberalization from favorably influencing employment conditions in Pakistan. Our policy recommendations based on the study's results stress the need for skill enhancement measures to increase labor productivity, helping it become competitive according to the demands of globalization.

Keywords: Trade openness, labor-demand elasticity, Pakistan.

JEL Classification: F16.

1. Introduction

Fundamental changes in global economic policy have made trade liberalization a key element of development policies since the 1970s. The neoliberal view of trade liberalization advocates market-oriented economic reforms with the aim of improving efficiency and stability in the economy. The formation of the World Trade Organization in 1995 gave impetus to the process of trade liberalization, which is usually measured in terms of changes in the trade regime and/or by realized trade flows such as a country's export and import flows. Edwards (1993)

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describes a liberal trade regime as one in which all trade distortions, including import tariffs and export subsidies, are completely eliminated.

Trade liberalization is favored primarily on the grounds of facilitating economic growth through its dynamic advantages of higher capacity utilization, more efficient investment projects, and by promoting export growth performance and enhanced productivity. The realized cost associated with trade liberalization is the loss in tariff revenues due to tariff reductions, which accounts for 10 to 20 percent of government revenues in developing countries. To compensate for this tariff revenue loss, a larger tax burden is imposed on the consumer, which has a distortionary effect on the economy. It is also asserted that the gains from trade liberalization are not distributed uniformly and create imbalances among and within countries.

Regarding trade liberalization and labor market linkages, proponents of trade liberalization argue that labor is one of the chief beneficiaries of greater openness in developing countries. This perspective expects trade liberalization to motivate such countries to shift away from capital-intensive production to labor-intensive production, keeping in view the respective comparative advantages that increase labor demand in labor-abundant countries, leading to higher wages and employment, and lower wage inequality.

One aspect of the trade–labor linkage that has received recent attention is the impact of trade liberalization on labor-demand elasticity. The importance of this aspect was first emphasized by Rodrik (1997), who argued that trade makes the demand for labor more elastic, which in turn leads to larger employment and wage shocks as a result of given vertical shifts in the labor demand curve (arising from shocks to productivity or output demand). Further, this increase in elasticity erodes the bargaining power of labor vis-à-vis capital in sharing supernormal profits. Finally, it also results in labor bearing a larger burden of the impact of nonwage labor costs. Thus, through this channel, workers are subject to greater pressure as a result of trade liberalization (see Slaughter, 1997).

Pakistan adopted a trade liberalization policy in 1988 against the backdrop of World Bank/IMF supported Structural Adjustment Program. The country underwent substantial trade liberalization and the effective rate of protection has fallen sharply since the early 1990s. A sequential shift was expected to occur from capital-intensive to labor-intensive production, in turn leading to employment generation because of the greater incentives afforded to labor-intensive exports in particular, along with higher wages. Nevertheless, labor-demand elasticity may also increase when pursuing trade liberalization due to tougher competition in the goods market, the substitution of patently unskilled—if cheaper—labor, and the global economic environment.

Most of the empirical literature on this issue focuses on developed countries. The linkage between trade and labor markets in the context of developing countries—specifically Pakistan—has yet to be thoroughly explored. In this regard, this study aims to investigate trade–labor linkages in Pakistan's manufacturing sector through the labor-demand elasticity. This is achieved by adopting a panel data approach for the period 1970/71–2000/01 for 22 selected manufacturing industries as a whole, and by disaggregating data into pre- and post-trade liberalization data. The estimation technique used is the common intercept model (CIM) for first-differenced data and the fixed effects model (FEM). Owing to the critical role of the manufacturing sector in contributing to gross domestic product (GDP) and employment, the study provides an important insight into the sensitivity of labor demand with respect to the trade liberalization policies adopted by Pakistan.

The rest of the article is organized as follows. Part 2 provides a review of the relevant literature. Part 3 gives an overview of the trade policies adopted by Pakistan with special reference to the phases of trade liberalization. Part 4 presents our model specification and estimation strategy. Part 5 details the data used. Part 6 presents and interprets the study's results, and Part 7 concludes the article.

2. A Review of the Literature

Theoretical Perspectives on Trade and Labor Market Linkages

The relevant literature deals with the various ways in which trade liberalization is channeled to the labor market. The basic precept of free trade is that it is more efficient for a country to produce goods that it is better able to produce according to its factor endowments relative to its trading partners. Regarding trade among countries, the Heckscher-Ohlin (HO) theory states that a country will export that commodity the production of which requires the intensive use of a relatively abundant and cheap factor, and will import that commodity the production of which requires the intensive use of a scarce and expensive factor.

A theorem arising from the HO model—the factor price equalization theorem—states that prices equalize across countries under an international mobility of factors depending on the assumption of similar technology shared by two countries and the existence of perfectly competitive markets. This holds that international trade homogenizes the absolute return on the factor of homogenous production among economies. Starting from the proposition of the HO theory, the Stolper-Samuelson theorem was the first theoretical formulation to explain the effects of free trade on income distribution among production factors. The crucial point is the correspondence between product price and input prices, which implies that an increase in the relative price of a good leads to an increase in the relative return on the factor used intensively to produce that good.

The traditional trade theories explained above may provide a solid base for incorporating labor market implications into the trade model, but they leave a significant part of international trade unexplained. Relaxing the assumptions of constant economies of scale, perfect competition, and differences in technology requires new complementary trade theories. Increasing returns to scale on a larger scale of operation make the greater division of labor and specialization possible. International competition forces every firm/plant to produce only one or a few varieties of the same product rather than many different types; this keeps the unit cost low, making it possible for all factors of production to gain from trade. The technological gap and product-cycle models can be regarded as an extension of the basic HO model in a technologically dynamic world (Salvatore, 1996).

Hamermesh (1993) best summarizes what determines an industry's equilibrium own-price labor-demand elasticity with "the fundamental law of factor demand." He assumes that the production function exhibits constant returns to scale, as described by *F*, and given as

$$Y = F(L, K) \qquad F_i > 0, F_{ii} < 0, F_{ij} > 0 \tag{a}$$

Y is output, and *K* and *L* are homogenous capital and labor inputs, respectively. A firm that maximizes profits subject to a limit on costs will set the marginal value of the product of each factor equal to its price.

$$F_L - \lambda w = 0 \tag{b}$$

$$F_K - \lambda r = 0 \tag{c}$$

w and *r* are the exogenous prices of labor and capital, respectively; λ is a Langrangean multiplier showing how extra profits are generated by relaxing the cost constraint; and the price of output is assumed to be unity. The cost constraint is given as

$$C^0 - wL - rK = 0 \tag{d}$$

The ratio of equations (b) and (c) is the marginal rate of technical substitution, which equals the factor-price ratio for a profit maximizing firm. The own-wage labor demand elasticity at a constant output and constant *r* is given as (Allen, 1938, pp. 372–373)

$$\eta_{LL} = -[1-s]\,\sigma < 0 \tag{e}$$

$s = wL/Y$, the share of labor in total revenue. Intuitively, the constant-output elasticity of labor demand is smaller for a given level of technology (σ), when labor's share is greater because there is relatively less capital toward which to substitute when the wage rate rises. When the wage rate increases, the cost of producing a given output rises. The price of the product will then rise, reducing the quantity of output sold. The scale effect depends on the (absolute value of the) elasticity of product demand (η) and on the share of labor in total costs (which determines the percentage increase in price). The scale effect is added in equation (e) and, modifying notations slightly, given as

$$\eta_{LLj} = -[1-s]\,\sigma - s\eta_j \tag{f}$$

η_{LLj} is industry *j*'s own-price labor-demand elasticity (defined as negative), *s* is labor's share of industry in total revenue, σ is the constant-output elasticity of substitution between labor and other factors of production, and η_j is the product-demand elasticity for industry *j*'s output market. The variables *s*, σ, and η_j are all defined as being positive.[1]

[1] An increase in the wage rate affects the demand for labor in two ways: through the substitution effect and the scale effect. The first part of equation (6), -[1-s]σ, deals with the substitution effect, i.e., for a given level of output, showing how much the industry substitutes away from labor toward other factors when the wage rate rises. This term is often referred to as "constant-output labor-demand elasticity." The scale effect postulates that the wage rate increase causes the marginal cost of production to rise; under pressure to increase product prices and reduce output, this causes a fall in employment. The second part of equation (6), $s\eta_j$, shows the scale effect. When the wage rate rises, both effects tend to reduce labor demand. The four laws of Hicks and Marshall concerning the substitution and scale effects are given in standard books on labor economics.

Through the scale effect, the trade and labor market linkage is specified with the help of equation (f). The differential of equation (f) with respect to η_j yields

$$\partial \eta_{LLj} / \partial \eta_j = -s < 0 \tag{g}$$

This shows that, as product demand becomes more elastic, i.e., η_j rises, so does labor demand, i.e., η_{LLj} falls. This works according to the fourth law of the Hicks-Marshall laws of factor demand. The larger the share of labor in cost and revenue (s), the stronger the pass-through from η_j to η_{LLj}.

Similarly, taking the differential of equation (f) with respect to σ (constant-output elasticity of substitution between labor and other factors of production) shows that, as this substitutability increases, labor demand becomes more elastic, i.e., η_{LLj} falls.

$$\partial \eta_{LLj} / \partial \sigma = -[1 - s] < 0 \tag{h}$$

Also, the smaller the share of labor in the industry's cost and revenue, the stronger the pass-through from σ to η_{LLj}. For any given value of σ, higher wages trigger larger (smaller) changes in the quantity of labor demanded the less (more) important labor is in total costs. In short, labor-demand elasticity can be increased through international trade by increasing η_j/σ. However, the Allen-Hamermesh approach used by Slaughter (2001) is specified for a perfectly competitive market; in an imperfectly competitive market, an increase in wages has a pure cost effect, but reduces at the same time the market share of the firm and thus its markup. As a result of this pro-competitive effect, there may be an incomplete pass-through between prices and wages, and the adjustment of labor demand would be then smaller than expected (Mirza & Pisu, 2003).

Hence, the trade–labor relationship is more easily said than predicted. This is far more than a theoretical concern and demands rigorous empirical work, the findings of which may provide a better insight into the mechanism behind the trade–labor linkage with reference to Pakistan.

Empirical Evidence on Trade and Labor Market Linkages

A channel of trade–labor linkage that has received much attention in recent years is the impact of trade on labor-demand elasticities. Most of the empirical literature focuses mainly on developed countries. In contrast, the linkage between trade and labor markets in developing countries has yet to be thoroughly explored, specifically for Pakistan. Here, we provide a brief review of the relevant studies.

A recent study by Riihimaki (2005) that uses industry-level data for Finland for the period 1975–2002 finds support for the idea that economic integration can lead to increased own-price labor-demand elasticity. The log-linear specification for which the quantity of factor employment is regressed on real factor prices and real production is applied to estimate labor-demand elasticity. Using a general theoretical model of intra-industry trade, the study analyzes the economic integration effect on labor-demand elasticity. This is provided that intensified trade competition increases labor-demand elasticity while the economies of scale decrease the elasticity of labor demand by decreasing the elasticity of substitution between differentiated products. If integration gives rise to an increase in input substitutability and/or outsourcing activities, labor demand will become more elastic. Overall, the results support the hypothesis that economic integration has contributed to the increased elasticity of total labor demand in Finland.

A study by Bruno et al. (2004) estimates labor-demand elasticity using an industry-year panel for a number of industrialized countries—including major European countries, Japan, and the US—for the period 1970–96. The employment adjustment cost is accommodated by estimating a dynamic specification. The findings suggest increasing elasticity over time in absolute terms for all manufacturing sectors in the UK and US, but decreasing elasticity for Italy, Japan, and Spain. A mixed picture is obtained for France for which elasticity increases in absolute value for only one subset of sectors (transport, traditional, and chemical) .

In another study by Haouas and Yagoubi (2004), the effect of trade liberalization on labor-demand elasticity is investigated using an employment demand equation for Tunisia's manufacturing industries for the period 1971–96. The production function is assumed to be a Cobb-Douglas function. To capture unobserved demand shocks, the authors use a fixed effects model (FEM). The estimated elasticities lie within the range of 0.213 to 0.453, which Hamermesh (1993) identifies as a reasonable range. But the parameter of elasticity change—the parameter corresponding to the wage variable that interacts with the liberalization dummy—appears to be small and largely insignificant. The lower responsiveness of labor-demand elasticity to trade liberalization is explained by the tight labor market regulations in place in Tunisia during 1987–96.

Using industry-level data disaggregated by state, Hasan, Mitra and Ramaswami (2003) find that trade liberalization has a positive impact on labor-demand elasticity in the Indian manufacturing sector. The elasticity turns out to be negatively related to protection levels that vary across industries and over time. Furthermore, the study finds that not only is labor-demand elasticity higher for Indian states with more flexible labor regulations, it is affected by trade reforms to a larger degree. After trade reforms, volatility in productivity and output is translated into larger wage and employment volatility, theoretically a possible consequence of higher labor-demand elasticity.

Slaughter (2001) adopts a two-stage approach to industry-year panel data for the US for 1961–91. He provides mixed support for the view that trade contributes to increased elasticity. The author finds that the demand for production labor has become more elastic in the American manufacturing sector overall and in five of eight industries within the sector; the same is not true, however, for nonproduction labor. For production workers as well as for nonproduction workers, time appears to be a very strong predictor of elasticity patterns and there is a large unexplained residual for changing factor-demand elasticities.

Slaughter's (2001) approach is also followed by Krishna, Mitra, and Chinoy (2001) and Fajnzylber and Maloney (2001), who find no support, however, for the conjecture that labor demand is more elastic in response to trade liberalization. Using Turkish plant-level data spanning a period of dramatic trade liberalization, Krishna et al. (2001) investigate empirically the link between trade openness and factor-demand elasticity. Their analysis suggests that the putative linkage between greater trade openness and labor-demand elasticity may be quite weak, which they explain by the variety of frictions that affect firms' labor-demand decisions.

Fajnzylber and Maloney (2001) provide only very mixed support and no consistent patterns for the idea that trade liberalization has an impact on own-wage elasticity. They use establishment-level data to provide consistent dynamic estimates of labor-demand functions for three Latin American countries (Chile, Colombia, and Mexico) across trade policy regimes. The results show that estimates of elasticity change greatly in magnitude, if not significantly, over time, and that comparisons across countries should take this into account when attempting to make inferences about the flexibility or efficiency of labor markets.

3. The Evolution of Trade Policy in Pakistan

Pakistan has adopted a variety of policies for its trade sector with special focus on its manufacturing sector. In the 1950s, three major steps were taken, including (i) the overvaluation of the rupee relative to other countries; (ii) the application of quantitative controls to imports to regulate the level and composition of imported goods, a highly differentiated structure of tariffs on imports; and (iii) export taxes on two principal agricultural exports: jute and cotton. These steps point to the absence of a real export promotion policy at least until 1956.

The export promotion scheme was introduced later on, which covered 67 primary commodities and 58 manufacturing goods whereby exporters were entitled to import licenses for certain specific items to the extent of 25 and 40 percent on various categories of manufacturing goods and 15 percent on the export of raw materials (Ahmed, 1984). During this period, the large-scale manufacturing sector grew by 23.6 percent between 1949 and 1954, and afterward by 9.3 percent up till 1960. During the 1960s, there was direct emphasis on the promotion of manufactured exports with the introduction of an export bonus scheme in 1959 based on a multiple exchange rate system.[2] This scheme, along with import licensing and liberalization, proved to have a dramatic impact: annual large-scale manufacturing growth increased from 8 percent in 1955 to 17 percent in 1965. The export bonus scheme also had a positive effect on exports in the early 1960s.

In 1972, the Pakistani government took steps to abolish the import licensing system, as well as the multiple exchange rate system and export bonus scheme. Economic activity in this decade slowed down, and the performance of the manufacturing sector weakened due to the nationalization of different industrial units, banks, and other private units. The most dramatic step taken was the devaluation of the rupee by 56 percent. Later, a series of steps were adopted to liberalize the trade regime: the number of banned goods was reduced and most nontariff barriers, which had been imposed after the oil shocks and foreign exchange stringency of the 1970s, were also removed.

[2] A multiple exchange rate system is explained as (i) different exchange rates for imports and exports; (ii) different exchange rates for different import categories (high-priority imported goods overvalued exchange while others that were not on the government's priority list undervalued the exchange rate); and (iii) different exchange rates for different export categories.

Since the 1980s, Pakistan has followed a combination of policies to move toward a more neutral trade regime. The most significant change was the formulation of a new trade policy in 1987 whereby tariff slabs were cut from 17 to 10, a uniform sales tax replaced previous rates that varied across commodities, and maximum tariff rates were reduced from 225 to 125 percent. Another policy that affected exports was the delinking of the rupee from the US dollar and the introduction of a flexible exchange rate system. In the 1990s, the government privatized various public units and provided exporters with a host of incentives in the form of tax holidays, tariff cuts, and other fiscal incentives. Pakistan's import policy continued to rationalize the import tariff, reducing nontariff barriers and simplifying the tariff structure.

This overview of trade policy in Pakistan indicates a steady move toward a free trade regime. Since Pakistan has adopted a number of measures to liberalize imports and promote exports over time, this could have far-reaching effects on its goods and factor markets.[3]

Table 1 provides means and standard deviations for production and trade measures of selected manufacturing industries for the pre- and post-trade liberalization period. Over the selected period, the trend in manufacturing sector employment follows an inconsistent pattern and exhibits fluctuations. Overall, employment increased by approximately 50 percent over 1970/71–2000/01. When comparing the pre- and post-trade liberalization periods, employment is seen to have increased under pre-trade liberalization (19.45 percent) more than under post-trade liberalization (3.9 percent). Hence, although overall employment has increased, a sharp rise is not observed in employment in manufacturing industries during the post-trade liberalization period. Conversely, there is a reduction in 1995 as compared to employment in 1990.

[3] Trade policies beyond the year 2000 are not discussed in detail since they do not fall under the data covered in this empirical analysis.

Table 1: Summary Statistics of Key Variables for Manufacturing Industries

Period	Year	Employment	Real production ('000)	Real wages/ hour/worker ('000)	Openness
	1970	17,810	13,662	0.0370	1.767
		(42,680)	(21,841)	(0.0155)	(3.010)
Pre-trade liberalization	1975	22,089	19,212	0.0423	1.700
		(46,897)	(30,521)	(0.0161)	(2.068)
	1980	18,960	34,875	0.0630	1.100
		(39,143)	(49,137)	(0.0170)	(1.128)
	1985	21,275	53,448	0.0850	1.475
		(37,818)	(68,543)	(0.0280)	(3.628)
	1990	26,101	71,697	0.0960	1.034
		(50,783)	(101,457)	(0.0360)	(1.929)
Post-trade liberalization	1995	23,789	80,407	0.1135	1.717
		(48,169)	(128,711)	(0.0690)	(4.170)
	2000	27,110	106,917	0.1340	2.298
		(66,185)	(170,265)	(0.0670)	(6.866)

Notes: (a) Employment is measured as the average number of workers engaged; openness is measured as exports + imports as a percentage of manufacturing output.
(b) Standard deviations are reported in parentheses.

As Majid (2001) states,

> Progressively over the last two decades growth in manufacturing has become more labor-productivity driven (than employment-expansion driven) and in the 1990s it seems to have been de-linked from employment expansion altogether.

Output growth in the manufacturing sector as reported in Table 1 shows a steadily rising trend over time. A dramatic change is seen to occur over the three decades: output increases by more than 650 percent over the period 1970–2000, implying a sharp rise and jumps in output due to the adoption of the industrialization policies discussed earlier.[4] The

[4] The highest growth in manufacturing output was in 1980, which increased by 80 percent. The government's industrial policy in 1978 and 1984 reiterated its thrust on continuing a pattern of industrialization. Although the 1990s have been termed a low-growth period by Majid (2001), this was due to a reduction in protection, deflationary tendencies in the economy, inconsistent policies,

real wage per worker (expressed in thousands) shows a consistent and slowly rising trend over time. Although it increases by more than 200 percent over time, the figures appear to be quite low in accordance with the rising inflation in the economy.

4. Model Specification and Estimation Strategy

Our model is based on a labor demand equation to examine the impact of trade liberalization on labor-demand elasticity. The manufacturing firm is assumed to choose a level of production *(y)*, with domestic factor input labor *(L)*, and *w* as the price of labor. These specifications are consistent with various goods and labor market structures.

Domestic labor demand is given as

$$ln\ L_{it} = \alpha + \beta_y\ lny_{it} + \beta_\omega\ ln\omega_{it} + \beta_{trlib}\ lntrlib_{it} + e_{it} \quad (1)$$

Labor (*L*) is defined as the average number of daily persons engaged in total manufacturing. Production (*y*) consists of the value of manufacturing finished products and byproducts, etc., is measured in thousands, and converted into real values by deflating it by the wholesale manufacturing price index (1980/81 = 100). Wages (*w*) include wages and salaries paid plus cash and noncash benefits paid to workers. This is measured by dividing the employment cost by *L*, in thousands. The data is further converted into wages per hour by dividing it by 48 working hours per week.

The term *trlib* stands for trade liberalization and is measured by two commonly used indicators: (i) the share of trade (exports plus imports) in each manufacturing unit's production (*lnopen*), and (ii) the average tariff rate computed for each manufacturing sector by dividing import duties by the value of imports in specific manufacturing sectors (*lnimpd*). The term β_y (output elasticity of labor demand) measures percentage changes in labor demand with respect to percentage changes in output; β_ω (wage elasticity of labor demand) measures percentage changes in labor demand with respect to percentage changes in wages; β_{trlib} measures percentage changes in labor demand with respect to trade liberalization; *i* stands for 22 selected manufacturing industries; and *t* refers to each five-year period between 1970/71–2000/01.

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lower levels of investment, and the poor law-and-order situation (Kemal, 1998). Manufacturing growth increased by 34 percent over 1985–1990, and at an even lower rate (12 percent) over 1990–1995. Hence, trends in employment are similar to those in production during pre- and post-trade liberalization.

Panel Data Model

Since labor-demand elasticity measurement is a long-run phenomenon, using a panel data approach allows us to effectively capture the long-term fluctuations caused by the structural and institutional characteristics of different industries in the analysis. In this model, the existence of unobservable factors controlling industry-specific labor-demand elasticity can be taken into account in the estimation procedure.

A pooled ordinary least squares (OLS) model refers to a common intercept model (CIM) in which only one intercept is used for all cross-sectional units. Equation (1) is the specific form of this type of model, where α stands for the common intercept for 22 selected manufacturing industries over the period 1970/71–2000/01. The model is applied to pooled data in levels and first-differences. Applying the model to first-differenced data is preferable to using a simple OLS model because the former eliminates cross-industry differences rather than merely disregarding them. The straight application of OLS to this model discards the temporal and space dimension and thus throws away useful information. The limitations of OLS in this sort of application prompt interest in alternative methods such as the FEM.

Fixed Effects Model

The FEM approach assumes that shifts across industries are deterministic. The intercept term is allowed to vary across industries while random variations are assumed to be independent. For an FEM, equation (1) is modified accordingly as

$$ln\ L_{it} = \alpha + \alpha_i + \beta_y\ lny_{it} + \beta_\omega\ ln\omega_{it} + \beta_{trlib}\ lntrlib_{it} + e_{it} \quad (2)$$

α_i indicates the industry-specific term. Here, we use the least-squares dummy variable estimation technique. The FEM can also incorporate time effects by adding a time dummy variable to equation (2), which is constant across industries but evolves over time. Hence, equation (2) can be augmented by a set of $T - 1$ time dummies and the estimates would have a standard interpretation relative to the base or reference year chosen. Equation (2) can be written for both industry- and time-specific effects as

$$ln\ L_{it} = \alpha + \alpha_i + \alpha_t + \beta_y\ lny_{it} + \beta_\omega\ ln\omega_{it} + \beta_{trlib}\ lntrlib_{it} + e_{it} \quad (3)$$

α_t refers to time-specific effects. The combined time- and industry-specific regression model eliminates the omitted-variables bias of a CIM that arises from unobserved factors across industries. The time-specific effects are likely to capture the effects of policy interventions, trade policy shifts, and significant changes in productivity due to innovation, the impact of global changes, and so on.[5]

The choice between the findings of the FEM and random effects model (REM) is determined by the Hausman Specification test. The random effects formulation treats random effects as independent of the explanatory variables, and violating this assumption may lead to inconsistency and bias in the estimated parameters. If the effects are correlated with the explanatory variables, the fixed-effects estimators are consistent and efficient (for details, see Wooldridge, 2002).

Estimation Issues

Two main issues arise in estimating a labor demand model: (i) the identification problem, and (ii) the endogeneity of the regressors in the specified equations. From an economic theory perspective, both labor demand and labor supply depend on relative wages. It is therefore not clear what combination of labor-demand and labor-supply elasticities is obtained from the model.

In order to overcome this problem, we make a similar assumption to that of Slaughter (2001); Greenaway, Hine, and Wright (1999); and Faini, Falzoni, Galeotti, Helg, and Turrini (1999). In particular, labor supplies are assumed to be perfectly elastic. In this way, shifts in the labor supply curve, as measured by movements in wages, are able to trace the labor demand curve (whose position is controlled by the other regressors included in the model that are thought to leave the labor supply schedule unaffected).

The endogeneity of some regressors may yield biased estimates of labor-demand elasticity. In our study, labor demand and output have a bi-directional link in the neoclassical context. This causation could lead to endogeneity in output, as capital is not controlled in the model. However, both y and w can be checked for endogeneity by applying the same technique as the Hausman Specification test (for details, see Stock & Watson, 2004; for a detailed discussion on endogeneity, see Green, 2007).

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[5] A random effects model takes industry-specific effects as random compared to an FEM where they are assumed to be deterministic. This is based on the assumption that random variations in various cross-sectional units come from overlapping, not from the same sample. See Wooldridge (2002) for detail.

5. Data Description

The dataset used in our study covers a panel of 22 manufacturing industries in Pakistan over the period 1970/71–2000/01, which were selected according to the Pakistan Standard Industrial Classification, 1970, comparable at a three-digit level to the International Standard Industrial Classification, 1968. The industries included in this study cover 81 percent of reporting establishments of manufacturing (Pakistan Economic Survey for 2000/01). Moreover, they account for 90 percent of production and 86.4 percent of employment in total manufacturing.[6]

The *Census of manufacturing industries* (CMI)—the only major source of data on manufacturing industries in Pakistan—suffers from certain limitations, such as under-coverage of manufacturing firms, changes in the definition of some variables over time, and gaps and irregularity in survey publications. Nonetheless, with no alternatives, we have used the CMI as our major source of data. Due to the unavailability of consecutive time series, we have used data with five-year gaps.[7] We have also segregated the data into pre- and post-trade liberalization periods for comparison: the period 1970/71–1980–85 represents the pre-trade liberalization period, and the period 1990/91–2000/01 indicates post-trade liberalization. All the variables are measured in natural log form.

The data on output (y), wages (w), and employment (L) was collected from various issues of the CMI, published by the Federal Bureau of Statistics (FBS). The data on imports and exports was taken from the FBS's publication, *50 years of Pakistan in statistics*. Since this data was given according to major commodity groups, we arranged it in accordance with the industrial divisions. Finally, the data on import duties was taken from various issues of the *CBR yearbook*, published by the Federal Board of Revenue.

6. Empirical Results and Interpretation

Table 2 reports the results for the CIM using first-differenced data and the FEM. Regression in the FEM is carried out with both time- and industry-specific effects, and thus the estimates are free of any omitted-variables bias, which the CIM is usually expected to suffer from.[8] The

[6] Authors' calculations based on data from the CMI for 2000/01.

[7] Nevertheless, employing panel data does not deprive us of an efficiency gain due to a large number of degrees of freedom.

[8] The estimation was carried out in STATA 9.

results are reported only for the openness measure of trade liberalization (*lnopen*) since the second measure, import duties (*lnimpd*), appeared to have an insignificant effect in all the models.[9]

Table 2: Estimates of First-Difference Model and Fixed Effects Model

Dependent variable: *lnL*

	First-difference model			Fixed effects model		
Variable	**All years**	**Pre-TL**	**Post-TL**	**All years**	**Pre-TL**	**Post-TL**
C	-0.042	0.013	-0.0106**	-2.360	-2.820*	-3.430**
	(0.033)	(0.058)	(0.041)	(1.540)	(1.690)	(1.630)
lny	0.623*	0.532*	0.812*	0.602*	0.446*	0.768*
	(0.121)	(0.142)	(0.096)	(0.127)	(0.098)	(0.110)
lnw	-0.765*	-0.871*	-0.411**	-0.539*	-0.675*	-0.519*
	(0.087)	(0.087)	(0.163)	(0.103)	(0.119)	(0.124)
Lnopen	-0.101**	-0.148*	-0.019	-0.122	-0.224*	0.0015
	(0.050)	(0.044)	(0.056)	(0.088)	(0.078)	(0.068)
D75	-	-	-	-0.007	0.021	-
				(0.089)	(0.079)	
D80	-	-	-	-0.305*	-0.193	-
				(0.115)	(0.122)	
D85	-	-	-	-0.273**	-0.094	-
				(0.135)	(0.154)	
D90	-	-	-	-0.295**	-	-
				(0.143)		
D95	-	-	-	-0.452*	-	-0.132*
				(0.157)		(0.046)
D00	-	-	-	-0.523*	-	-0.216*
				(0.163)		(0.065)
N	132.000	66.000	66.000	154.000	88.000	66.000
R^2	0.660	0.680	0.670	0.690	0.71	0.69
F-test	30.390	46.820	55.700	15.510	13.350	20.080
F-statistic for fixed effects (p-value)				23.460 (0.000)	15.850 (0.000)	37.340 (0.000)
χ^2-statistic for Hausman Specification test (p-value)	-	-	-	11.980 (0.007)	21.540 (0.000)	32.040 (0.000)

Notes: (a) The results are robust with regard to white heteroscedasticity.
(b) Standard errors are reported in parentheses.
(c) *, **, and *** indicate significance at 1, 5, and 10 percent, respectively.

[9] For brevity's sake, Table A1 does not provide the results for import duties; these are available from the authors on request.

The panel data was first checked for stationarity as inferences from the F-statistic might be spurious in the case of nonstationary data and the test statistic will have nonstandard distributions. The Levin, Lin, and Chu (2002) test statistic for panel data is applied in this regard. The results are reported in Table A1 (see Appendix) and show no sign of a unit root. All the variables are integrated of the same order, I (0) in levels. Hence, the results based on this panel data are deemed reliable.

Results for the test for endogeneity of the output and wage variables are provided in Tables A2 and A3 (see Appendix), respectively. As already explained, these variables are likely to suffer from endogeneity problems leading to inconsistency in the estimated models to which we have applied 2SLS for estimation. The findings presented in both tables report no endogeneity problem regarding production and wages. The second column of each table provides estimates of the reduced form equation for production and wages, respectively; and the third column gives estimates of two-stage least squares (2SLS) based on the structural form equation. In the next column, we report the results obtained from the CIM in order to compare them with the 2SLS. The last column reports the result of an auxiliary regression of log employment on the residuals obtained from the reduced form equation to check for endogeneity in production and wages.

Applying the instrumental variable (IV) technique to the 2SLS model demands that the instruments be relevant and exogenous. We use one-year lags of output (*Llny*), wages (*Llnw*), and openness (*Llnopen*) as IVs in the model. In Table A2, the use of lagged values of the problematic variable and exogenous variables (wages and openness) is considered to be a good instrument since there is a smaller likelihood of correlation between the lagged values and error term than with the level values. Regarding the relevance of IVs in the output model, the value of the F-test statistic is 407.93. Since this exceeds the critical value of 10, it implies that the IVs used in the regression are relevant. In order to check the validity of the instruments, we apply the Sargan test, which yields a value of 0.406—this is less than the critical value. Hence, we do not reject the null hypothesis that the over-identifying restrictions are satisfied. This validates the instruments used in the 2SLS model.

We apply the Hausman Specification test with regard to the exogeneity of the production variable. The residual term is statistically insignificant and shows that production is exogenous in the pooled OLS model. These results validate the estimates obtained from OLS. Table A3 reports the required results for the exogeneity test for the wage variable, in which we use one-year lags for wages (*Llnw*), output (*Llny*), and openness (*Llnopen*) as IVs. These are deemed relevant and exogenous since the value of the F-test statistic is 27.30; this exceeds the critical value and shows that the IVs are relevant.

In checking the validity of the instruments, the value obtained from the Sargan test is 1.956, which is less than the critical value. This validates the instruments being used in the 2SLS model. Regarding the exogeneity of wages, the Hausman Specification test shows that the residuals from the structural form equation in Table A3 are statistically insignificant and indicate that wages are exogenous.

In general, the results for the own-wage elasticity of labor demand and output elasticity are in accordance with our expectations and with standard economic theory. The value for R^2 is reasonably high, keeping in view the presence of cross-industry variations. The F-statistic points to the overall significance of the models. We also examine the possibility of heteroscedasticity by applying the White heteroscedasticity test. The problem of autocorrelation is not expected, bearing in mind that the data has five-year gaps after each year. It is important to mention here that the variations in all the models were tested for interaction between *lnopen* with *lnw* and *lny*. However, the results obtained from these regressions are statistically insignificant in most cases, implying that the openness measure of trade liberalization has an insignificant impact on employment when interacted with wages and output.[10]

The Hausman Specification test rejects the REM in favor of the FEM, implying that the regressors and unmeasured characteristics of manufacturing industries are correlated. The industry-specific effects are reported in Table 3. The findings of the test for equality are reported in Table 4 in order to measure whether any statistical difference emerges in output, wages, and openness elasticities across the pre- and post-trade liberalization periods.

[10] For brevity's sake, these results are not reported here.

Table 3: Industry-Specific Effects

No.	Industry	Fixed effects	No.	Industry	Fixed effects
1	Food	-1.050*	12	Rubber products	-1.080*
		(0.113)			(0.404)
2	Beverages	-2.360*	13	Glass and glass products	-0.730*
		(0.675)			(0.248)
3	Tobacco	-2.610*	14	Nonmetal products	-1.070*
		(0.543)			(0.272)
4	Leather and leather products	-1.950*	15	Iron and steel	-0.990*
		(0.320)			(0.247)
5	Footwear	-1.450*	16	Metal products	-1.930*
		(0.385)			(0.689)
6	Wood products	-1.120*	17	Nonelectrical machinery	-1.420*
		(0.323)			(0.565)
7	Paper and paper products	-1.300*	18	Electrical machinery	-1.530*
		(0.259)			(0.471)
8	Industrial chemicals	-1.350*	19	Transport equipment	-1.950*
		(0.256)			(0.632)
9	Other chemicals	-2.790*	20	Photographic and optical groups	-1.570*
		(0.259)			(0.553)
10	Drugs and medicines	-1.310*	21	Other manufacturing	-1.170*
		(0.441)			(0.300)
11	Petroleum and coal products	-0.864*			
		(0.286)			

Notes: (a) Standard errors are reported in parentheses.
(b) The textiles industry is the base category and is thus excluded from the model.

Table 4: Test for Equality

Variable	Differenced model	Fixed effects model
Own-wage elasticity	0.460**	0.156
	(0.185)	(0.172)
Output elasticity	-0.280	-0.322**
	(0.171)	(0.147)
Openness	0.129***	0.222**
	(0.071)	(0.103)

Notes: (a) Standard errors are reported in parentheses.
(b) ** and *** indicate significant differences between coefficients across pre- and post-trade liberalization periods at 5 and 10 percent, respectively.

Structural Stability Test

The Chow test is applied to check the possible structural stability of the model. Since the simple Chow test is not valid in the presence of heteroscedasticity, a hetero-adjusted Chow test is used instead. Table 5 reports the results for the hetero-adjusted Chow test both for the first-difference model and the FEM. The log of employment is regressed on the key variables and these are also interacted with the liberalization dummy to find if there are any significant differences in parameters the across pre- and post- trade liberalization periods.

Table 5: Hetero-Adjusted Chow Test

Dependent variable: *lnL*

Variable	First-difference model	Fixed effects model
C	0.0131	-3.900**
	(0.058)	(1.540)
Lny	0.532*	0.560*
	(0.142)	(0.127)
Lnw	-0.871*	-0.730*
	(0.087)	(0.090)
Lnopen	-0.148*	-0.103
	(0.044)	(0.092)
Dtrlib	-0.118***	1.106
	(0.071)	(1.170)
*dtrlib*lny*	0.280***	-0.0530***
	(0.171)	(0.031)
*dtrlib*lnw*	0.459**	0.046
	(0.185)	(0.111)
*dtrlib*lnopen*	0.128***	0.029
	(0.071)	(0.039)
N	132	154
R^2	0.690	0.740
F-test	43.980	22.150
F-statistic for Chow test	4.330*	1.320

Notes: (a) Standard errors are reported in parentheses.
(b) *, **, and *** indicate significance at 1, 5, and 10 percent, respectively.
(c) The Chow test is applied at F (3, 124) for first-difference results. The null hypothesis for the Chow test is: $H_0 = \gamma_1 = \gamma_2 = \gamma_3 = 0$. H_0 is rejected in this model and implies that pooling is not justified. The Chow test for the FEM is applied at F (3, 125). H_0 is not rejected in the FEM and implies that pooling is justified here.

The variable *dtrlib* stands for the trade liberalization dummy. It takes a value of 1 for the post-trade liberalization period and 0 for the pre-trade liberalization period. The value of the F-statistic in the first-differenced model exceeds the critical value and implies that pooling is not justified here. The results for *dtrlib*, interaction between *dtrlib* and log production (*lny*), log wages (*lnw*), and log openness (*lnopen*) in the first-difference model are statistically significant, indicating a significant difference across the pre- and post-trade liberalization periods.

However, the FEM presents the reverse: the estimates for the trade liberalization dummy variable (*dtrlib*) appear to be statistically insignificant, indicating no difference between pre- and post-trade liberalization. The parameters for interaction between *dtrlib* and other variables indicate an insignificant difference in elasticities across the pre- and post-trade liberalization period. Thus, a pattern of insignificant elasticity appears on one hand while pooling is justified on the other. Consequently, we rely on the results of the full time period in the FEM's case. Although the results for output and wages are similar in the FEM and first-difference model, the FEM controls for industry- and time-specific effects, which also appear to be significant and are thus preferable.

The results for output elasticity in both models are statistically and positively significant at 1 percent, and are supported by the Hicks-Marshall law of factor demand, which asserts that labor-demand elasticity will be higher in response to the higher price-elasticity of product demand. However, values for output elasticity that are between 0.5 and 0.8 are inelastic in the manufacturing sector. The findings of lower elasticity are similar to the majority evidence for the manufacturing sector in Pakistan, while the test for equality yields a higher output-elasticity for the post-trade liberalization period.

The wage variable appears to have a statistically significant negative effect on employment at 1 percent in both models. According to economic theory, a rise in the wage rate will increase the relative cost of labor and induce employers to use less labor and more other factors of production, according to the substitution effect. However, as a result of the scale effect, an increase in wages will cause the marginal cost of production to rise and put pressure on product prices to increase and output to decrease, causing a fall in employment. In addition, the own-wage elasticity of labor demand does not change significantly across the two phases of trade liberalization as shown by the findings of the FEM reported in Table 4.

The openness effect in the FEM appears to be statistically insignificant, controlling for all years and industries. This shows that openness has not affected employment in the way suggested by standard trade theory. The results for pre- and post-trade liberalization are similar to the first-difference model, which shows that openness is significant for the pre-trade liberalization period and statistically insignificant for the post-trade liberalization period. However, pooling is justified in these models as reported in Table 5, and the test for equality reported in Table 4 provides evidence of decreased openness-elasticity in the FEM. A comparison across pre- and post-trade liberalization periods is, however, not that straightforward as the openness parameter is significant for pre-trade liberalization but insignificant for post-trade liberalization. Again, using the interaction of wages and output with openness fails to show a significant pattern (Table 5).

The figures for the capital-labor ratio show that it kept increasing from 1970 onward. Although the food and textile sectors are major contributors to manufacturing output and are considered less capital-intensive, this ratio also increases over time in these sectors. Sectoral shifts are important in this matter. In the 1990s, the share of food production declined from 24.3 to 14.2 percent of overall output. The share of textiles decreased from 24.3 to 20 percent, while that of the industrial chemical sector, which is highly capital-intensive, increased significantly.[11] Hence, capital intensity might better explain the features of employment in the manufacturing sector. Due to trade liberalization in the long run, technical infusion may raise the demand for capital and labor productivity, and hence the demand for skilled labor.

When observing the results for the time dummies in the FEM, the coefficient for the years 1980 to 2000 appear to be statistically negatively significant, demonstrating a significant difference between employment in 1970 (the base category) and employment in later years. The time factor thus proves to be a strong predictor of employment patterns in this model. The results are consistent with the empirical evidence on trends in employment in Pakistan's manufacturing sector. The high-growth 1980s and low-growth 1990s have contributed little to employment generation in this sector.

[11] Here, capital is measured using a proxy: fixed assets such as land, buildings, plants and machinery, and other fixed assets expected to have a productive life of one year plus the depreciation, addition, and alteration made during that year.

The overall significance of industry-specific effects is determined by the F-test, reported in Table 2 (conducted for fixed effects). The results for industry fixed effects are reported in Table 3. The coefficient for industry-specific dummies shows that labor absorption in the textiles sector is highest, while employment in petroleum is lowest due mainly to institutional and internal factors that vary from one industry to the other but are assumed to be constant over time. We have tried to identify the measurable factors responsible for these variations by estimating the impact of the capital-output ratio on fixed effects.[12] The effect of the capital-output ratio is statistically significant at 1 percent, and explains 28 percent of the variation in industry fixed effects.

Overall, our findings suggest that trade liberalization in the manufacturing sector has an insignificant effect on labor-demand elasticity. Although Pakistan has adopted a stance in favor of trade liberalization over time, and the effective rate of protection has fallen very sharply since the early 1990s, the consequential shift from labor-intensive production to capital-intensive production has been gradual and not in keeping with the static comparative advantage. This, in turn, has not led to an increase in employment generation, and could be due to technical infusion over time (which would demand skilled labor and capital components) or to increased competition in international markets for exports and the easy availability of input.

7. Conclusions and Policy Implications

The impact of trade liberalization on the labor market via the channel of labor-demand elasticity has gradually begun to receive attention in the literature on developing countries, but there is still a dearth of empirical research on this aspect in Pakistan's context. According to empirical evidence from a number of countries, trade liberalization does not directly affect the labor market, specifically from the perspective of sensitivity. Trade reforms are commonly perceived as being implemented in such a way that minimizes their impact on the labor market. In addition, the labor market's sluggish response to trade liberalization may be due to imperfect competition in the labor market.

This study has examined the impact of trade liberalization on labor-demand elasticities in selected manufacturing industries in Pakistan, using pooled and disaggregated data for pre- and post-trade

[12] Authors' calculations based on data from the CMI (various issues).

liberalization periods spanning 1970/71 to 2000/01. Overall, our findings suggest that trade and labor market linkages are not as strong as suggested by the H-O-S type of theory of international trade. According to trade theory, openness can lead to an increase in labor demand in labor-abundant countries due to comparative advantage, and this is expected to increase labor-demand elasticities as labor comes under pressure due to stiffer competition in the goods and labor markets. But in Pakistan's case, labor-demand elasticities are not as affected, rather, openness has had an insignificant effect on labor demand during the period of trade liberalization.

Most importantly, when time and industry-specific factors are introduced into the models used, these factors appear to have greater significance. Employment in all years, other than 1975, is significantly lower than that in the base year (1970s). Thus, one might infer that the overall reduction in labor demand and its insensitivity can be explained by increased capital intensity in the manufacturing sector. Trade liberalization may result in enhanced labor productivity in the long run, but for fewer workers with greater skills as required in the globalized era, leading to higher demand and higher wages for skilled workers. In particular, the infusion of new technology requires skilled labor and capital for production, whereas in Pakistan, little attention is paid to skills enhancement and vocational training for labor.

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Appendix

Table A1: Panel-Data Unit-Root Test

	Levin, Lin, and Chu test statistic	
Variable	**With trend and intercept**	**Integration order**
Employment	-12.130	I (0)
	(0.000)	
Production	-6.680	I (0)
	(0.000)	
Wage	-7.670	I (0)
	(0.000)	
Openness	-16.730	I (0)
	(0.000)	
Import duty	-21.530	I (0)
	(0.000)	

Notes: (a) All variables are checked for stationarity in levels.
(b) Probability values are reported in parentheses.
(c) The null hypothesis of the unit root against the stationary alternative is rejected for all variables. All variables are integrated of order zero, i.e., I (0).

Table A2: Exogeneity Test for Production Function

Variable	Reduced-form equation (*lny*)	2SLS (*lnL*)	OLS (*lnL*)	Exogeneity test structural-form equation (*lnL*)
C	4.070*	-9.000*	-8.030*	-8.980*
	(1.240)	(2.340)	(2.070)	(1.590)
Lny	-	0.847*	0.832*	0.847*
		(0.039)	(0.035)	(0.039)
Lnw	0.195	-1.06*	-0.983*	-1.060*
	(0.132)	(0.22)	(0.196)	(0.143)
Lnopen	-0.363*	0.075**	0.077*	0.076**
	(0.055)	(0.031)	(0.029)	(0.033)
D75	-	-	-0.029	-
			(0.146)	
D80	0.086	-0.069	-0.122	-0.072
	(0.141)	(0.186)	(0.191)	(0.186)
D85	-0.038	0.084	0.017	0.081
	(0.148)	(0.195)	(0.199)	(0.205)
D90	-0.233	0.159	0.089	0.157
	(0.159)	(0.205)	(0.207)	(0.218)
D95	-0.391**	0.105	0.027	0.102
	(0.171)	(0.207)	(0.206)	(0.230)
D00	-0.238	0.118	0.029	0.115
	(0.184)	(0.229)	(0.230)	(0.248)
Llny	0.929*	-	-	-
	(0.027)			
Llnw	0.112	-	-	-
	(0.136)			
Llnopen	0.391*	-	-	-
	(0.059)			
Residual	-	-	-	-0.076
				(0.051)
N	132	132	154	132
R^2	0.930	0.800	0.810	0.800
F-test	172.920	67.380	77.820	55.250
F-statistic for IV	407.930*	-	-	-
χ^2-statistic for Sargan test	-	0.406	-	-

Notes: (a) The results are robust with regard to heteroscedasticity.
(b) Standard errors are reported in parentheses.
(c) *, **, and *** indicate significance at 1, 5, and 10 percent, respectively.
(d) The Sargan test is applied at χ^2 (2).

Table A3: Exogeneity Test for Wage Function

Variable	Reduced-form equation (*lnw*)	2SLS (*lnL*)	OLS (*lnL*)	Exogeneity test structural-form equation (*lnL*)
C	-3.830	-9.990*	-8.030*	-9.820*
	(0.812)	(2.470)	(2.070)	(2.460)
lny	0.091	0.842*	0.832*	0.840*
	(0.062)	(0.042)	(0.035)	(0.042)
lnw	-	-1.165*	-0.983*	-1.149*
		(0.225)	(0.196)	(0.224)
lnopen	0.015	0.078*	0.077*	0.077**
	(0.044)	(0.034)	(0.029)	(0.034)
D75	-	-	-0.029	-
			(0.146)	
D80	0.420*	-0.018	-0.122	-0.024
	(0.089)	(0.201)	(0.191)	(0.201)
D85	0.427*	0.169	0.017	0.159
	(0.094)	(0.238)	(0.199)	(0.238)
D90	0.365*	0.259	0.089	0.247
	(0.105)	(0.260)	(0.207)	(0.259)
D95	0.425*	0.216	0.027	0.203
	(0.113)	(0.280)	(0.206)	(0.279)
D00	0.526*	0.249	0.029	0.234
	(0.117)	(0.312)	(0.23)	(0.312)
Llny	-0.058	-	-	-
	(0.060)			
Llnw	0.644*	-	-	-
	(0.073)			
Llnopen	0.008	-	-	-
	(0.047)			
Residual	-	-	-	0.051
				(0.079)
N	132	132	154	132
R^2	0.720	0.780	0.810	0.800
F-test	34.640	57.630	77.820	54.230
F-statistic for IV	27.300*	-	-	-
χ^2-statistic for Sargan test	-	1.956	-	-

Notes: (a) The results are robust with regard to heteroscedasticity.
(b) Standard errors are reported in parentheses.
(c) *, **, and *** indicate significance at 1, 5, and 10 percent, respectively.
(d) The Sargan test is applied at χ^2 (2).

Table A4: Estimates of Fixed Effects Model

Dependent variable: *lnL*

	Fixed effects model (with import duties as a percentage of total imports as the trade liberalization measure)		
Variable	**All years**	**Pre-trade liberalization**	**Post-trade liberalization**
C	-1.800***	-1.880	-1.240
	(1.006)	(1.750)	(1.240)
Lny	0.810*	0.719*	0.760*
	(0.073)	(0.137)	(0.085)
Lnw	-0.564*	-0.701*	-0.499*
	(0.094)	(0.120)	(0.128)
Lnimpd	-0.005	-0.029	-0.016
	(0.020)	(0.024)	(0.021)
D75	0.048	0.076	-
	(0.083)	(0.074)	
D80	-0.283*	-0.134	-
	(0.103)	(0.108)	
D85	-0.286*	-0.058	-
	(0.103)	(0.142)	
D90	-0.300**	-	-
	(0.129)		
D95	-0.433*	-	-0.140*
	(0.137)		(0.045)
D00	-0.521*	-	-0.230*
	(0.150)		(0.068)
N	154	88	66
R^2_{within}	0.750	0.730	0.690
F-test	22.560	15.300	19.740
Wald test	-	-	-
Lagrange Multiplier test (p-value)	-	-	-
F-test for fixed effects	32.110	17.990	40.450
(p-value)	(0.000)	(0.000)	(0.000)
χ^2-statistic for Hausman Specification test (p-value)	-	-	-

Notes: (a) The results are robust with regard to white heteroscedasticity.
(b) Standard errors are reported in parentheses.
(c) *, **, and *** indicate significance at 1, 5, and 10 percent, respectively.

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A Semi-Nonparametric Approach to the Demand for Money in Pakistan

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Abstract

The degree of substitutability of different monetary assets serves as a valuable source of information for Pakistan's monetary authorities in the context of money demand analysis. Barnett's (1980) concept of the micro-foundations of money demand has paved the way for a more comprehensive demand system analysis. Locally flexible functional forms are unable to estimate substitution elasticities at all data points, and thus, we use the asymptotically ideal model, which is a semi-nonparametric globally flexible functional form. Our data on income, price, and substitution elasticities show that there is less-than-perfect substitution among monetary assets. The results of Allan and Morishima elasticities show that the former are inherently biased toward showing monetary assets as complements, making Morishima a better choice. The study recommends that it is high time Pakistan's monetary authorities abandoned the simple-sum aggregation method, which assumes perfect substitution among monetary assets.

Keywords: Substitution, semi-nonparametric, globally flexible, Morishima elasticity.

JEL Classification: E41.

1. Introduction

The behavior of money in the context of demand systems has been well explained by Chetty (1969) in terms of the complementarity and the substitutability of different monetary assets, with the latter serving as a key guideline for many monetary authorities. Most central banks, especially in developing countries, use the simple-sum aggregation technique, in which all monetary assets are treated as perfect substitutes, which means that this aggregation methodology completely disregards the "price" of money.

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Barnett (1980), however, raised many objections to the application of simple-sum aggregation and suggested the use of index number theory for aggregation. Earlier, his concept of the "user cost of money" in 1978 had paved new avenues in monetary aggregation theory. The Divisia-based aggregation—which is based on weighted aggregation and thus able to portray real substitution and complimentary relationships among monetary assets—appeared to be a better alternative to the simple-sum method.

Since parametric functions do not accurately approximate data-generating functions, and thus usually restrict the substitution or complimentarity relationship among monetary assets, a better option is a semi-nonparametric function that illustrates the microeconomic properties of the consumer's money demand function. This approach translates the consumer's portfolio adjustments into substitution and complimentarity of monetary assets. In Pakistan, however, this aspect has been relatively ignored. This study aims to fill these gaps and estimates a semi-nonparametric asymptotically ideal model (AIM) for the money demand function. The AIM is a globally flexible function and allows us to easily impose regularity conditions. Using this globally flexible functional form (FFF), we estimate price, income, and substitution elasticities, the results of which could give valuable insight to Pakistan's monetary authorities for effective policy formulation.

2. A Review of the Literature

Since the advent of Divisia aggregates and micro-foundations, the search for an appropriate functional form for a monetary demand system has remained controversial. Initially, studies in the literature used the Cobb-Douglas and constant elasticity substitution (CES) utility functions, mainly because of their evident advantage in resolving consumer maximization problems, and because they were easy to use and interpret. Uzawa (1962), however, proved that it was incorrect to use these functional forms. To overcome this problem, the use of FFFs was introduced; Offenbacher (1979) was the first to employ an FFF, i.e., the translog. Models with FFFs provide estimates of elasticity at any point of their data and, according to Barnett, Geweke, and Wolfe (1991), do so at a high degree. FFF models thus revolutionized micro-econometrics and made it possible for neoclassical microeconomic theory to have econometric applications.

While locally FFFs were able to estimate elasticities at approximation points and gained in accuracy, they also violated global regularity. A number of empirical studies show that these models failed to meet the regularity conditions for optimization in large regions. Guilkey and Lovell (1980) found that the generalized Leontief and translog failed to estimate elasticities at different data points. Barnett (1983, 1985), Barnett and Lee (1985), and Barnett, Lee, and Wolfe (1985, 1987) provided a partial solution to this problem by proposing the Minflex-Laurent model. Other examples of these types of functions are the quadratic almost-ideal demand system (AIDS) model in Banks, Blundell, and Lewbel (1997), and the general exponential form in Cooper and McLaren (1996).

While these functions were locally flexible and regular over a large region, they were still not globally regular. The problem that flexibility was achieved only at a single point, persisted. An innovation in this respect was the semi-nonparametric FFF, which had global flexibility and in which asymptotic inferences were, potentially, free from any specification errors (Serletis, 2007). Semi-nonparametric functions were able to offer an asymptotically global approximation to even to multifarious economic relationships. According to Serletis,

> By global approximation one means that the flexible functional form is capable, in the limit, of approximating the unknown underlying data generating function at all points and thus of producing arbitrarily accurate elasticities at all data points (2007).

Two such semi-nonparametric functions are the Fourier FFF introduced by Gallant (1981), and the AIM introduced by Barnett and Jonas (1983), and further employed and explained by Barnett and Yue (1988). Fleissig and Swofford (1996, 1997), Fisher and Fleissig (1997), Fisher, Fleissig, and Serletis (2001), Fleissig and Serletis (2002), and Drake, Fleissig, and Swofford (2003) also use semi-nonparametric techniques and AIM specifications in their research.

Havenner and Saha (1999) estimate a number of AIM forms with multiple datasets, and list the following major advantages of using AIM specifications: (i) they are able to approximate functions over the entire range of a sample, (ii) they are globally flexible and capable of imposing regularity conditions globally rather than just locally, and (iii) there is no problem of over-fitting.

Yue (1999) uses an AIM to estimate a demand for money function for the US economy. The model guarantees asymptotic convergence to an underlying neoclassical utility function. The study finds two additional features of an AIM demand system for applied work. First, although there are a relatively large number of free parameters to be estimated, it is impossible to over-fit the noise in the data. Second, while neoclassical component functions cannot express movements due to measurement errors—being irregular—the AIM system simply ignores them. Yue also estimates income and price elasticities, as well as the elasticity of substitution of monetary assets. He finds that income- and cross-price elasticities suggest portfolio shifts among monetary aggregates in the 1970s and 1980s for US data. Although there are a few problems with this AIM specification, the results are encouraging for those who believe that microeconomic principles, such as utility maximization, can be applied usefully to macroeconomic problems.

Fleissig and Serletis (2002) use a Fourier series instead of AIM specifications to calculate semi-nonparametric estimates of substitution for Canadian monetary assets. The authors compute short- and long-run Morishima elasticities of substitutions for Canadian liquid assets. Their study justifies the use of a semi-nonparametric function with the argument that parametric functions fail to accurately approximate data-generating functions, and often restrict the substitutability or complementarity relationship between assets. The results show that monetary assets are substitutes for one another at all data points, both in the short- and long run.

Drake et al. (2003) apply a similar semi-nonparametric method to UK data, but while using an AIM demand system. Their study shows that the traditional Allan-Uzawa elasticity of substitution can be misleading when more than two assets are being analyzed, in which case the Morishima elasticity of substitution is more appropriate.

Drake and Fleissig (2004) conduct a cross-country study for eight EU countries for the period 1979:Q2 to 2001:Q2. The study encapsulates monetary assets by using the Divisia aggregation method, and then uses the demand system approach to estimate the elasticities of substitution for monetary assets. The purpose of the demand system approach is to derive demand share equations and elasticities of substitution from the unknown indirect utility function. The study's results show that the estimated elasticities are significantly lower than those required to form simple-sum aggregates, thus giving way to Divisia aggregation. With respect to currency substitution, the study also finds strong evidence of currency substitution in Europe. This strong currency substitution with respect to the pound sterling in Europe suggests that a European monetary union that was to include the UK would be more viable.

Serletis and Shahmoradi (2005) focus on the demand for money in the US in the context of two globally FFFs—the Fourier and the AIM. The authors compare these two models in terms of their violation of the regularity conditions for consumer maximization, and provide a policy perspective using parameter estimates that are consistent with global regularity. The study makes a strong case for abandoning simple-sum aggregation, and also computes income- and price-elasticities and elasticity of substitution.

In Pakistan, very few studies have focused on the microeconomic foundations of the demand for money. The only relevant study is Tariq and Matthews (1997), which is confined to a comparison of simple-sum and Divisia aggregates. Although the authors do not find significant differences between the two, they argue that, if financial innovations continue, Divisia aggregates will prove far superior in the future. Since 1997, Pakistan's financial sector has undergone a significant positive change, and there is dire need to reinvestigate the case for stability as well as the micro-foundations of the money demand function for Pakistan.

3. Data and Methodology

Barnett (1978) introduced the idea of the "user cost of money," which became the foundation for microeconomic analysis of the monetary aggregation process. The user cost of monetary assets enables economists to investigate the representative consumer's choice set, not only over consumption goods, but also monetary services. Thus, the representative consumer's utility can be portrayed as a function of consumption goods, leisure, and monetary services:

$$u = u\,(c, l, x) \tag{1}$$

Here, c is a vector of the services of consumption goods, l is leisure time, and x is a vector of the services of monetary assets. Since this is a weakly separable utility function, we focus only on the consumer's monetary problem. Following Serletis and Shahmoradi (2005, 2007), we assume that the consumer' monetary problem is

$$\max f\,(x) \text{ subject to budget constraint } p'x = y$$

Here, x as defined above is the vector of services of monetary assets, p is the corresponding vector of monetary assets' user cost, and y is expenditure on monetary services. Since these monetary assets are all different, the consumer's utility function becomes

$$f(x) = f(f_A(x_1, x_2, x_3, x_4), f_B(x_5, x_6, x_7, x_8), f_C(x_9, x_{10})) \quad (2)$$

Here, x_1 to x_{10} represent different monetary assets (see Table 1). Keeping in view the subgroups shown in the table, we calculate Divisia quantity and price indices. To design the demand system based on the given objective function above instead of using the simple-sum index, the Divisia quantity index is estimated to allow for less-than-perfect substitutability among the monetary components being analyzed.

In this study, we have used annual data on the Pakistan economy for the period 1972–2007. Our main sources are the Government of Pakistan's *Handbook of Statistics on the Pakistan Economy* (2005), various statistical bulletins of the State Bank of Pakistan (SBP), and data from the International Monetary Fund.

In the demand system approach, income and price elasticity, as well as the elasticity of substitution, play an important role in explaining the responsiveness of different arguments in the system. In this regard the functional form of the demand system is of critical importance. Different studies have used one of several functional forms including the Cobb-Douglas, CES, translog, AIDS, and quadratic functional form, etc., but all these are either nonflexible or only locally flexible. Only semi-nonparametric functions provide asymptotically global approximation for complex economic relationships. A globally FFF is capable of producing arbitrarily accurate elasticities at all data points. The two kinds of FFF include the Fourier and the AIM.

Table 1: Component Assets of Monetary Subgroups

Subgroup	Variable	Asset
A	X_1	Currency in circulation
	X_2	Other deposits with SBP
	X_3	Currency in tills of scheduled banks
	X_4	Banks' deposits with SBP
B	X_5	Current deposits
	X_6	Call deposits
	X_7	Other deposits
	X_8	Savings deposits
C	X_9	Time deposits
	X_{10}	Residents' foreign currency deposits

3.1. AIM Specification

We use an AIM due to its established superiority over the Fourier. The AIM is relatively simple to use in economic analysis, while the Fourier is more appropriate to engineering and physics. Moreover, an FFF in lower orders could violate the regularity conditions (Serletis, 2007).

The general form of an AIM specification for three goods is:

$$h(v) = a_o + \sum_{k=1}^{k}\sum_{i=1}^{3} a_{ik} v_i^{\lambda(k)} + \sum_{k=1}^{k}\sum_{m=1}^{k}\left[\sum_{i=1}^{3}\sum_{j=1}^{3} a_{ijkm} v_i^{\lambda(k)} v_j^{\lambda(m)}\right]$$
$$+\sum_{k=1}^{k}\sum_{m=1}^{k}\sum_{g=1}^{k}\left[\sum_{i=1}^{3}\sum_{j=1}^{3}\sum_{h=1}^{3} a_{ijhkmg} v_i^{\lambda(k)} v_j^{\lambda(m)} v_h^{\lambda(g)}\right] \quad (3)$$

Here, $\lambda(z) = 2^{-2}$ for $z = \{k, m, g\}$ is the exponent set; v_i, v_j, and v_h are the income-normalized prices of the three aggregates; and a_{ik}, a_{ijkm}, … are the parameters to be estimated. We reduce the number of parameters by deleting their diagonal terms. Similarly, to avoid extensive multiple subscripting, we re-parameterize by stacking coefficients on the same pattern as Barnett and Yue (1988).

With n assets and a degree of approximation of K, the number of parameters to be estimated in the AIM (K) model is given by the following formula:

$$\frac{nk}{1!} + \frac{n(n-1)k^2}{2!} + \frac{n(n-1)(n-2)k^3}{3!} + \ldots.$$

The AIM (1) specification used in the study after being re-parameterized is

$$h(v)_{k=1} = b_o + b_1 v_1^{1/2} + b_2 v_2^{1/2} + b_3 v_3^{1/2} + b_4 v_1^{1/2} v_2^{1/2}$$
$$+ b_5 v_1^{1/2} v_3^{1/2} + b_6 v_2^{1/2} v_3^{1/2} + b_7 v_1^{1/2} v_2^{1/2} v_3^{1/2} \quad (4)$$

Here, v_i represents income normalized prices, b_i is the parameter of the AIM's indirect utility function, and k is the model's order of expansion. The above AIM specification is an indirect utility function; we can obtain demand share equations s_i by applying Roy's Identity to the indirect utility function as follows:

$$s_i = \frac{v_i(\partial f_k(v)/\partial v_i)}{v'(\partial f_k(v)/\partial v_i)} \quad (5)$$

The share equations obtained in our three-goods case are

$$s_1 = (b_1 v_1^{1/2} + b_4 v_1^{1/2} v_2^{1/2} + b_5 v_1^{1/2} v_3^{1/2} + b_7 v_1^{1/2} v_2^{1/2} v_3^{1/2}) / D \quad (6)$$

$$s_2 = (b_2 v_2^{1/2} + b_4 v_1^{1/2} v_2^{1/2} + b_6 v_2^{1/2} v_3^{1/2} + b_7 v_1^{1/2} v_2^{1/2} v_3^{1/2}) / D \quad (7)$$

$$s_3 = (b_3 v_3^{1/2} + b_5 v_1^{1/2} v_3^{1/2} + b_6 v_2^{1/2} v_3^{1/2} + b_7 v_1^{1/2} v_2^{1/2} v_3^{1/2}) / D \quad (8)$$

D is the sum of the numerators in all three share equations, which we estimate using SAS 9.1 software and the model procedure, i.e., Proc Model, and applying full information maximum likelihood regression (FIML).

Having estimated the demand systems, the next step is to calculate both income and price elasticity. Both elasticities are of particular importance because they can be used to direct policy in terms of how the arguments of the underlying function affect the quantities demanded. We estimate these elasticities directly using the demand share equations through the transformation

$$x_i = \frac{s_i m}{p_i} \qquad i = 1, 2, \ldots, n \quad (9)$$

Here, s_i is the respective share, m is income, and p_i is price. Income elasticity is calculated as

$$\eta_{im} = \frac{m}{s_i}\frac{\partial s_i}{\partial m} \quad (10)$$

Price elasticity is calculated as

$$\eta_{ij} = \frac{p_j}{s_i}\frac{\partial s_i}{\partial p_j} - \delta_{ij} \quad (11)$$

$\delta_{ij} = 0$ for $i \neq j$ and 1 otherwise. If $\eta_{ij} > 0$, the assets are gross substitutes; if $\eta_{ij} < 0$, they are gross complements; and if $\eta_{ij} = 0$, they are independent.

The Allen elasticity of substitution between two assets is calculated as

$$\sigma_{ij}^{a} = \eta_{im} + \frac{\eta_{ij}}{s_i} \tag{12}$$

The Morishima elasticity of substitution is calculated as

$$\sigma_{ij}^{m} = s_i(\sigma_{ji}^{a} - \sigma_{ii}^{a}) \tag{13}$$

Morishima elasticity yields better estimates because Allen elasticity can provide substitution between only two assets, and its estimation method is biased toward showing assets as complements.

3.2. Semi-Nonparametric Estimates of Money Demand

As mentioned earlier, parametric functions do not accurately approximate data-generating functions, and thus usually restrict the substitution or complimentarity relationship between different monetary assets. The global flexibility of our model provides an opportunity to calculate the elasticity at each point of the functions instead of only at the mean. To determine the substitutability or complimentarity of different monetary assets, we use weighted (Divisia) monetary aggregates because they allow less-than-perfect substitutability and provide a sound theoretical background. The indirect utility function is conceived keeping in view the consumer problem.

As demonstrated earlier, the AIM (1) specification of the indirect utility function used after re-parameterization is given in Equation 4; by applying Roy's Identity to the indirect utility function, we obtained share equations in the form of Equations 6 to 8. These share equations were estimated using Proc Model in SAS software, using the FIML method (see Table 2). The indirect utility function is homogeneous of degree 0 in prices and income; this was achieved by using income-normalized prices. The adding-up restriction was imposed due to the linearity of the budget constraint, and $n - 1$ shares were estimated.

The nonlinear parameter estimates obtained indicate that all the parameters, barring b_2, are highly significant and the magnitude of R^2 indicates the model's goodness of fit (see Table 2). The results also prove the validity of having imposed the adding-up restriction.

Table 2: AIM Estimates (Model Procedure)

Nonlinear FIML Summary of Residual Errors

Equation	DF model	DF error	SSE	MSE	Root MSE	R^2	Adj. R^2
S1	3	32	0.254	0.007	0.089	0.959	0.956
S2	3	32	0.918	0.029	0.169	0.948	0.944

Nonlinear FIML Parameter Estimates

Parameter	Estimated coefficient	Approx. standard error	t-value	Approx. Pr > |t|
b_1	0.213	0.0304	6.98	<0.0001
b_2	-0.022	0.0625	-0.36	0.7243
b_3	0.809	0.0848	9.54	<0.0001
b_4	0.304	0.0610	5.01	<0.0001
b_5	-0.317	0.0360	-8.73	<0.0001
b_6	-0.172	0.0170	-10.33	<0.0001
b_7	0.018	0.0020	10.76	<0.0001
Restriction	-0.167	0.0010	-13828	<0.0001

Source: Authors' calculations.

The nonlinear estimates provided by the AIM are not easily interpreted in terms of economic theory, and we explore their economic content through the elasticities of income, price, and, more importantly, substitution. The fit of both models is tested by plotting the actual and predicted values of both (see Figures 1 and 2), all of which fall within 95-percent confidence limits.

Figure 1: Predicted and Actual Values of Model S1

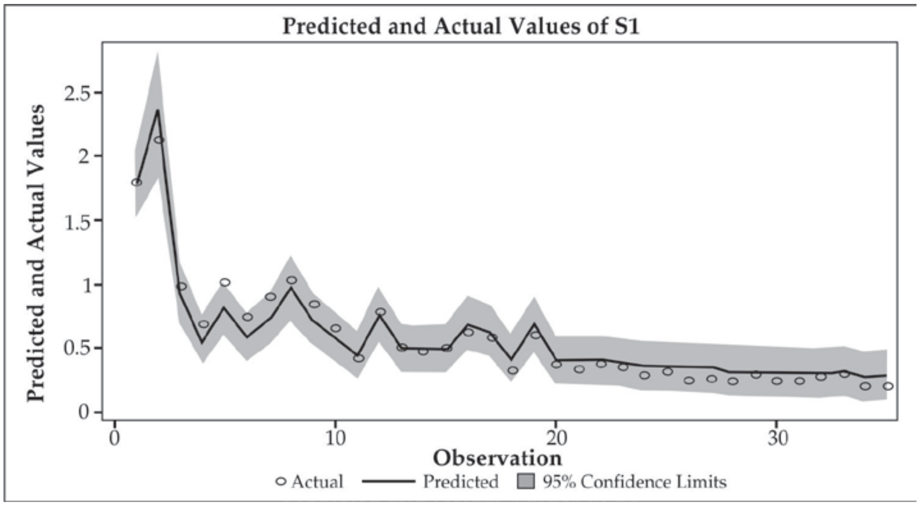
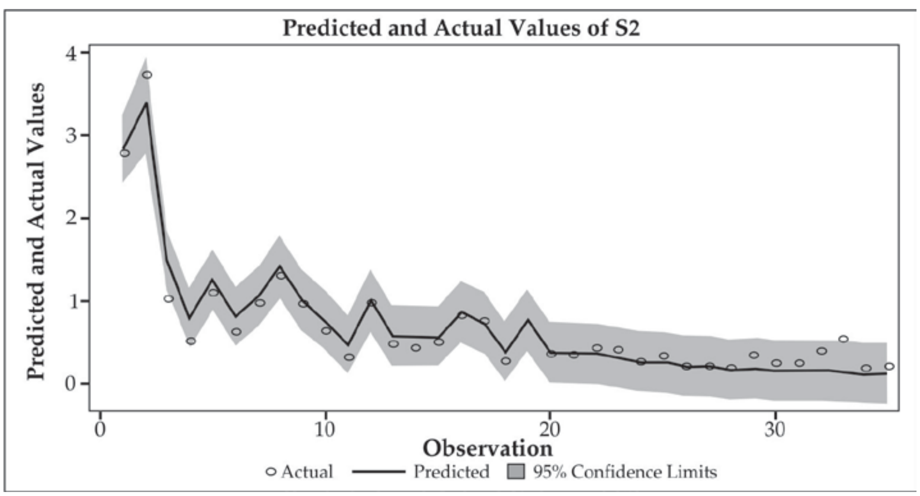


Figure 2: Predicted and Actual Values of Model S2



To calculate the elasticities, we compute derivatives of the demand share equations and plug these into their respective elasticity formulae. Price elasticity (E_{ij}) is calculated as

$$E_{ij} = \frac{p_j}{s_i}\frac{\partial s_i}{\partial p_j} - \delta_{ij}$$

$\delta_{ij} = 0$ for $i \neq j$ and 1 otherwise. If $E_{ij} > 0$, the assets are gross substitutes; if $E_{ij} < 0$, they are gross complements; and if $E_{ij} = 0$, they are independent.

The results for own- and cross-price elasticities are reported in Table 3. They show that own-price elasticities are negative, indicating a negative relationship between price and quantity of money; this is consistent with the downward-sloping demand curve relationship. An important finding is that our model satisfies the curvature requirement, i.e., that the Hessian matrix be negative semi-definite, which is clearly achieved by the negative own-price elasticities. There are a few cases of violations of curvature in the case of E_{33}, but they cease by increasing the AIM's degree of approximation. However, since our sample is not so large, we estimate only AIM (1).

The table's cross-price elasticities are both negative and positive. In theory, the cross-price elasticity can take any sign: a positive sign would indicate that the goods were gross substitutes, and a negative sign would indicate that they were gross complements. The dominant behavior of E_{31}, E_{32}, and E_{13} implies that the more liquid assets—currency in circulation and time deposits—have a complementary relationship, which is borne out by the literature (see Serletis, 2007; Serletis & Shahmoradi, 2005; Yue, 1991).

The cross-price elasticity results indicate the interesting transition of Pakistan's financial sector, which underwent a significant change in the late 1990s. In the early 1970s (after nationalization), the financial sector had borne a government footprint to the tune of 92 percent (the remaining assets were held by foreign banks). The structural transformation of the late 1990s, however, created space for the private sector. The SBP was granted more autonomy, the Pakistan Banking Council was dissolved, the Securities and Exchange Commission of Pakistan came into being, and international accounting standards were adopted. These reforms helped emancipate the banking sector, and their impact was also evident in monetary decisions as weighted average lending rates gradually came down from 15.6 percent in 1998 to 8.81 percent in June 2005.

In Table 3, the cross-price elasticity E_{23} reflects this structural change. Due to the banking sector reforms and decrease in lending rates, the sign of E_{23} has been reversed. Due to the decrease in returns on long-term assets, investment moved toward the more liquid assets.

Table 3: Own- and Cross-Price Elasticities

Year	E_{11}	E_{22}	E_{33}	E_{12}	E_{13}	E_{21}	E_{23}	E_{31}	E_{32}
1973	-1.217	-2.760	1.462	-6.947	-4.088	-2.512	-0.155	2.047	2.616
1974	-1.467	-3.507	2.040	-10.067	-5.318	-3.569	-0.659	2.807	3.134
1975	-0.629	-1.184	0.554	-1.447	-1.557	-0.237	0.917	0.356	1.695
1976	-0.608	-0.804	-0.157	0.335	0.003	0.668	1.102	-0.754	0.155
1977	-0.598	-0.993	0.345	-0.626	-0.878	0.099	0.744	-0.017	0.943
1978	-0.595	-0.787	-0.104	0.257	-0.096	0.572	0.886	-0.624	0.181
1979	-0.575	-0.855	-0.174	-0.196	-0.552	0.305	0.706	-0.257	0.575
1980	-0.561	-0.972	-0.608	-1.240	-1.472	-0.079	0.545	0.219	1.207
1981	-0.546	-0.771	-0.171	-0.123	-0.563	0.368	0.614	-0.317	0.463
1982	-0.545	-0.681	-0.084	0.361	-0.179	0.672	0.716	-0.716	0.015
1983	-0.588	-0.625	-0.412	0.696	0.183	1.007	0.730	-1.389	-0.877
1984	-0.498	-0.678	0.263	-0.192	-0.786	0.418	0.514	-0.329	0.477
1985	-0.550	-0.617	-0.263	0.644	0.024	0.856	0.649	-1.036	-0.435
1986	-0.549	-0.609	-0.283	0.700	0.039	0.936	0.678	-1.121	-0.515
1987	-0.536	-0.591	-0.262	0.678	-0.006	0.848	0.565	-1.005	-0.456
1988	-0.459	-0.568	0.167	0.150	-0.715	0.635	0.475	-0.584	0.215
1989	-0.477	-0.549	0.028	0.391	-0.449	0.707	0.429	-0.676	-0.026
1990	-0.573	-0.568	-0.472	0.871	0.096	1.159	0.479	-1.704	-1.262
1991	-0.366	-0.372	0.199	0.380	-0.842	0.716	0.176	-0.627	-0.022
1992	-0.540	-0.532	-0.446	0.849	0.009	0.976	0.316	-1.320	-0.960
1993	-0.540	-0.525	-0.451	0.922	-0.002	1.020	0.283	-1.426	-1.031
1994	-0.515	-0.493	-0.431	0.882	-0.059	0.906	0.189	-1.192	-0.851
1995	-0.522	-0.488	-0.479	0.879	-0.092	0.887	0.113	-1.228	-0.916
1996	-0.554	-0.510	-0.562	0.846	-0.172	1.029	0.042	-1.645	-1.335
1997	-0.534	-0.486	-0.553	0.842	-0.201	0.919	-0.010	-1.425	-1.123
1998	-0.585	-0.521	-0.633	0.712	-0.407	1.078	-0.167	-2.176	-1.835
1999	-0.579	-0.515	-0.635	0.714	-0.422	1.052	-0.184	-2.139	-1.785
2000	-0.583	-0.507	-0.680	0.578	-0.721	0.994	-0.401	-2.291	-1.902
2001	-0.541	-0.475	-0.629	0.711	-0.415	0.763	-0.181	-1.372	-1.068
2002	-0.559	-0.487	-0.674	0.688	-0.697	0.883	-0.338	-1.838	-1.450
2003	-0.559	-0.487	-0.678	0.662	-0.727	0.855	-0.346	-1.769	-1.429
2004	-0.527	-0.455	-0.644	0.745	-0.509	0.682	-0.215	-1.225	-0.900
2005	-0.499	-0.418	-0.608	0.821	-0.409	0.609	-0.178	-1.011	-0.674
2006	-0.542	-0.469	-0.708	0.705	-1.103	0.978	-0.555	-1.926	-1.527
2007	-0.557	-0.479	-0.704	0.702	-1.013	0.919	-0.483	-1.986	-1.480

Source: Authors' calculations.

Income elasticity was calculated using the formula

$$E_{iy} = \frac{y}{s_i}\frac{\partial s_i}{\partial y} \qquad i = 1, 2, 3$$

E_{iy} is the income elasticity of the ith asset, y is income, and s_i is the ith share. The results presented in Table 4 show that all the income elasticities for the three sub-aggregates are positive, implying that these monetary assets are normal goods and consumers demand more money as their incomes increase.

Table 4: Income Elasticities of Monetary Assets

Year	E_{1y}	E_{2y}	E_{3y}
1973	0.262	0.006	0.004
1974	0.213	0.004	0.003
1975	1.089	0.034	0.020
1976	1.316	0.114	0.097
1977	1.249	0.049	0.029
1978	1.366	0.108	0.083
1979	1.379	0.069	0.042
1980	1.259	0.043	0.021
1981	1.465	0.078	0.045
1982	1.509	0.124	0.083
1983	1.132	0.239	0.252
1984	1.570	0.080	0.040
1985	1.415	0.184	0.148
1986	1.397	0.192	0.158
1987	1.448	0.190	0.148
1988	1.706	0.104	0.051
1989	1.681	0.128	0.068
1990	1.079	0.278	0.298
1991	1.908	0.126	0.053
1992	1.189	0.276	0.273
1993	1.197	0.281	0.276
1994	1.279	0.279	0.258
1995	1.187	0.298	0.292
1996	0.938	0.314	0.343
1997	1.008	0.316	0.335
1998	0.706	0.309	0.339
1999	0.716	0.310	0.339
2000	0.582	0.291	0.307
2001	0.824	0.318	0.340
2002	0.662	0.302	0.318
2003	0.638	0.298	0.313
2004	0.833	0.319	0.336
2005	1.019	0.330	0.338
2006	0.579	0.285	0.292
2007	0.594	0.289	0.298

Source: Authors' calculations.

This finding is consistent with previous studies (Akhtar, 1994; Khan, 1994), and implies that, as per capita income rises, the demand for money increases since the income elasticity is positive. Over time, the decrease in income elasticity of reserve money indicates that, with financial developments such as debit and credit cards, and ATMs, etc., the extent of preference for cash has diminished. On the other hand, the increasing magnitude of income elasticities for narrow and broad aggregates shows that the demand for these assets rises as incomes increase (see Table 4).

Next, we estimate the elasticity of substitution, which measures the degree of substitutability of financial assets. These estimates are of critical importance because they are directly related to our main hypothesis concerning the perfect substitutability of monetary assets. The calculation of elasticities of substitution over time using a globally flexible function enables us capture the consumer's portfolio adjustments with changes in the user cost of financial assets. Two options are available in this regard: Allen elasticity of substitution (AE) and Morishima elasticity of substitution (ME). Blackorby and Russell (1981, 1989) argue that Allen elasticity does not provide correct estimates if there are more than two assets. In this situation, Morishima elasticity provides robust and unambiguous results.

The Allen elasticity of substitution is calculated using the formula

$$AE_{ij} = E_{iy} + \frac{E_{ij}}{s_i}$$

E_{iy} is the income elasticity of the *i*th asset and E_{ij} is the cross-price elasticity of demand for asset *i* due to changes in the price of asset *j*. The results for the Allen elasticities of substitution are presented in Table 5.

Table 5: Allen Elasticities of Substitution

Year	AE_{11}	AE_{22}	AE_{33}	AE_{12}	AE_{32}	AE_{31}
1973	-0.414	-0.984	0.519	-2.230	0.943	1.140
1974	-0.474	-0.935	0.539	-2.484	0.843	1.317
1975	0.449	-1.113	0.549	-0.313	1.662	0.382
1976	0.432	-1.413	-0.205	1.953	0.392	-0.999
1977	0.664	-0.846	0.338	0.685	0.879	0.012
1978	0.565	-1.121	-0.083	1.767	0.365	-0.757
1979	0.741	-0.801	0.218	1.179	0.627	-0.243
1980	0.714	-0.695	0.474	0.317	0.938	0.234
1981	0.816	-0.711	0.218	1.339	0.518	-0.331
1982	0.681	-0.925	-0.045	2.066	0.107	-1.004
1983	-0.225	-1.678	-1.033	3.267	-2.438	-2.953
1984	0.936	-0.608	0.300	1.375	0.525	-0.378
1985	0.334	-1.087	-0.398	2.739	-0.747	-1.886
1986	0.242	-1.193	-0.473	2.989	-1.013	-2.199
1987	0.375	-0.968	-0.358	2.777	-0.746	-1.862
1988	0.981	-0.577	0.248	1.886	0.309	-0.869
1989	0.864	-0.589	0.103	2.192	0.034	-1.089
1990	-0.654	-1.767	-1.432	4.209	-4.239	-4.857
1991	1.310	-0.257	0.241	2.301	0.029	-0.971
1992	-0.259	-1.164	-0.896	3.486	-2.324	-3.266
1993	-0.391	-1.187	-0.986	3.776	-2.608	-3.916
1994	-0.076	-0.849	-0.690	3.298	-1.689	-2.880
1995	-0.282	-0.879	-0.820	3.305	-1.916	-3.166
1996	-0.939	-1.474	-1.602	3.902	-4.336	-5.230
1997	-0.679	-1.095	-1.242	3.455	-2.927	-4.167
1998	-1.604	-2.106	-2.760	4.007	-8.164	-8.261
1999	-1.539	-1.988	-2.684	3.898	-7.624	-7.994
2000	-1.795	-2.206	-3.196	3.427	-9.056	-9.029
2001	-0.985	-1.035	-1.452	2.850	-2.704	-4.252
2002	-1.649	-1.622	-2.372	3.385	-5.415	-7.275
2003	-1.657	-1.631	-2.334	3.261	-5.349	-6.950
2004	-1.029	-0.822	-1.254	2.701	-1.919	-3.994
2005	-0.610	-0.430	-0.771	2.513	-0.887	-2.959
2006	-2.078	-2.064	-2.794	4.109	-7.353	-9.146
2007	-2.091	-1.849	-2.721	3.728	-6.311	-9.277

Source: Authors' calculations.

The dominant pattern assumed by the estimates of Allen own-substitution elasticity is negative, as expected. But the remaining three Allen elasticities are not deemed reliable due to their inherent drawback as pointed out by Blackorby and Russell (1981, 1989). To overcome this, we use Morishima elasticity, which is calculated as

$$ME_{ij} = s_i(AE_{ji} - AE_{ii})$$

Here, s_i is the share of the *i*th asset. Estimates for the Morishima elasticities of substitution are shown in Table 6 and Figures 3 to 5.

Table 6: Morishima Elasticities of Substitution

Year	ME_{12}	ME_{21}	ME_{13}	ME_{31}	ME_{23}	ME_{32}
1973	-1.757	-3.473	2.799	-4.819	5.372	-1.613
1974	-2.549	-5.781	3.824	-6.559	6.637	-2.694
1975	-0.645	0.825	-0.066	-0.993	2.864	0.377
1976	0.449	1.771	-0.985	0.796	0.949	1.268
1977	-0.528	1.697	-0.665	0.140	1.914	0.421
1978	0.233	1.849	-0.982	0.818	0.952	1.006
1979	-0.299	1.946	-0.886	0.588	1.403	0.559
1980	-0.771	1.332	-0.495	-0.418	2.151	-0.034
1981	-0.254	2.005	-0.968	0.658	1.201	0.476
1982	0.305	1.940	-1.110	0.836	0.669	0.826
1983	1.208	1.611	-1.182	0.878	-0.248	1.139
1984	-0.255	1.952	-1.033	0.496	1.115	0.292
1985	0.779	1.859	-1.131	0.899	0.165	0.930
1986	0.912	1.839	-1.160	0.877	0.079	0.976
1987	0.755	1.910	-1.119	0.928	0.114	0.848
1988	0.078	2.054	-1.174	0.518	0.739	0.353
1989	0.277	2.127	-1.141	0.822	0.477	0.449
1990	1.468	1.663	-1.389	0.781	-0.688	0.946
1991	-0.009	2.479	-1.397	0.927	0.278	0.054
1992	1.175	1.719	-1.122	0.806	-0.429	0.763
1993	1.248	1.775	-1.199	0.778	-0.508	0.736
1994	1.042	1.812	-1.065	0.837	-0.367	0.631
1995	1.094	1.736	-1.025	0.771	-0.430	0.594
1996	1.399	1.534	-1.267	0.561	-0.817	0.595
1997	1.235	1.565	-1.104	0.588	-0.631	0.536
1998	1.562	1.319	-1.684	0.301	-1.308	0.460
1999	1.527	1.319	-1.657	0.292	-1.264	0.445
2000	1.506	1.144	-1.776	0.013	-1.391	0.276
2001	1.152	1.363	-0.976	0.385	-0.586	0.441
2002	1.356	1.267	-1.362	0.063	-0.959	0.332
2003	1.331	1.234	-1.289	0.033	-0.938	0.328
2004	1.063	1.405	-0.839	0.336	-0.438	0.422
2005	0.898	1.618	-0.720	0.572	-0.252	0.426
2006	1.459	1.233	-1.442	-0.328	-1.057	0.152
2007	1.413	1.249	-1.490	-0.241	-0.999	0.218

Source: Authors' calculations.

Figure 3: Morishima Elasticity ME32

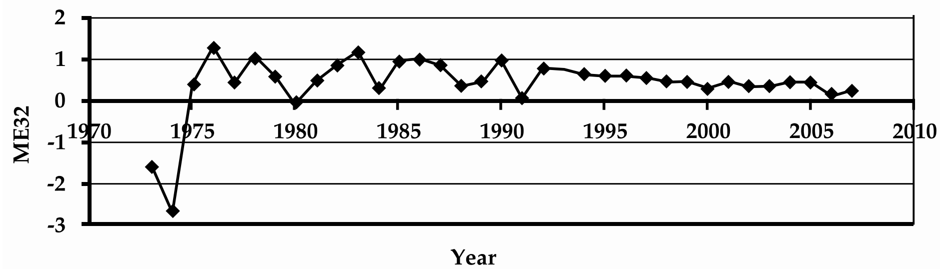


Figure 4: Morishima Elasticity ME23

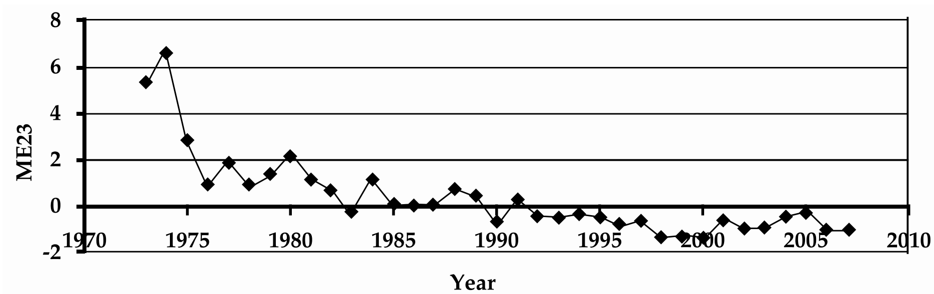


Figure 5: Morishima Elasticity ME31

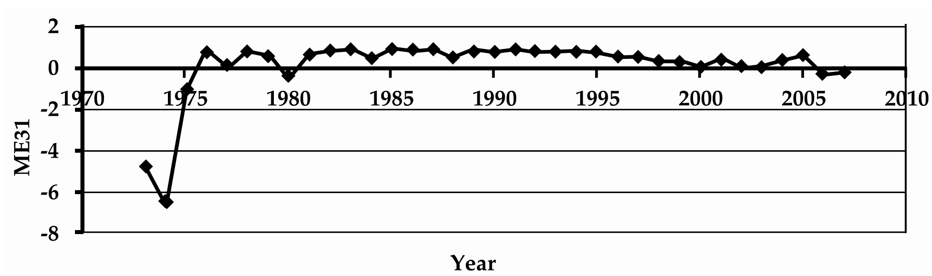


Table 6 shows that, in most years, the first three elasticities—ME_{12}, ME_{21}, and ME_{13}—indicate substitution that is greater than unity. This finding is due mainly to the fact that the first subgroup includes the most liquid assets and the second includes demand deposits; with the development of the financial sector in Pakistan and smaller user cost of demand deposits, these two subgroups emerge as substitutes.

The results for the last three elasticities—ME_{23}, ME_{13}, and ME_{32}—are smaller than unity. The less-than-perfect substitution of these monetary assets indicates that we cannot treat them as equivalents, and so a simple summation of these assets to form monetary aggregates would be misleading. It also indicates that weighted aggregates are a better option for monetary aggregation. This result supports our main hypothesis that all monetary assets are not perfect substitutes for one another, as simple-sum aggregation might otherwise imply.

The results for both Allen and Morishima elasticities of substitution, when calculated at mean, augment our previous findings (see Table 7). According to Blackorby and Russell (1981, 1989), Allen elasticity is biased toward showing assets as complements. This is also evident from the table where, except for AE_{12}, all the elasticities show the assets to be Allen complements.

Table 7: Allen and Morishima Elasticities at Mean

Allen Elasticity	Morishima Elasticity	Allen Elasticity	Morishima Elasticity
AE_{11}	-0.266	AE_{11}	-0.266
AE_{22}	-1.162	AE_{22}	-1.162
AE_{33}	-0.824	AE_{33}	-0.824
AE_{12}	2.374	AE_{12}	2.374
AE_{32}	-2.045	AE_{32}	-2.045

Source: Authors' calculations.

4. Conclusion and Recommendations

Our estimates of both Allen and Morishima elasticities corroborate previous findings in the literature, and strengthen the argument in favor of less-than-perfect substitution among monetary assets. On the basis of our results, we can conclude that simple-sum aggregates are inferior and do not have a strong theoretical base, while Divisia aggregates, which assume less-than-perfect substitution, provide more information content for policy formulation. Moreover, the variability in the elasticity of substitution is an indication of the stability of any nonlinear function.

The study's results show that the elasticity of substitution in the nonlinear AIM varies considerably. Thus, the money demand model is stable and monetary authorities should target the broad money aggregate. The consistent failure to handle inflation and money supply issues can be avoided by improving the monetary aggregation technique that is used. This transition from simple-sum to Divisia aggregation has been successful in many developed countries, and Pakistan, too, needs to switch to improved techniques given that its policies that are based on inferior aggregates have not proved successful.

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The Effect of Ownership Rights on Urban Households' Access to Credit in Lahore

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Abstract

Land titling and ownership rights have recently been advocated in policy circles as a powerful tool for poverty reduction. The lack of formal titling prevents the use of property as collateral, and hence prevents the capital embedded in these assets from being "unlocked." Some studies show a fairly insignificant relationship between informal loans and property rights, while others indicate a significant positive relationship between formal loans (credit cards, bank loans, etc.) and land ownership. The objective of this article is to look at the impact of owned titled land on formal and informal loans among urban households in Lahore. Here, formal loans are seen in terms of bank loans and credit cards while informal loans are characterized as loans taken from relatives, friends, or local moneylenders. The findings suggest that land ownership has a positive and significant relationship with formal loans but no relationship with either bank loans or informal loans alone.

Keywords: Property rights, land ownership, credit access, formal loans, urban households.

JEL Classification: Q15, O16, D14.

1. Introduction

Institutions and their evolution play a key role in shaping the environment in which economic agents interact. Given that property relations are "the backbone of the economic structure of society" (Bardhan, 1989), the codification and enforcement of property rights are considered important preconditions for economic growth and development.

Property rights are defined as registered or titled land, i.e., the legal ownership status of which is sanctioned by a property title or deed that is recognized by the state. The title functions like a contract between the holder and the state, with the latter pledging to recognize the former's rights and protect them. Land registration provides an extra layer of

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security to the titleholder as it guarantees that no other (registered) title exists that contradicts his/her rights. In essence, it makes the contract between the titleholder and the state verifiable by a third party, i.e., a registrar. A formal title that represents alienable rights increases the collateral value of that land.

While development economists have tried to look at the importance of property rights in economic development, credit provision has gained the reputation of a key tool for mobilizing resources and increasing income for households through channels of increased investment. Together, the relationship between owned property and credit accessibility—and its broad effect on the economy—has gained widespread interest among development economists.

Feder, Onchan, Chalamwong, and Hongladarom (1988) identify two linkages between titles and economic performance. On one hand, land tenure facilitates households and enterprises in gaining access to credit by reducing the asymmetries between borrowers and lenders, and increasing the collateral value of land and the amount of credit available. On the other, it enhances tenure security by reducing any informational asymmetry in the ownership status of the land, which can then be used for investment. Both these linkages lead to an increase in credit demand.

De Soto (2000) emphasizes that a lack of property rights impedes the transformation of wealth owned by the poor into capital. Proper titling would allow people to collateralize their land. In turn, this credit could be invested as capital in productive projects, promptly increasing labor productivity and income, and thus economic development. Also, if land were easier to collateralize, banks would charge a lower interest rate (Besley, 1995). Owned land could also be used for sale, lease, or mortgage by households, providing them with liquidity.

The productivity of land depends on the complementary investments carried out in it, be it agricultural investment or urban/commercial. These investments yield benefits over time while the cost is borne upfront. Thus, any investor will first weigh the risks and costs of bearing the investment against its benefits. One major risk is "tenure insecurity" where the investor faces the risk of land ownership disputes, eviction, or expropriation by the government. Institutional arrangements involving registration systems and land titles help reduce land insecurity. Feder and Nishio (1996) argue that,

> with ownership officially documented and verified, the risk of challenges to ownership is reduced, and the likelihood of having to incur high costs in defending one's possession of land is lower, incentives to invest are enhanced and land productivity is increased.

De Soto (2000) summarizes the importance of owned property in one phrase: "Without representations, assets are dead capital."

Formal capital markets in developing countries—including Pakistan—function very poorly. Presently, Pakistan ranks 113th of 129 countries according to the 2011 International Property Rights Index,[1] with a score of 4.1 out of 10. De Soto (as cited in Woodruff, 2001) explains why capital markets fail in developing countries as follows:

> Capital markets fail for the majority because the majority do not own formally titled property. While the majority of residents in developing countries do own property, ownership of property is secured informally, through neighborhood associations or mafias, for example, rather than through formal titles and a property registration system. The lack of formal titling prevents the use of property as collateral, and hence prevents the capital embedded in these assets from being "unlocked." Entrepreneurs in developed market economies are able to turn their houses into capital to start businesses; entrepreneurs in the developing world are not. This inability to convert such assets into capital is "the major stumbling block that keeps the rest of the world from benefiting from capitalism."

Owned titled land not only helps increase credit demand, it also provides security to the lender, thereby increasing credit supply. The loan market in general comprises formal, informal, and semiformal credit markets. Formal credit consists of loans provided by banks (private or government) in cash or through credit cards, while informal credit includes loans provided by private moneylenders, relatives, and other individuals. Semiformal credit consists of loans provided by various national, international, and private donors in the form of microfinance.

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[1] A new international index published under the Property Rights Alliance in Washington, DC, and the Hernando De Soto Fellowship Program.

The three types vary in lending terms and conditions. The formal credit market, in particular, does not cater to low-income households because of their inability to provide proper collateral. This inability is, however, due to a lack of formal ownership rights rather than lack of underlying assets. For example, in many rural areas, households own substantial property, mainly land, but do not have access to credit because they fail to provide proper documentation to certify their ownership.

Besley (1995) argues that the formal credit market is generally beset by "enforcement and information problems" while informal lenders often have close contact with borrowers, which reduces the risk of default. This is why access to formal credit relies heavily on the provision of collateral while informal loans involve far less collateral than similar commercial banks.

Some studies (Carter & Olinto, 2003; Pender & Kerr, 1999; Place & Migot-Adholla) show an insignificant relationship between formal loans and owned property, while others indicate a significant positive relationship between formal loans and land ownership (Feder et al., 1988; Field & Torero, 2006; Galiani & Schargrodsky, 2010; Lopez, 1996). Galiani and Schagrodsky (2010) additionally show an insignificant relationship between informal loans and credit access.

The objective of this study is to examine the relationship between owned land and access to formal and informal credit among urban households in Lahore, Pakistan. Here, formal loans are looked at in terms of current bank loans (i.e., recent bank loans taken by household heads directly from their banks) or credit card loans (i.e., loans taken by household heads using a credit card). Informal loans are characterized as loans taken from relatives, friends, or local moneylenders.

Using a probit estimation technique, we report some interesting findings. The empirical results show that owned land has a positive and significant effect on access to formal loans (as proposed by theory), although bank loans alone seem to have an insignificant relationship with ownership rights. Informal loans (as expected) show no significant relationship with home ownership status.

Section 2 looks at some of the existing literature on this issue. Section 3 presents the study's hypothesis. Section 4 describes the methodology and data used. Section 5 presents the empirical results and discussion, and Section 6 provides some concluding remarks.

2. A Review of the Literature

The existing literature shows mixed results when examining the economic effects of property rights or land ownership and titling. Many studies examine the effect of owned titled land on credit access, housing investment, agricultural productivity, labor supply, and income (Besley, 1995; Carter & Olinto, 2003; Deininger, 2003; Deininger & Binswanger, 1999; Feder et al., 1988; Field & Torero, 2006; Galiani & Schargrodsky, 2010; Place & Migot-Adholla, 1998; Roth, Cochrane, & Kisamba-Mugerwa, 1994). Most focus on rural areas, although the impact of land ownership is applicable to urban settings as well.

Feder et al. (1988) use data on rural areas of Thailand to find a positive relationship between title and credit—land ownership increases land security, and enables landowners to use their land as collateral to gain access to formal credit at lower interest rates, thereby increasing farm productivity. Hayes, Roth, and Zepeda (1997) support this result with evidence from Gambia, while Deininger and Binswanger (1999) also show that formal land titles positively affect access to credit.

Besley (1995) argues that strong property rights are important for access to credit, and indicates their relative importance in bringing about lower interest rates for households who own land as collateral. The study presents ambiguous results where land rights appear to have a positive effect on agricultural investment in the Ghananian region of Angola, but a less significant impact in the region of Wassa. Carter and Olinto (2003) find that the impact of rural titling programs on credit supply and investment demand in Paraguay is strongly size-differentiated, rationing small producers out of the credit market even when they have titled collateral.

Petracco and Pender (2009) examine the impact of land tenure and titling on access to formal and informal credit for rural households in Uganda. They compare four categories of households: households with and without a customary land certificate, freehold tenure households with and without a title, freehold households with a title versus customary households with a certificate, and freehold households without a title versus households without a certificate. The authors show that, for rural households in Uganda, land tenure has a more significant effect on credit access than land title. There is a statistically significant difference in access to any credit and informal credit between freehold and customary households without a title. Land tenure and title do not have a significant relationship with formal credit, due mainly to the limited supply of formal credit for all rural households.

Field and Torero (2006) evaluate the impact on credit of obtaining a property title through a land-titling program in Peru. Their results are somewhat ambiguous as they suggest that property titles are associated with approval rates on public sector loans only when lenders request titles, not otherwise. Galiani and Schargrodsky (2010) look at the effects of land titling on housing investment and credit access. They show that there is a positive relationship between land titling and mortgage credit but no relationship with access to other forms of credit (including informal sources).

Dower and Potamites (2010) show that land titles not only function as collateral, but also have ex ante informational value. Using household survey data on Indonesia, the authors show that formal land titles provide ex ante information about the likelihood of compliance with loan contracts when dealing with borrowers who have no established credit history. Formal land titles increase a household's probability of being offered a formal loan, while the loan size is influenced by whether or not the title is offered as collateral.

Johnson, McMillan, and Woodruff (2002) suggest, more from the business sector's point of view, that land titling is an important factor in gaining access to credit. They hold that, within countries, there is variation in both the perceived security of property rights and in access to bank credit. Given these countries' banking systems, small firms are able to borrow only if they can provide adequate collateral. The implications of this can be extended to households to see whether weak property rights limit households in the same way as they limit firms in gaining easy credit. The study also discusses whether property rights are a sufficient factor in gaining access to external finance.

Finally, De Laiglesia (2004) discusses the theory underpinning the mechanism between property rights and credit by highlighting the strong assumptions that underlie the property rights system, such as that land, credit, and other factor markets should function well.

3. Hypothesis

Based on what has been suggested by theory, we test three main hypotheses:

Hypothesis 1: If an asset (i.e., land) is properly owned, then there is increased access to bank loans.

- H_0: Land title has no significant impact on access to bank loans.
- H_1: Land title has a significant impact on access to bank loans.

Hypothesis 2: If land is properly owned, access to either bank loans or credit cards increases.

- H_0: Land title has no significant impact on access to formal loans.
- H_1: Land title has a significant impact on access to formal loans.

Hypothesis 3: If the household head owns land, access to informal loans increases.

- H_0: Land title has no significant impact on access to informal loans.
- H_1: Land title has a significant impact on access to informal loans.

4. Methodology

Our empirical analysis relies on a cross-sectional study carried out by conducting a household survey in ten areas of Lahore: 150 in-person questionnaires were completed, covering a range of income groups. The areas were purposely chosen to represent a diverse cross-section, while the households interviewed within each area were selected at random.

The sample was divided among low-income, middle-income, and high-income areas of Lahore. The areas included were Walton, the Cantonment, Defence, Gulberg, Bhatta Chowk, Charar Pind, Model Town, Nasham-e-Iqbal, Samanabad, and Temple Road. The questionnaire (see Appendix) included close-ended questions on the household's ownership and title, resident status, socio-demographic characteristics, and whether the household head had recently obtained a loan from a bank or informal source. The rest of this section briefly describes the dataset used and the variables' frequencies.

4.1. Variables

Table 1 presents the frequencies (in percentage terms) of the sample population of households who have, at some point in time, taken a bank loan or informal loan, or used credit cards with respect to whether or not they have property rights over the land on which they live. The table also includes frequencies for the covariates that are included in our estimations, cross-tabulated with titled owned land and land not owned. These variables measure primarily household demographics.

The dependent variables used to measure credit access are all binary responses with values of 0 or 1, where 1 indicates that a household head has used the source of credit in question, and 0 indicates that they have not. The sources of formal credit include bank loans and credit cards. To determine the effect of ownership rights on access to informal loans, the survey also asked whether households had recently taken a loan from an informal source, i.e., friends, relatives, or local moneylender.

The main independent variable—also a binary response—is the ownership status of land. It is worth mentioning here that our regressions cannot distinguish between the effect of titled property and untitled property on access to credit, and can only measure the effect of titled owned land versus land not owned. Although the survey asked households whether they had a registered title for their land and what their resident status was, most households who owned their place of residence also claimed to have titles. However, there may have been households who owned the land but did not have a property/land title certificate. Our dataset was unable to separate the two types of households. There is also a difference in the quality of title among the areas included in the survey as areas. The Defence area has its own system of transferring ownership through the Defence Housing Authority.

Table 1: Summary Statistics

Dependent and independent variables	Owned (%)	Not owned (%)
N = 150	*N = 107 (71%)*	*N = 43 (29%)*
Household heads who have taken bank loans (current bank loan = 1)	68.75	31.25
Household heads who use credit cards (credit card = 1)	86.05	13.95
Household heads who have taken formal loans (current formal loan = 1)	79.37	20.63
Household heads who have taken informal loans (current informal loan = 1)	71.93	28.07
Household heads aged between 19 and 29 (age 19 to 29)	33.33	66.67
Household heads aged 56 or above (age 56 and above)	64.29	35.71
Household heads aged between 30 and 55 (age 30 to 55)	76.11	23.89
Households with monthly earnings of Rs20,000–60,000 (earn 20,000 to 60,000)	67.35	32.65
Households with monthly earnings of Rs60,000 or above (earn above 60,000)	76.60	23.40
Households with monthly earnings of Rs20,000 or below (earn below 20,000)	70.37	29.63
Households whose percentage of income saved per month is above 5% (income saved = 1)	74.03	25.97
Household heads educated up to university level (university = 1)	81.40	18.60
Household heads educated up to higher secondary level (intermediate = 1)	41.67	58.33
Household heads educated up to secondary level or below (primary secondary = 1)	81.40	18.60
Households already in debt to a formal lender (bank in debt = 1)	76.00	24.00
Households who have ever used committees to obtain funds (committee = 1)	75.31	24.69

Source: Author's calculations.

The list of other independent variables included was taken from Field and Torero (2006). Although their study looks at the issue differently (they collected their data from banks rather than households, and looked at credit supply to households rather than credit demand), the variables they use apply to our regressions as well. These include household earnings per month measured in rupees, the highest level of education completed by the household head, the age group to which the household head belongs, income earned from other sources (such as rental income, foreign remittances, or home business),[2] the percentage of income saved by the household, the total number of household members, the number of working members, the gender of the household head,[3] and the average distance from the nearest bank.

Apart from regular savings, we also use another independent variable—also an informal source of savings and finance—known as a "committee," under which a group of people get together and contribute an equal amount of money to a common pool on a monthly basis. Every month, one member of the group takes the whole sum of money, which is a fixed amount equal to the total contributions to the pool. Some committees use a lottery/draw system to select the person who will get this money each month, while others mutually agree to the order of receipt at the beginning of the committee. The committee ends when all members of the group have received the fixed amount in their turn.

4.1.1. Dependent Variables

Table 1 shows that the majority of households (71 percent) in our sample have ownership rights. Among those who own land, only 21 percent have recently taken a bank loan, 35 percent use credit cards, and 47 percent have recently taken a loan from an informal source. This implies that most households use informal rather than formal markets as a source of funds.

The demand for bank loans seems to be unrelated to land ownership, which is puzzling as far as theory is concerned. This result is further strengthened by our regression analysis in Section 5. The data on bank loans may be biased since many households were hesitant to give information on whether they had ever taken loans from banks, and if so, what amount they had taken.

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[2] The variable measuring income earned from other sources is not used in the final estimation because the number of observations was insufficient.

[3] In our survey, all households reported a male household head.

In our sample, out of 43 (29 percent) households who reported using credit cards, 37 (86 percent) owned land while 6 (14 percent) did not. Out of 107 (71 percent) households who did not use credit cards, 70 (65 percent) owned land while 37 (35 percent) lived on land they did not own. Here, we can see some relationship between the use of credit cards and ownership rights. When bank loans and credit cards are combined, we find a much stronger relationship between households who own titled land and those who do not. Among the 42 percent of households who had obtained credit from formal sources, 79 percent owned land.

In total, 57 (38 percent) households had taken informal loans while 93 (62 percent) had not. Of the former, 41 (72 percent) owned land and only 16 (28 percent) did not. If we look at frequencies alone, informal loans appear to have a somewhat stronger relationship with owned land, but our empirical analysis does not show a significant relationship between the two.

4.1.2. Independent Variables

Of the control variables used in our regression analysis, age, literacy, and income are categorical variables while committee is a dummy variable. The dependency ratio and average distance between the household and nearest bank are continuous.

The household head's age is divided into three broad categories: (i) young (19–29 years old), (ii) middle-aged (30–55 years old), and old (56 years old or more). Similarly, for the education variable, the most educated household heads are those with a university degree (either under- or postgraduate) while other categories include education levels up to primary/secondary and higher secondary/intermediate. In terms of monthly earnings, households earning more than Rs60,000 per month are classified as high-income, those earning between Rs20,000 and Rs60,000 as middle-income, and those earning less than Rs20,000 as low-income.

As Table 1 shows, 77 percent of the households interviewed had heads aged between 30 and 55, 19 percent had heads older than 56, and only a small fraction, approximately 4 percent, of the sample population had heads aged between 19 and 29. Middle-aged and old household heads are expected to have more access to formal loans than younger heads because the former are likely to have more experience, established businesses, or more property to disclose in case of default (or even have collateral/guarantees to offer).

The more educated a household head, the higher his or her chances of gaining access to formal loans. From the bank's point of view, this involves a lower default risk. In our sample, 63 percent of the population interviewed held either Bachelor's or Master's degrees, while 29 percent had attained less than secondary level education. Only 8 percent of the population had been educated up to higher secondary level.

The frequencies show that, out of 150 households, 36 percent belong to the Rs20,000-or-below income bracket, 33 percent to the Rs20,000–60,000-income bracket, and 31 percent to the high-income bracket of Rs60,000 or above. Households in higher income brackets are expected to have more access to formal loans. Formal financial markets do not generally cater to low-income households, mainly because of their lending terms and conditions and the inability of low-income households to provide collateral. Our data shows that almost none of the low-income households had applied for a loan. Banks are likely to give more debt to households able to show greater amounts of income in their bank accounts as this helps bank lower their default risk. We expect low-income households to have more access to informal rather than formal loans.

Households who tend to save more are likely to have a lower demand for credit, both as formal and informal loans. The variable included in the regressions is saved income, which takes a value of 1 for households whose monthly savings are equal to or more than 5 percent of income earned, and a value of 0 for those whose monthly savings are less than 5 percent of income earned.

The "average distance" variable measures the average distance between a household and formal lender, i.e., a bank. The maximum value of this variable is approximately 10 km while the lowest is 1 km, and its mean is 1.75 km. The variable is expected to have a negative relationship with access to formal loans because, as the average distance between a household and the nearest bank increases, the cost of taking out a loan also rises in terms of expenses incurred by travel and the opportunity cost of time spent.

Bank indebtedness shows whether a household has obtained a bank loan in the past. This is different from our dependent variable, which measures whether a household is currently in debt to a bank. Our data shows that 33 percent of all households interviewed had taken a bank loan in the past, of which 76 percent owned titled land. The household's indebtedness is considered because whether or not it is currently in debt to a bank will affect its ability and willingness to re-avail formal credit. This variable is expected to carry a positive sign relative to current informal loans. Households that have taken bank loans in the past may still be paying large interest payments; they are expected to now avail more informal loans.

The committee system is a popular source of funds in Pakistan; it acts like a savings scheme as well as a source of informal loans for households. The committee variable is expected to have a negative relationship with formal loans, as the two sources of funds are substitutes for one another. However, it is expected to have a positive relationship with informal loans since most households who take informal loans may also be inclined to use committee schemes as a source of funds. Our data shows that 54 percent of the sample population has used committee schemes at various times as a source of funds for household investments.

4.2. Econometric Model

We use a straightforward test to measure the effect of ownership rights on credit access, while controlling for other variables that might also influence the latter. Since our dependent variables are binary responses, we use a maximum likelihood estimation of a binary response index model, which takes the form

$$P(y=1|x)=G(x\beta)\equiv p(x) \tag{1}$$

Here, $p(x)$ is a function of x alone through the index $x\beta = \beta_1 + \beta_2\, x_2 \ldots + \beta_K\, x_K$ while x is a vector of explanatory variables. The probit model is a special case of index models with

$$G(z)\equiv\phi(z)\equiv\int_{-\infty}^{z}\phi(v)dv \tag{2}$$

where $\phi\,(z)$ is the standard normal density,

$$\phi(v)=(2\pi)^{-\frac{1}{2}}\exp\left(-\frac{z^2}{2}\right) \tag{3}$$

and errors are assumed to follow a standard normal distribution.

We estimate the following simple regression model:

$$Y_i=\alpha+\gamma ownership_i+\beta X_i+\varepsilon_i \tag{4}$$

Y_i (the outcome of interest) indicates whether household i recently obtained a loan from either mode of credit access, $ownership_i$ indicates whether or not household i owns land, and X_i is a matrix of other covariates. These covariates include demographic variables that are basic pieces of household information and possibly related to the demand for credit, such as the household head's age, the household's monthly earnings, the percentage of income saved per month, and the household head's level of education.

Other control variables include the household's average distance from the nearest formal lender, whether or not the household uses credit cards as a mode of credit access, whether or not it uses a committee scheme, and its current state of indebtedness. The results of these regressions are discussed in the next section. The significance of the variables is judged on the basis of their p-value.

5. Results and Discussion

Table 2 reports probit estimates for bank loan, formal loan, and informal loan regressions run on ownership and other household characteristics.

5.1. Bank Loans

Column 1 of Table 2 presents the regression results for bank loans without other sources of credit (i.e., credit cards and informal loans). The signs carried by some of the explanatory variables, such as age, education, income saved, and committee, match our hypothesized signs, but the magnitude and significance of the coefficients varies. Here, we can see that bank loans are negatively related to savings. The relationship is significant, indicating a 12.5 percent fall in the probability of taking a bank loan for households who save more than 5 percent of their income per month as compared to households who save less than 5 percent.

The other savings method used by households is the committee scheme, which may be considered a substitute both for credit cards and bank loans (sources of formal credit). As hypothesized, the sign between the committee variable and access to bank loans is negative, showing that households engaged in committee schemes are less likely to apply for bank loans. The relationship is, however, insignificant.

In theory, the relationship between bank loans and land ownership should be positive since titled owned land is expected to increase access to formal credit, but the regression results in Column 1 does not indicate this. The probit estimate shows that the likelihood of a household gaining access to bank loans does not change with land ownership—the two are thus observed to be unrelated.

Even when we add other sources of credit to the regression (Table 2, Column 2), bank loans and land ownership remain unrelated. One explanation for this could be the use of a small sample. Additionally, we have not included factors such as the extent to which a household might observe religious decrees, which could affect its willingness to obtain funds through bank loans as buying a loan at an interest rate is considered unlawful in Islam.[4]

[4] During the survey, many households explicitly said that they did not believe in taking loans from banks because the latter charged interest rates, which Islam does not allow.

Table 2: Probit Regression Results

	Bank loans (1 = yes)		Formal loans (1 = yes)			Informal loans (1 = yes)	
Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Age 19 to 29	-0.059	-0.068	-0.194	-0.232	-0.045	-0.088	-0.098
	(-0.390)	(-0.470)	(-0.740)	(-0.890)	(-0.220)	(-0.440)	(-0.500)
Age 30 to 55	0.010	-0.018	-0.346**	-0.333**	-0.019	-0.072	-0.081
	(0.130)	(-0.210)	(-2.210)	(-2.150)	(-0.170)	(-0.590)	(-0.680)
Income saved	-0.125*	-0.131*	-0.377***	-0.350**	0.090	0.092	0.088
	(-1.690)	(-1.770)	(-2.600)	(-2.350)	(0.990)	(1.000)	(0.950)
Intermediate	0.001	-0.011	-0.266	-0.207	0.155	0.180	0.178
	(0.010)	(-0.060)	(-0.730)	(-0.540)	(0.820)	(0.940)	(0.940)
University	0.176	0.187*	0.118	0.142	0.127	0.117	0.142
	(1.620)	(1.710)	(0.670)	(0.800)	(0.910)	(0.830)	(0.970)
Earn 20,000 to 60,000	-0.171*	-0.151	0.162	0.139	-0.262**	-0.218*	-0.228*
	(-1.650)	(-1.420)	(0.950)	(0.800)	(-2.190)	(-1.780)	(-1.850)
Earn above 60,000	0.172	0.315*	0.871***	0.858***	-0.291**	-0.219	-0.171
	(1.260)	(1.900)	(4.970)	(4.730)	(-2.070)	(-1.320)	(-1.040)
Work to total	-0.138	-0.026	-0.412	-0.527	-1.067***	-1.067***	-1.066***
	(-0.570)	(-0.110)	(-1.090)	(-1.280)	(-2.630)	(-2.630)	(-2.640)
Credit card	-	-0.132*	-	-	-	-0.194	-0.219*
		(-1.650)				(-1.550)	(-1.790)
Current informal loan	-	0.105	-	-0.117		-	
		(1.360)		(-0.910)			
Current formal loan			-		-	0.127	
						(1.050)	
Bank indebtedness			-		-	-	-0.023
							(-0.210)
Ownership	-0.052	-0.023	0.301**	0.307**	0.076	0.118	0.126
	(-0.710)	(-0.320)	(2.500)	(2.530)	(0.800)	(1.220)	(1.280)
Average distance from bank	0.011	0.013	0.082**	0.078**		-	
	(0.490)	(0.590)	(2.140)	(2.010)			
Committee	-0.108	-0.131*	-0.214*	-0.193	0.076	0.085	0.071
	(-1.600)	(-1.890)	(-1.720)	(-1.500)	(0.860)	(0.940)	(0.800)
Pseudo-R^2	0.222	0.259	0.520	0.524	0.118	0.140	0.135
No. of observations	149	149	149	149	149	149	149

Notes: z-stats are given in parentheses; *, **, and ** indicate significance at 10, 5, and 1 percent, respectively.

Source: Author's calculations.

The results for the other variables used in the last regression also remain the same. Savings remain negatively and significantly related to bank loans with almost the same magnitude. The committee variable also continues to show a negative—but, in this case, significant—relationship with bank loans.

We can also see that the most educated and highest earners are most likely to borrow from banks, i.e., the greater the likelihood of a household head holding a Bachelors or Master's degree, the higher his or her chances of access to bank loans compared to less educated household heads with only secondary education or less. The probit estimate shows that a household head with up to tertiary education has an 18.7 percent higher chance of obtaining a bank loan than a household head with only secondary education or less. For households earning above Rs60,000 per month, the probability of obtaining a bank loan is 31.5 percent higher than those earning below Rs20,000.

Bank loans are also negatively related to other sources of formal credit, i.e., credit cards—showing that the two are substitutes for one another—while their relationship with informal loans is positive, but insignificant. Banks are most likely to look at a household's credit card indebtedness when giving a loan, thus limiting total formal credit. Since banks cannot monitor informal loans, the relationship between informal loans and bank loan is ambiguous.

The next two regressions, therefore, combine access to credit cards and bank loans as a single source of formal loans and determine its relationship with land ownership.

5.2. Formal Loans (Bank Loans and Credit Card Loans)

In Table 2, Columns 3 and 4 show the regressions run on formal loans with and without access to informal loans. In both cases, the relationship between formal loans and land ownership is positive and significant at 5 percent. Column 4 reports that households who own their place of residence are 30.7 percent more likely to obtain bank loans and credit cards than households who do not.

Household heads who earn Rs60,000 a month or more have greater access to formal loans, probably because they are more likely to use credit cards than those whose incomes are less than Rs20,000. This may hold true for two reasons: (i) lower-income households have less access to formal financial markets and are thus limited to informal ones, and (ii) only people with higher incomes are likely to hold bank accounts and only household heads who have bank accounts are granted credit cards.

We also see that household heads aged between 30 and 55 have a lower probability of obtaining formal loans than older household heads (aged 56 or over), given a set of certain household attributes. This could be because older household heads may have greater experience, own established businesses, or have more property to offer as collateral or guarantees in order to borrow funds.

As expected, savings—both regular and committee-based—show a significant negative relationship with formal loans. Surprisingly, the relationship between formal loans and the average distance between a household and the nearest bank is positive. However, it might not be all that important a result given that borrowers likely have vehicles, making travel easier.

The relationship between current informal loans and formal loans is seen to be negative, which shows that households using informal loans are less likely to resort to formal loans as a source of funds. The current dataset, however, does not show that the relationship is significant.

Finally, looking at the bank loans and formal loans regression together, it appears that households are not being able to use their ownership rights to securitize bank loans. Only when bank loans are combined with credit cards do we see a positive significant relationship between owned land and formal credit.

5.3. Informal Loans

In Table 2, Columns 5, 6, and 7 present the regression results for informal loans. In theory, formally titled owned land does not have any significant impact on access to informal loans. Our results show the same: in all three regressions, informal loans do not show a significant relationship with land ownership, as hypothesized. The regression results for most variables remain the same in the three columns.

Column 5 presents the regression results for informal loans without other sources of credit. As low-income households do not have complete access to the formal financial system, they are left with informal loans as their only source of obtaining funds. This is borne out by the regressions: households earning more than Rs60,000 a month have 29.1 percent less chance of obtaining informal loans as compared to low-income households earning Rs20,000 or less. Similarly, the probability of obtaining informal loans falls by 26.2 percent if the household head earns between Rs20,000 and Rs60,000 as opposed to those who earn Rs20,000 or less.

As hypothesized, the variable measuring the ratio of total number of working members to total number of household members is negative and significant. In brief, the lowest-income households and those with a high dependency ratio (low work-to-total ratio) have the highest propensity to take informal loans.

Informal loans appear to be unrelated to savings, while education and age also show a statistically insignificant relationship with informal loans, although the effect of these is partially accounted for by household income. The use of committee schemes has a positive but insignificant relationship with access to informal loans, which could be because households choosing to take informal loans and use committees have similar characteristics—low incomes and high dependency ratios. Thus, it might not be wrong to say that most households who take informal loans also use committees as a source of funds.

In Columns 6 and 7, we add sources of formal credit to our analysis. The use of credit cards shows a negative and significant relationship with informal loans, suggesting that household heads already using credit cards have a lower probability of taking informal loans than those who do not use credit cards. The two appear to act as substitutes for one another as sources of short-term credit. An interesting question here is whether households take informal loans to repay formal loans. To answer this, we add the variable of bank indebtedness to our regression in Column 7, which shows that households already in debt to a bank do not seem to use informal loans to repay formal loans.

6. Conclusion

The main assertion of this article has been that ownership rights allow urban households in Lahore greater access to credit markets by using owned land as collateral. Despite the limitations of using a small sample size, our results yield some interesting findings.

The probit estimate of the bank loan variable regressed on the ownership variable indicates that the likelihood of a household gaining access to bank loans does not change with land ownership as shown by

Field and Torero (2006) for private loans. The regression does not include factors such as the degree to which a household observes religious decrees concerning interest, although this could affect its willingness to obtain funds through bank loans, as buying a loan on an interest rate is considered unlawful in Islam.

In addition, bank loans are negatively related to the use of credit cards, showing that banks might monitor a household's credit card indebtedness when providing a loan, thus limiting the former's total formal credit, or that individuals choose to use credit cards instead of bank loans. For individuals, the costs of applying for a formal loan may deter them from submitting an application. For banks, the cost of formal procedures of collateral processing, foreclosure, and resale is large relative to the average size of a loan, which may also restrict the use of owned land as collateral by such households in gaining access to bank loans.

When credit cards and bank loans are combined as one variable, i.e., formal loans, we see a significant positive relationship between land ownership and access to formal loans. Households who own their place of residence have a 30.7 percent higher chance of obtaining formal loans compared to households who do not.

Our results also show an insignificant relationship between land ownership and informal loans. We observe that households with the lowest income and high dependency ratio (low work-to-total ratio) have the highest propensity to take informal loans, as shown by our probit estimates. Moreover, credit cards and informal loans appear to be substitutes for one another as sources of short-term credit.

The reason for the limited impact of ownership on bank loans may be the limited supply of formal credit. The study suggests that, in order to understand the effect of land ownership on access to credit, one also needs to incorporate banking practices into the analysis.

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Appendix

Questionnaire

Economic Effects of Ownership Rights in Urban Lahore

General Information

1. Area? ____________________

2. Language of interview?

- Urdu
- English
- Punjabi
- Other (specify) ____________________

3. Your age group?

- 18–29
- 30–42
- 43–55
- 56 or above

4. Gender?

- Male
- Female

5. What is the highest level of education completed by your male parent?

- No education
- Primary/secondary/matriculation
- Intermediate/higher secondary
- Bachelor's
- Master's

6. Occupation? ____________________

   Monthly earnings of your household?

- Below Rs7,500
- Between Rs7,500 and Rs20,000
- Between Rs20,000 and Rs60,000
- Between Rs60,000 and Rs90,000
- Above Rs90,000

7. Do you rent out part of your residence?

- Yes
- No

8. If yes, then what is your monthly rental income?

- Below Rs15,000
- Rs15,000 to Rs30,000
- Rs30,000 to Rs50,000
- Rs50,000 or more

9. Do you run any home business?

- Yes
- No

10. If yes, then what is the average monthly income that you earn from it? _______________

11. Do you earn any additional income from foreign remittances?

- Yes
- No

12. If yes, then what is your additional monthly income from foreign remittances?

- Below Rs15,000
- Rs15,000 to Rs30,000
- Rs30,000 to Rs50,000
- Rs50,000 or more

13. Are there any additional income sources apart from those mentioned above?

- Yes
- No

14. If yes, then what is your estimated income from this/these source(s)? __________

15. What percentage of your income is saved per month?

- Below 5 percent
- 5–10 percent
- 10–20 percent
- 20–30 percent
- 30 percent or above

Property Rights

1. Do you possess a registered title for this land?

- Yes
- No 	If yes, for how many years? __________

2. Which of the following describes your resident status? Choose one.

- Owner
- Rented
- Government-subsidized
- Squatter
- Other ______________

3. Number of household members?

Male	Female	Total

4. Number of working members? __________

5. Gender of household head?

- Male
- Female

Credit Access

1. Have you taken loans from a bank lately?

- Yes
- No   If yes, then how many times? __________

2. Amount of loan taken __________

3. Interest rate charged __________

4. If no, then do you want to try ranges for loan amounts and interest rates?

Loan amounts	Interest rates
• Less than Rs50,000	Less than 10 percent
• Rs50,000–100,000	11–15 percent
• Rs100,000–250,000	15–25 percent
• More than Rs250,000	

5. Reason for taking the loan?

- Wedding
- Education
- Health
- Business loan
- To buy a car
- Other ____________________

6. How many times in TOTAL have you applied for a loan? __________

7. Were you asked for collateral?

- Yes
- No

8. If yes, then what were the types of collateral that you were asked for?

- Land
- Factory
- Home
- Vehicles, e.g., car
- Jewelry/gold
- Other ____________________

9. Do you have a bank account?

- Yes
- No

10. If yes, then what type of account is it?

- Checking
- Savings
- Other _____________

11. How far is your bank's branch from your house? _______________

12. Have you ever taken loans through credit cards?

- Yes
- No If yes then what was the credit limit? __________

13. Apart from taking a loan from a bank, have you taken a loan from:

- A friend
- A relative
- Other _______________
- Local unregistered moneylender Amount given _____

14. Do you currently owe a bank any money?

- Yes
- No

15. Do you currently owe money to someone else?

- Yes
- No If yes, then how much? __________

16. Have you used a committee to raise money for a large purchase?

- Yes
- No

17. If so, what is the order of payments?

- Lottery
- Random
- Other _______________

18. Have you applied for a mortgage?

- Yes
- No

19. If yes, then what interest rate was offered to you and when?

- Less than 10 percent
- 10–13 percent
- 13–16 percent
- 16 percent or above Year __________

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Working Capital Management and the Profitability of the Manufacturing Sector: A Case Study of Pakistan's Textile Industry

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Abstract

This study explores the association between working capital management and the profitability of textile firms in Pakistan. The efficiency of working capital management is reflected by three variables: cash conversion efficiency, days operating cycle, and days of working capital. We use return on assets, economic value added, return on equity, and profit margin on sales as proxies for profitability. A balanced panel dataset covering 160 textile firms for the period 2000–05 is analyzed and we estimate an ordinary least squares model and a fixed effect model. Return on assets is found to be significantly and negatively related to average days receivable, positively related to average days in inventory, and significantly and negatively related to average days payable. Also, return on assets has a significant positive correlation with the cash conversion cycle, which would suggest that a longer cash conversion cycle is more profitable in the textiles business. The findings of the regression analysis show that average days in inventory, average days receivable, and average days payable have a significant economic impact on return on assets. The findings of the fixed effect model reveal that average days in inventory and average days receivable both have a significant impact on return on assets.

Keywords: Working Capital, profitability, textile sector, Pakistan.

JEL Classification: G32, C33.

1. Introduction

Corporate finance is an area of immense importance for business organizations. The decisions made by financial managers significantly affect the overall profitability of a business organization as well as the interests of a wide variety of stakeholders. Managers adopt risk minimization strategies and, accordingly, take a series of well-organized measures to ensure day-to-day operational smoothness, which not only helps to avoid insolvency but also enhances the prospects of profitability for the organization.

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The management of working capital is a major part of managing financial operations as it is thought to be linked to profitability. Working capital efficiency appears to be a function of credit policy and the cost-efficient supply of raw material and inputs. Frequently, managers encounter trade-off situations in their endeavors. For instance, improving the efficiency of accounts receivable can generate bad debts; allowing for discounts can improve the collection of receivables but the fast collection of receivables can also lead to lost sales due to a strict credit policy. A sound working capital management (WCM) policy is usually structured around the consideration of these realities.

In this context, it makes sense to look at how profitability behaves in relation to working capital practices. This study examines the same for the textiles sector, in the hope to reveal certain extra caveats. In particular, one could ask a number of interesting questions in this context. Is there a blend of current assets that is more beneficial? Can a particular working capital strategy be more rewarding for indigenous business firms? How many days of working capital (DWC) should textile firms hold? Does this vary over a period of time or does it vary from company to company? Can a relationship be established between the efficiency of working capital and higher profitability? These questions could generate important guidelines for the implementation of policy planning in Pakistan.

The results of the study will most likely be useful in understanding the dynamics of and, thus, in improving WCM practices toward maximizing profitability. It could help guide financial managers toward more specialized handling of day-to-day operations and achieving optimal levels for increased efficiency. The results drawn from the experience of the textiles sector could lead to valuable conclusions for other sectors of Pakistan's economy. Here, we analyze the experience of 160 textile firms for the period 2000–05 on the basis of secondary data. The sample includes three main types of firms: spinning, weaving, and composite, and our main data sources include the State Bank of Pakistan and *Business Recorder*.

Section 2 discusses the relevant literature, while Section 3 describes the sources of data and methodology used. Section 4 analyzes the data, and Section 5 presents our statistical findings. Finally, Section 6 provides a summary and conclusions.

2. A Review of the Literature

The literature on this topic has grown significantly in recent years. Surprisingly, there is, largely, consensus among different authors, who identify almost similar determinants of WCM. A number of studies find that there is a positive association between WCM and profitability. Shin and Soenen (1998) investigate 58,985 firm-year data for the period 1975–94, to identify the relationship between a firm's profitability and net trade cycle. The evidence they derive from their analysis implies a strong negative relationship between the two variables.

There has also been some work on Pakistan's anti-dumping laws in relation to textile business practies. Since prices in local and international markets are a major concern, the investigation of these laws has implications for working capital policies that affect the cost of production in local markets. Yazdani (1999) makes an interesting contribution to the research in this area: he emphasizes the role of government intervention in minimizing the effects of dumping on the profits of textile firms, who require huge resources to monitor and reduce the impact of dumping. In addition to these effects, overall production costs can have grave consequences for firms.

Lyroudi and Lazaridis (2000) have conducted a study on similar grounds of the Greek food and beverage industry. They find that a positive relationship exists between the cash conversion cycle (CCC) and current and quick ratios, and between the CCC and return on assets (ROA). The profit margin is observed to move positively with CCC, and the latter is found to have no association with leverage ratios.

Anand and Gupta's (2001) empirical survey of working capital performance in corporate India helps identify the core determinants of WCM. Their study investigates the working capital performance of 427 of the S&P-500 companies over the period 1998/99 to 2000/01. They argue that cash conversion efficiency (CCE), DWC, and days operating cycle (DOC) are the key variables that chief financial officers need to keep in mind when making decisions regarding higher profitability.

The above-mentioned studies seem to derive their conclusions by assuming a number of circumstantial factors to be constant. Linking profitability to improved WCM practices alone is far from reality where there may be a dozen overriding factors that affect a firm's profitability. With working capital, there is the possibility of seasonal factors being associated with profitability; credit requirements, business expansion, and firms' credit policy are other important considerations. These, however, have been largely neglected by the aforementioned studies.

Deloof (2003) suggests, on the basis of a study of 1,009 nonfinancial firms in Belgium over the period 1992–96, that managers may find it possible to maximize shareholders' wealth by improving WCM efficiency. The author argues that doing so is made possible by the fast collection of receivables and by keeping an optimal level of inventory. The study finds that gross operating income moves in an opposite direction to average days receivable (DR), average days in inventory (DI), average days payable (DP), and CCC. The analysis also reveals a negative relationship between accounts payable and profitability, which is consistent with the view that less-profitable firms wait longer to pay their bills. The study also finds that bills receivable have a highly significant negative relationship with profitability.

The Deloof (2003) study raises a number of critical arguments, such as that firms in such a large sample must vary in terms of size, age, technology, and asset size, etc. Liquidity issues will vary greatly depending on the risk settings of businesses in the sample; and firms will have different credit ratings shaping the dynamic buying patterns of purchase. Kemal (2005) discusses industrial problems in Pakistan and argues that, despite the growth in industrial production, investment levels have fallen. He identifies multiple factors in this respect, including high production and transaction costs, and allocative, technical, and X-inefficiencies.

Khan, Shah, and Hijazi (2006) have conducted a study of 30 listed nonfinancial firms in Pakistan to analyze the impact of WCM on profitability. Their results show a significant negative relationship between firms' gross profit and the average number of DI and DP, and CCC. But with such narrow datasets, the results can hardly be generalized across different sectors. Lazaridis and Tryfonidis (2006) take the case of 131 firms listed on the Athens stock exchange with the same objective as Khan et al. Their study relies on a five-year panel dataset, and shows that the CCC significantly affects the profitability of firms. This argument reflects the relationship between managing working capital and increasing firm value.

Shah and Sana (2006) also investigate this relationship, using financial data on oil and gas companies in Pakistan for the period 2001 to 2005. Their findings suggest that it is possible for financial managers to maximize shareholders' wealth by efficiently managing working capital. They report that profit margins move in a significantly opposite direction to receivables, cash cycles, sales growth, and inventory conversion periods. Further, they examine the causal relationship that confirms that the efficient management of working capital moves positively with profitability.

Padachi (2006) uses a set of 58 small manufacturing firms in Mauritius with 340 firm-year observations from 1998 to 2003. The study confirms that firms with more receivables and higher levels of inventory are less profitable. The author conducts a comparative analysis of five major industry groups, and asserts that working capital has a negative correlation with ROA. The study concludes that the efficient management of working capital increases profitability.

WCM is thus deemed an essential tool that helps measure both the operational and financial efficiency of a business firm. Raheman and Nasr (2007), who analyze financial data on 94 Pakistani firms listed on the Karachi Stock Exchange for the period 1999 to 2004, reiterate this message. Their main finding is that liquidity and profitability are negatively related and that the association is significant as well. The study supports some earlier studies in that it establishes the negative association between firms' profitability and the different components of working capital.

Garcia-Teruel and Martinez-Solano (2007) use financial data on 8,872 Spanish firms for the period 1996 to 2002 to investigate the effects of WCM on profitability. Their investigation reveals the obvious: that profitability increases if the contributing factors of working capital are efficiently managed. They summarize that profitable firms collect their receivables early, take less time to convert their inventories into finished goods, pay their dues early, and have a short CCC. Previous similar studies have focused more on large firms and attempted to explore the relationship between the micromanagement of working capital and its effects on profitability (see, for example, Shin & Soenen, 1998).

Authors like Anand and Malhotra (2007) have attempted to develop objective metrics to measure efficiency at the industry and firm level. Using data on 339 Indian companies for the period 2001/02 to 2003/04, the authors report that the firms' operating cycles and CCCs are both reduced, but they cannot establish a positive relationship between profitability and the efficient management of working capital.

Burki (2008) looks at the industrial performance of Pakistani firms by investigating the efficiency standards adopted by local business firms. The aim of this particular study is to monitor the effects of efficiency on the public policy in place. The research focuses on the government's need to adjust to a macroeconomic balance; it measures the impact of global industrial practices on indigenous practices, and emphasizes a decentralized industrial policy. The author sets a picture in which efficiency can be achieved on the broader economic horizon, and makes a number of policy suggestions that could help local firms attain higher business efficiency.

Summing up, the issue has been well researched around the world. Some authors argue that there is a significant positive relationship between WCM and profitability, while others disagree. Most studies on Europe indicate that a firm can be more profitable if working capital is managed efficiently. Studies on India report mixed findings, while those on Pakistan confirm the positive association. However, the issue remains open to further research.

3. Methodology and Data

Our study is designed to initially rank textile firms in Pakistan on the basis of objective metrics of WCM and profitability, and then find any rank correlation between them. The following hypotheses will be tested, using the data.

H_{01}: There is positive rank correlation between WCM and the profitability of textile firms.

H_{02}: The cash cycle affects the profitability of these firms.

H_{03}: A shorter inventory conversion period has an economic impact on the ROA employed by each firm.

H_{04}: A shorter average collection period for receivables has a positive impact on ROA.

H_{05}: Textile firms with longer average DP are less profitable.

We adopt an extended form of the well-known methodology given by Anand and Gupta (2001)—used to determine the working capital performance of nonfinancial firms in India—and devise a similar model for profitability. Textile firms are ranked both on the basis of a working capital performance ranking (WCPR) model and a profitability performance ranking (PPR) model. We compute Spearman's rho and Kendall tau_b and test their significance to find support for the stated hypotheses.

A regression analysis follows to test the significance of the theory that the higher profitability of textile firms is dependent on the explanatory variables of WCM. The regression is performed using both an ordinary least squares (OLS) model and a fixed effects model (FEM). The balanced panel regression analysis using the FEM considers the firm effect, for which dummy variables are created. Since we are using data for only a six-year period, dummies for time are not created. ROA is taken as an explained variable, while CCE, DI, DP, and DR are explanatory variables.

Numerous factors affect the profitability of textile firms, including pricing policy, sales growth, and total assets, etc. Our regression analysis therefore incorporates the following control variables: the size of the firm (proxied by the natural log of sales), gearing ratio (GR), ratio of current assets to total assets, and gross working capital turnover ratio (GWCTR). The results are given in tabular form and the findings discussed below.

3.1. Working Capital Management Model (WCM)

Anand and Gupta's (2001) methodology computes WCPR, using the variables CCE, DOC, and DWC. The definition and computation of these variables is explained below.

3.1.1. Cash Conversion Efficiency (CCE)

A textile firm with a higher CCE is deemed more efficient, i.e., in terms of the cash it generates through the effective management of its business, for instance, the sale of goods of a business per unit of sale revenue. First, the net cash flow from operating activities is derived as follows (the Appendix explains the abbreviations used).

$$NCFFOA = EBIT + D - T$$

CCE can be worked out in the second step:

$$CCE = NCFFOA/SR$$

A higher CCE indicates greater efficiency in WCM and vice versa. CCE is then converted into a meaningful normalized form so that these values can be measured on a comparable standardized scale:

$$N_{cce} = [(h_{comr} - c_{comr})/(h_{comr} - l_{comr})]$$

A firm whose N_{cce} equals 0 is considered the best-performing firm in terms of CCE.

3.1.2. Days Operating Cycle (DOC)

DOC is a financial metric that shows how fast a firm is able to convert its resources, i.e., the total time (in number of days) that a firm takes to acquire and convert inventories into sellable products, and then recovers in the form of hard cash inflows through cash collection. Theoretically speaking, it uses the following indices:

Days consumption and days cost of sales = inventory average daily cost of sales

Days sales = (account receivable/average daily credit sales)

The lower the DOC, the more efficient the firm. DOC is also converted into meaningful normalized form to allow standardized comparison:

$$N_{doc} = [(l_{doc} - c_{doc})/(l_{doc} - h_{doc})]$$

A smaller N_{doc} indicates a better performer for this parameter.

3.1.3. Days of Working Capital (DWC)

DWC is another formula used in short-term decisions by finance managers to actually see the gap or time available between the conversion of less-liquid assets to a more liquid form, and payment of due bills for purchases. The liquidity risk is measured by DWC and is used to decide whether suppliers' credit should be used to finance inventory and receivables or if other sources should be used. Symbolically,

DWC = DOC – creditors (days purchases)

"Days purchases" equals accounts payable divided by average daily purchases. A benchmark efficiency measure for DWC is supposed to be that which is neither higher on positive nor negative scales, and is concentrated where the number of DWC is 0. DWC is converted into meaningful normalized form as follows:

$$N_{dwc} = [(l_{dwc} - c_{dwc})/(l_{dwc} - h_{dwc})]$$

A smaller N_{dwc} indicates a better performer in managing liquidity risk.

3.1.4. Working Capital Performance Ranking Model (WCPR)

Anand and Gupta (2001) suggest the following model and reserve subjective consideration for the assignment of weights to factors. The expression assigns a 50-percent weight to CCE and a 25-percent weight each to DOC and DWC. A manufacturing firm in Pakistan with the lowest overall score based on the above rule would be ranked 1, signifying that it was the best performer in terms of WCM.

$$WCPR = N_{cce} * 0.50 + N_{doc} * 0.25 + N_{dwc} * 0.25$$

A firm with the lowest overall WCPR score would be ranked 1 and assumed to be the best performer in practicing WCM, and so on. However, the model suffers from the limitation of subjective assignment of weights. A different weight assignment criterion would change the ranking of firms.

3.2. Profitability Model

Firms remain under moral and legal obligation to give business returns to their shareholders and to be profitable. Profit is a derivation that has accounting limitations, such as choosing between LIFO, FIFO, or other methods of costing inventories, and the treatment of capital and revenue expenditures. However, in the light of international accounting standards and company byelaws, accounting profit is seldom used in financial analysis. We put forward a model for ranking firms, in which an index is developed by taking the weighted averages of ROA, return on equity (ROE), profit margin on sales (PMS), and economic value added (EVA). They are described and normalized as follows.

3.2.1. Return on Assets (ROA)

ROA is a widely used financial tool to determine the level and intensity of returns that a firm has generated by employing its total assets. Firms are usually considered well off when they generate returns that can attract further investors and lenders, and in trouble if they need to raise the finance required for growth or capital needs, or if their ROA does not convince financiers. ROA reflects the earnings generated by the capital invested, and is calculated as follows:

$$ROA = \text{net income}/\text{total assets}$$

ROA is converted into a meaningful normalized form to allow the comparison of textile firms on a standardized scale:

$$N_{roa} = [(h_{roa} - c_{roa})/(h_{roa} - l_{roa})]$$

A smaller ROA obtained using this rule indicates a better-performing firm.

3.2.2. Return on Equity (ROE)

ROE is a routine analysis tool that shows the returns a firm has generated using the equity of its owners. It is expressed as:

ROE = net income/shareholders' common equity

ROE is converted into meaningful normalized form as follows:

$$N_{roe} = [(h_{roe} - c_{roe})/(h_{roe} - l_{roe})]$$

A smaller ROE obtained using this rule indicates a better-performing firm.

3.2.3. Profit Margin on Sales (PMS)

PMS is a financial yardstick that shows how much a firm is making (before interest and taxes) for each sale of a dollar amount. Simply understood, a higher PMS means the more economical use of invested money. It is computed as follows:

PMS = operating income/gross sales

PMS is converted into meaningful normalized form as follows:

$$N_{pms} = [(h_{pms} - c_{pms})/(h_{pms} - l_{pms})]$$

A smaller PMS obtained using this rule indicates a better performing firm.

3.2.4. Economic Value Added (EVA)

EVA, a registered trademark of Stern, Stewart & Co. (Stewart, 1991), is an index that calculates returns after excluding the opportunity cost of the invested capital in the firm. It is calculated as follows:

EVA = NOPAT – (capital * cost of invested capital)

The cost of invested capital is calculated using the standard weighted average cost of capital method, in which the cost of equity is assumed to be 100/PE ratio and the cost of debt is taken as the ratio of financial expenses to total fixed liabilities as follows:

P/E ratio = current market value per share/earnings per share

Cost of debt = financial expenses/total fixed liabilities

Given the limited availability of data on the entire sample of textile firms included in this study, we use an industry average cost of capital, which is computed to be 11.072 percent on the basis of 414 firm-year observations. A corporate tax rate of 35 percent is used for the said period. This figure is used to compute a firm's EVA. Next, EVA is converted into a meaningful normalized form for standardization purposes as follows:

$$N_{eva} = [(h_{eva} - c_{eva})/(h_{eva} - l_{eva})]$$

A smaller EVA obtained using this rule indicates a better-performing firm.

3.2.5. Profitability Performance Ranking Model (PPR)

We calculate profitability performance by assigning a 25 percent weight to the four core parameters discussed above, and obtaining a weighted average score for each firm. An equal weight is assigned to each parameter on the premise that any firm with an edge in only one of these parameters cannot outperform another firm; rather, it will need the support of all four equally important parameters to perform better. Equal weights are assigned to all profitability parameters so that firms can be evaluated and ranked on the basis of good economic performance, and such that a firm can be ranked highest when it leads among all other firms in the industry in terms of these parameters. Although assigning weights is a subjective practice and changing them may change firms' ranking, assigning equal weights becomes a uniform importance criterion. The model can be written as follows:

$$PPR = N_{roa} * 0.25 + N_{roe} * 0.25 + N_{pms} * 0.25 + N_{eva} * 0.25$$

A firm with a score of 0 is ranked highest on the basis of this benchmark, while a score farther away from 0 indicates lower profitability performance.

We use the formal Spearman's rho or Kendall tau_b to compute rank correlation in terms of both WCM and profitability for each individual firm for the study period. The t-test is used to determine correlation significance.

3.3. Theoretical Model and Variables

The following theoretical model is used to measure the economic impact of working capital variables along with a set of control variables:

$$ROA = f(\ln S, GR, GWCTR, C_{t1}, ExWC)$$

This can be rewritten for each component of working capital as follows:

$$ROA = f(\ln S, GR, GWCTR, C_{t1}, DI) \quad (1)$$

$$ROA = f(\ln S, GR, GWCTR, C_{t1}, DR) \quad (2)$$

$$ROA = f(\ln S, GR, GWCTR, C_{t1}, DP) \quad (3)$$

$$ROA = f(\ln S, GR, GWCTR, C_{t1}, C_{t2}, CCC) \quad (4)$$

LnS is the natural log of sales, C_{t1} denotes current assets divided by total assets, C_{t2} denotes current liabilities divided by total assets, and ExWC denotes the explanatory variables DI, DP, DR, and CCC.

A regression analysis is used to identify which explanatory variables affect profitability. Accordingly, ROA is taken as the dependent variable, and DI, DR, DP, and CCC as explanatory variables. Since a number of factors can affect profitability (pricing policy, sales growth, etc.), we use the following control variables: sales as a proxy for firm size (natural log of sales) along with GR (debt/total assets), GWCTR (sales/current assets), current assets/total assets, and current liabilities/total assets.

3.4. Estimation of Regression Models

A balanced panel model (Gujrati, 2003) can be written as:

$$Y_{it} = \beta_1 + \beta_2 X_{2it} + \beta_3 X_{3it} + \ldots. + u_{it} \quad (i)$$

i = 1, 2, 3, … 160 (160 textile firms) and *t* = 1, 2, 3, 4, 5, 6 (six years), while u_{it} is an error term

Using OLS, as described by equation (i), we measure the statistical significance of explanatory variables (X) for dependent variable (Y), i.e., the statistical relationship between ROA (Y) and its determinants, X_2 (natural log of sales), X_3 (GR), X_4 (GWCTR), X_5 (current assets/total assets), and X_6 (working capital variables average DI, average DP, average DR, and CCC).

The assumption that $\beta = 0$ (taken as the coefficients in the proposed models) in the case of restricted regression is tested. One coefficient relates to any of the variables DI, DR, DP, and cash cycle, while four coefficients are derived using the control variables (firm size, GR, current asset turnover, and ratio of current assets to total assets). The expected sign of $\beta = 0$ negates any economic impact of these variables on ROA, if proven insignificant. Next, we assume an unrestricted regression model in which the y-intercept is allowed to vary for each firm from a balanced panel, and dummies are inserted to capture the firm effect.

Using pooled OLS can be subject to the problems of heteroscedasticity, multicollinearity, and autocorrelation. In addition, pooled OLS does not take into account the fixed effects of different economic sectors. This necessitates the use of a panel regression technique, in which a case an FEM or random effects model (REM) is used. In the case of an FEM, a robust (HAC) standard errors model can be used to control for heteroscedasticity and autocorrelation.

If we assume the time invariance of the intercepts of each sampled firm from a respective sector in the pooled regression model (i), the following FEM is used:

$$Y_{it} = \beta_{1i} + \beta_2 X_{2it} + \beta_3 X_{3it} + \ldots + u_{it} \quad \text{(ii)}$$

The conventional modeling of an FEM is termed a least squares dummy variable model, since a number of dummy variables are incorporated into (i) to capture values of the cross-sectional unit *i* in the panel set of time series *t*. Modern computer software for econometric modeling has made this very easy. In the FEM described in equation (ii), we assume that β_{1i} is fixed. If this intercept is assumed to be a random variable where $\beta_{1i} = \beta_1 + \epsilon_i$, then equation (iii) is presented as follows:

$$Y_{it} = \beta_1 + \beta_2 X_{2it} + \beta_3 X_{3it} + \ldots + w_{it} \quad \text{(iii)}$$

Equation (vii) is described as an REM or error components model, in which $w_{it} = \epsilon_i + u_{it}$. In this composite error term ϵ_i is the individual-specific error component and u_{it} is the combined time series and cross-section error component.

Researchers often face the problem of choosing between an FEM and REM, as there are a number of assumptions surrounding the error components mentioned above. Hausman (1978) developed a specification test to help choose an appropriate model, which works on the simple idea that estimators from an FEM or REM do not differ substantially. If the null hypothesis of the Hausman test is rejected, we use an FEM, rather than an REM. Statistical software such as GRETL helps estimate the robustness of an FEM with respect to heteroscedasticity and/or autocorrelation, and hence robust standard errors. This ensures the efficiency of estimates using an FEM.

3.5. Sources of Data and Data Collection Procedure

The major financial data used in this study is gathered from published reports of the State Bank of Pakistan for the period 2000 to 2005. Some variables, such as the amount of noninterest-bearing liabilities, taxes paid, and financial expenses, etc., are extracted from the annual reports of the included firms. The market values of firms' shares during the study period are taken from the *Business Recorder*. Since, after extracting data on all the required variables, there still remained some missing information, some firms in the industry could not be included in the sample. There are a total of 190 listed textile firms for the said period, with 169 firms categorized as composite, weaving, and spinning, and 21 as other textile firms. This study includes 160 listed firms in its sample, due to the unavailability of data on all textile firms.

4. Data Analysis

The methodology outlined in the previous section is applied to our data to estimate the key metrics of cash conversion, receivables, and payables along with inventory conversion. Textile firms are ranked on the basis of WCM performance according to the methodology discussed in Section 3.1. All textile firms are initially ranked on the basis of CCE, DOC, and DWC for a six-year average derived for each firm. All 160 firms are then ranked on the basis of the WCPR model and the top 20 reported.

This analysis also identifies the best-performing company for the said period, according to the respective specialized parameters used as variables for WCM. A similar investigation is conducted to determine profitability performance, and the ten best-performing firms are ranked on the basis of ROA, ROE, EVA, and PMS. Finally, the 20 best-performing firms are tabulated on the basis of the profitability model devised earlier.

4.1. Application of WCPR Model

4.1.1. CCE

When using this variable, some outliers are deleted from the analysis because the gross sales, operating profit, taxes, or depreciation figures for these firms appear to be anomalous—perhaps as a result of gross recording errors—and their use is assumed to yield abnormal CCE values. These deletions are made on the basis of 90 percent homogeneity; only 4.25 percent of the total observations are deleted as outliers.

Figure 1 shows that the textiles sector was at its best in the year 2001 but below average in 2004. The textile firm performing up to par in terms of CCE was Nayab Spinning and Weaving Mills, with a six-year average CCE of 0.96. The other nine leading firms according to this parameter follow in Table 1.

Figure 1: Average CCE for Textiles Sector (2000–05)

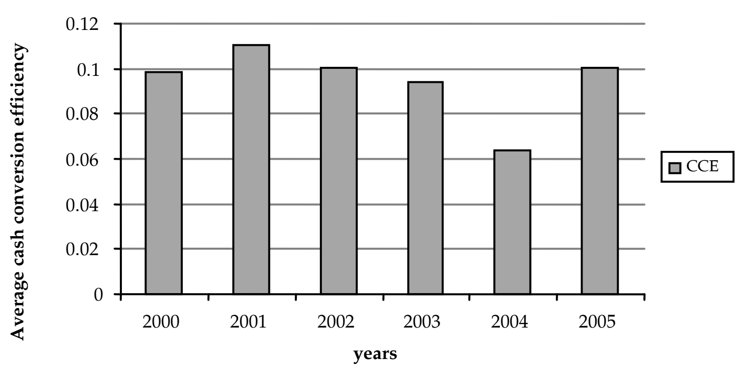


Table 1: Top Ten Textile Firms Ranked by CCE (2000–05)

Firm	Six-year average CCE	Rank
Nayab Spinning and Weaving Mills Ltd.	0.96	1
Sapphire Textile Mills Ltd.	0.91	2
Chaudry Textile Mills	0.71	3
Mohammad Farooq Textile Mills Ltd.	0.24	4
Dawood Cotton Mills	0.20	5
Legler-Nafees Denim Mills Ltd.	0.20	6
Artistic Denim Mills	0.20	7
Nishat (Chunian) Ltd.	0.18	8
International Knitwear Ltd.	0.17	9
Quality Textile Mills Ltd.	0.17	10

Source: Derived from author's model.

4.1.2. DOC

Figure 2 shows that the managerial practice of DOC declined industry-wide in the earlier phase. The industry appears to have performed more efficiently during 2002–04, but could not sustain this for long. The best-performing firm over the study period is Sunshine Cotton Mills Ltd., with a six-year average DOC of 15.57. This firm seems to have had a lead with respect to DR and DI. Table 2 shows the leading firms ranked according to the best practice of DOC over the study period.

Figure 2: Average DOC for Textiles Sector (2000–05)

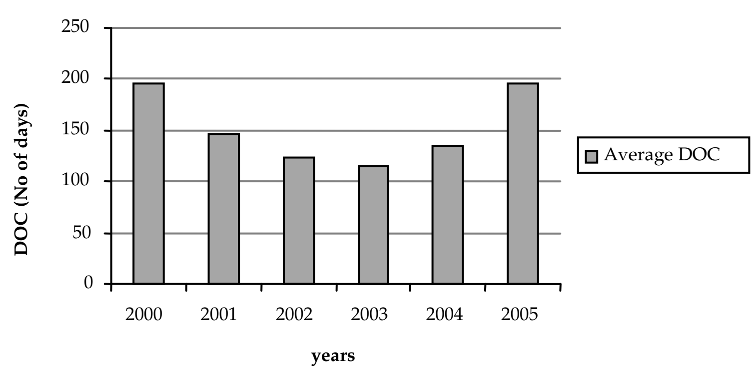


Table 2: Top Ten Textile Firms Ranked by DOC (2000–05)

Firm	Six-year average DOC	Rank
Sunshine Cotton Mills Ltd.	15.57	1
Noor Silk Mills Ltd.	21.17	2
Chaudry Textile Mills	22.15	3
Service Fabrics Ltd.	26.73	4
Al Qaim Textile Mills	26.79	5
Asim Textile Mills	27.47	6
Polyron Ltd.	27.54	7
Bilal Fibres Ltd.	36.90	8
Khyber Textile Mills Ltd.	37.41	9
Amin Spinning Mills	38.54	10

Source: Derived from author's model.

4.1.3. DWC

Figure 3 shows that the sampled textile firms performed exceptionally well during 2002–04, where 2003 was the most efficient year on the basis of average DWC. The industry seems to have better managed its DI, DR, and DP in 2003 than in the remaining years, but this might not be a fair conclusion since we know that averages offset movements above and below the central figure.

Figure 3: Average DWC for Textiles Sector (2000–05)

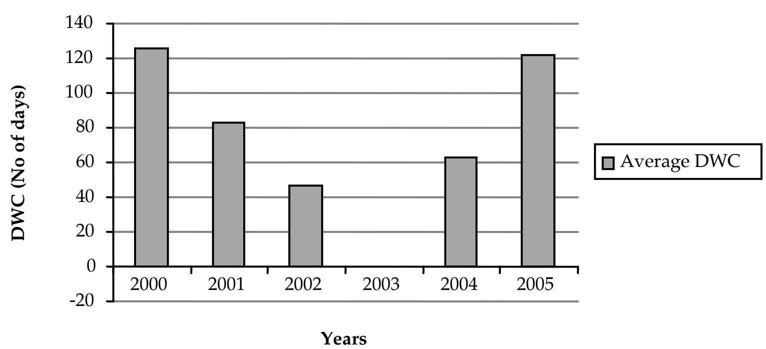


Table 3 lists the sector's leading performers, which appear to have efficiently practiced the management of DWC. Colony Thal Textile Mills is ranked highest, with a six-year average (lowest) value of 0.36 days over the study period. The table accommodates only those firms whose six-year average DWC falls close to 0;, firms are ranked on the basis of their distance from 0 on both sides (+, –).

Table 3: Top Ten Textile Firms Ranked by DWC (2000–05)

Firm	Six-year average DWC	Rank
Colony Thal Textile Mills	0.36	1
Hamid Textile Mills Ltd.	0.53	2
Mukhtar Textile Mills Ltd.	3.57	3
Khyber Textile Mills Ltd.	-3.78	4
Hajra Textile Mills Ltd.	4.20	5
Service Fabrics Ltd.	-4.79	6
Ali Asghar Textile Mills	6.91	7
Sally Textile Mills Ltd.	-7.71	8
Sunshine Cotton Mills Ltd.	-7.79	9
Noor Silk Mills Ltd.	-9.52	10

Source: Derived from author's model.

4.1.4. WCPR

In order to evaluate the performance of the entire sample, the components of WCM are normalized to bring all ratios to a standard scale that allows comparison. A composite index of WCPR is obtained by taking the weighted average of these components. Firms are ranked using the normalized forms of CCE, DOC, and DWC obtained from the model developed in Section 3.1. We consider the study period 2000–05 in order to rank all 160 firms on the earlier WCM model. The same ranking of all textile firms is later used to compute the rank correlation with their PPRs. Table 4 lists the top 20 firms in terms of WCM efficiency.

Table 4: Top 20 Textile Firms Ranked by WCPR

Firm	**Year**	**WCPR = NCCE * 0.5 + NDOC * 0.25 + NDWC * 0.25**	**Rank**
Saitex Spinning Mills Ltd.	2003	0.02446	1
Pak Fibre Industries Ltd.	2005	0.04004	2
Mehr Dastagir Textile Mills Ltd.	2005	0.04712	3
Saleem Denim Industries Ltd.	2002	0.06944	4
Saleem Denim Industries Ltd.	2003	0.07700	5
Saleem Denim Industries Ltd.	2001	0.08236	6
Mehr Dastagir Textile Mills Ltd.	2003	0.08862	7
Saleem Denim Industries Ltd.	2000	0.08863	8
Mehr Dastagir Textile Mills Ltd.	2002	0.08944	9
Amin Spinning Mills	2003	0.09296	10
Carvan East Fibres	2003	0.09799	11
Carvan East Fibres	2004	0.10338	12
Mehr Dastagir Textile Mills Ltd.	2001	0.10375	13
Elahi Cotton Mills	2004	0.10709	14
Carvan East Fibres	2002	0.10998	15
Kohinoor Industries Ltd.	2004	0.11450	16
Elahi Cotton Mills	2005	0.11483	17
Accord Textile Mills	2003	0.11745	18
Amin Spinning Mills	2002	0.11913	19
Accord Textile Mills	2002	0.11938	20

Source: Derived from author's model.

According to the table, seven textile firms dominate the top 20 rankings altogether in different study years. Since we are using a sample of 960 firm-year observations, the model ranks firms on the basis of efficient performance on an ordinal scale and not on the basis of time period, thereby producing a list of firms with the lowest WCPR in any year followed by other firms' higher scores in any other year of the study period.

Table 5 provides a summary of WCM practice by the textiles sector. On average, it shows low-performance benchmarks for the inventory conversion period and receivables collection period, thus producing a longer operating cycle. There are visibly huge gaps between maximum and minimum statistics, implying that there is room for textile firms to improve on these benchmarks. The maximum indicators reflect either sick units or the poor quality of figures captured in the data. Even the minimum figures do not seem to be realistic or reliable. CCE takes a negative minimum value in the case of one odd firm that appears to be taking advance receipts before delivering products, which is somewhat believable.

Table 5: Summary of Working Capital Variables for Textiles Sector

Summary	CCE	DR	DI	DOC	DP	DWC = DOC – creditors
Mean	0.11	37.83	116.10	148.17	80.09	73.16
Standard dev.	3.90	67.23	199.79	210.98	243.76	277.17
Range	149.58	1,624.98	3,414.00	3,534.39	4,961.46	6,611.63
Minimum	-107.48	0.00	0.31	0.37	0.25	0.12
Maximum	42.11	1624.98	3,414.31	3,534.39	4,961.71	3,488.27
Count	954	955	899	947	948	946

Source: Derived from author's model.

4.2. *Application of PPR Model*

4.2.1. ROA

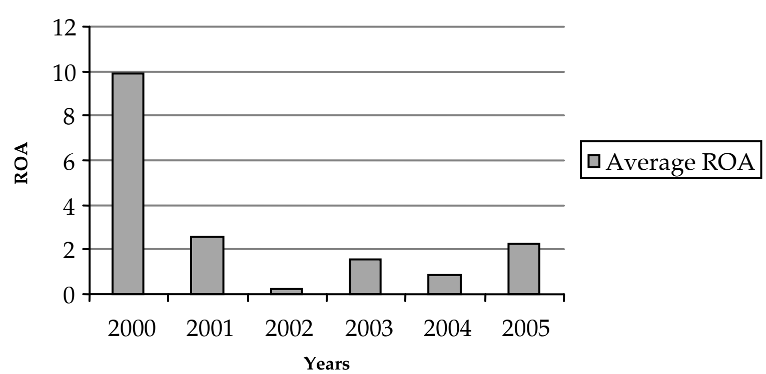
Table 6 ranks International Knitwear Ltd. as the top performer on the basis of its six-year average ROA of 20.47, followed by Allawasaya Textile Mills Ltd. with 18.88. Textile firms, like other firms, are morally and legally obligated to generate desirable returns from their employed assets, and market leaders pave the way for other firms to follow. Figure 4 shows that 2000 was the most successful year for the industry, with the highest return generated by assets employed. The subsequent years could not match this extraordinary return.

Table 6: Top Ten Textile Firms Ranked by ROA (2000–05)

Firm	Six-year average ROA	Rank
International Knitwear Ltd.	20.47	1
Allawasaya Textile Mills Ltd.	18.88	2
Artistic Denim Mills	18.13	3
Nadeem Textile Mills Ltd.	17.43	4
Nishat (Chunian) Ltd.	15.13	5
Mohammad Farooq Textile Mills Ltd.	14.27	6
Sana Industries Ltd.	14.13	7
Zahur Cotton Mills Ltd.	14.13	7
Gadoon Textile Mills Ltd	13.70	9
Din Textile Mills	13.37	10

Source: Derived from author's model.

Figure 4: Average ROA for Textiles Sector (2000–05)



4.2.2. ROE

Figure 5 shows that 2000 was the sector's best year in term of average ROE achieved, while 2004 shows a negative average ROE. Table 7 lists the best-performing textile firms that were able to create value for equity holders by giving them the highest returns on their invested capital. J. A Textile Mills Ltd. leads with the highest six-year average ROE, 121.90, and is thus ranked first followed by other leading performers in this respect.

Figure 5: Average ROE for Textiles Sector (2000–05)

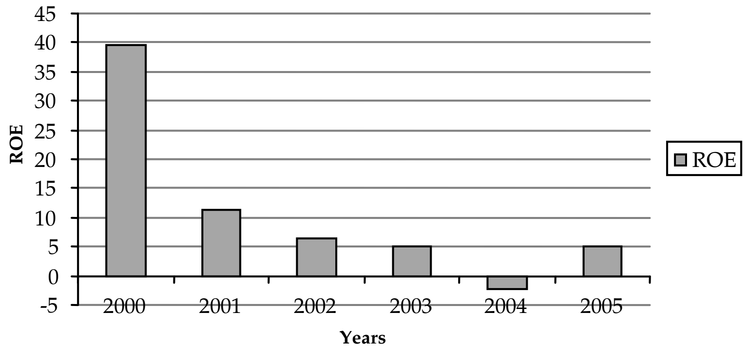


Table 7: Top Ten Textile Firms Ranked by ROE (2000–05)

Firm	Six-year average ROE	Rank
JA Textile Mills Ltd.	121.90	1
Chakwal Spinning Mills	98.22	2
Hala Enterprises Ltd.	97.45	3
International Knitwear Ltd.	80.53	4
Regent Textile Industries Ltd.	67.82	5
Mohammad Farooq Textile Mills Ltd.	57.30	6
Allawasaya Textile Mills Ltd.	42.73	7
Nishat (Chunian) Ltd.	40.30	8
Nadeem Textile Mills Ltd.	39.77	9
NP Spinning Mills Ltd.	37.05	10

Source: Derived from author's model.

4.2.3. EVA

The EVA benchmark identifies those firms that have added economic value after compensating for the cost of total funds employed. Deriving the cost of capital is usually a difficult job, and the weight and cost of each factor of capital is utilized in order to calculate the weighted average cost of capital. The data used in this study has several limitations when calculating EVA. A negative EPS results in a negative PE ratio and the cost of equity based on the PE ratio would therefore be negative. Since many firms in the sample exhibited this problem, an estimate of the weighted average cost of capital was calculated for each firm, for a dataset of 414 firm-year observations, and averaged. The cost of capital is estimated as 11.07 percent and used as an industry benchmark to calculate the EVA of textile firms. Interestingly, only seven of the entire sample of 160 firms showed a positive EVA on the basis of a six-year average; the remaining 153 had a negative EVA.

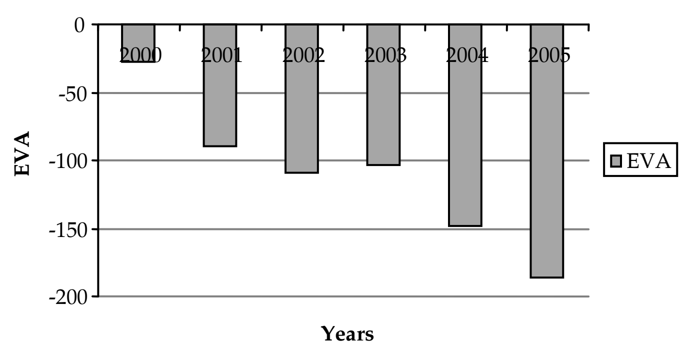
Table 8 ranks Artistic Denim Mills first, which has a six-year average EVA of approximately Rs85.9 million. Figure 6 gives an alarming picture of the economic impotency of the textiles sector in showing that average EVA follows a declining trend over the years (in rupees million).

Table 8: Top Ten Textile Firms Ranked by EVA (2000–05)

Firm	Six-year average EVA	Rank
Artistic Denim Mills	85.86	1
Gadoon Textile Mills Ltd.	64.11	2
Usman Textile Mills Ltd.	58.11	3
Mohammad Farooq Textile Mills Ltd.	13.63	4
International Knitwear Ltd.	4.51	5
Allawasaya Textile Mills Ltd.	2.77	6
Sind Fine Textile Mills Ltd.	1.68	7
Shadab Textile Mills Ltd.	-2.85	8
Safa Textiles Ltd.	-3.06	9
Sana Industries Ltd.	-5.27	10

Source: Derived from author's model.

Figure 6: Average EVA for Textiles Sector (2000–05)



4.2.4. PMS

Figure 7 shows that 2004 yielded an average negative net PMS while the remaining years maintained a low positive average net PMS.

Saitex Spinning Mills and Taj Textile Mills Ltd. share first rank in terms of best performance and the highest six-year average PMS (see also Table 9).

Figure 7: Average Net PMS for Textiles Sector (2000–05)

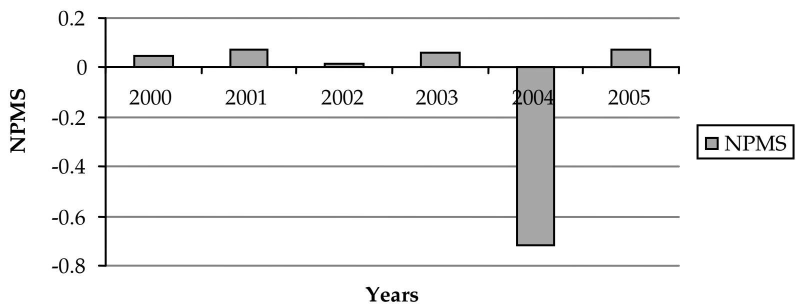


Table 9: Top Ten Textile Firms Ranked by PMS (2000–05)

Firm	Six-year average PMS	Rank
Saitex Spinning Mills Ltd.	1.32	1
Taj Textile Mills Ltd.	1.32	1
Nayab Spinning and Weaving Mills Ltd.	1.02	3
Sapphire Textile Mills Ltd.	0.90	4
Dawood Cotton Mills	0.32	5
Nadeem Textile Mills Ltd.	0.21	6
Mohammad Farooq Textile Mills Ltd.	0.21	7
Nishat (Chunian) Ltd.	0.15	8
Artistic Denim Mills	0.15	9
Legler-Nafees Denim Mills Ltd.	0.14	10

Source: Derived from author's model.

4.2.5. PPR

Textile firms are ranked on the basis of profitability and the ratios of ROA, ROE, EVA, and PMS are normalized, as discussed earlier. These calculations consider all 160 firms for the study period 2000–05. Table 10 lists the top 20 firms leading the sector in performance of profitability. According to the four profitability parameters used, Mohammad Farooq Textile Mills Ltd. performed best in 2003 with the lowest weighted average normalized score of 0.19.

Table 10 presents a summary of profitability performance metrics for the textiles sector. The average negative EVA reveals that, on average, the sector has not added any economic value to the industry. The cost of utilized funds is more than the accounting profits. Only six firms are seen to have added economic value to the industry while all the others in the sample show a negative EVA (as shown earlier in Table 8).

Table 10: Top 20 Textile Firms Ranked by PPR (2000–05)

Firm	Year	PPR = 0.25NROA + 0.25NROE + 0.25NEVA + 0.25PMS	Rank
Mohammad Farooq Textile Mills Ltd.	2003	0.1912	1
International Knitwear Ltd.	2004	0.2386	2
Gadoon Textile Mills Ltd.	2004	0.2431	3
Amin Spinning Mills	2004	0.2433	4
Regent Textile Industries Ltd.	2000	0.2451	5
Shahzad Textile Mills Ltd.	2000	0.2471	6
Chakwal Spinning Mills	2003	0.2911	7
Allawasaya Textile Mills Ltd.	2000	0.2913	8
Elahi Cotton Mills	2005	0.2966	9
Mehr Dastagir Textile Mills Ltd.	2005	0.2984	10
Sapphire Textile Mills Ltd.	2000	0.3002	11
JA Textile Mills Ltd.	2001	0.3018	12
Nadeem Textile Mills Ltd.	2004	0.3042	13
Paramount Spinning Mills Ltd.	2000	0.3059	14
Mahmood Textile Mills Ltd.	2000	0.3092	15
Din Textile Mills	2000	0.3101	16
Fazal Textile Mills Ltd.	2000	0.3103	17
Dar-es-salam Textile Mills	2000	0.3148	18
Artistic Denim Mills	2005	0.3149	19
Ishtiaq Textile Mills Ltd.	2000	0.3155	20

Source: Derived from author's model.

The following results reveal the inconsistency of these variables, and indicate a performance discrepancy in the textiles sector. This could denote a bigger problem in Pakistan, as it is possible that financial data (especially earnings) has been misreported, as most of the firms in this sector are family-owned.

4.3. *Computation of Rank Correlation*

Rank correlation is computed for the ordinal relationship between the performance and working capital of the sampled textile firms. The most popular measure of association is the Spearman's rho (see Lehmann & D'Abrera, 1998). The Kendall tau_b is another widely used measure of rank correlation, and is computed in this study as an alternative diagnostic. Pearson's rank correlation is computed as an extension of the analysis. All three measures are tested for significance levels.

Table 11 presents our findings, according to which all three diagnostics support an insignificant weak positive rank correlation. This is in agreement with our earlier hypothesis of a positive rank correlation. Many factors can positively affect firm profitability, and therefore a formal regression analysis is used to investigate economic impact. The finding of an insignificant weak positive correlation negates our first hypothesis; this finding is attributed to chance variation.

Table 11: Diagnostics for Rank Correlation

Kendall's tau_b measure of correlation (N = 960)		
	WCPR	PPR
WCPR	1	0.002 (0.949)
PPR	0.002 (0.949)	1
Spearman's rho measure of correlation (N = 960)		
WCPR	1	0.002 (0.944)
PPR	0.002 (0.944)	1
Pearson's correlation coefficient (N = 960)		
WCPR	1	0.002 (0.944)
PPR	0.002 (0.944)	1

Note: Coefficients are insignificant at the standard levels.

5. Regression Analysis

ROA is taken as explained while average DI, average DR, average DP, and cash cycle are taken as explanatory variables. Since there could be a number of reasons affecting profitability, such as pricing policy, sales growth, etc., we use the following control variables: size of the firm, GR, ratio of sales to current assets, and ratio of current assets to total assets.

The regression is carried out using both the OLS model and FEM as discussed earlier in Section 3.4. Four regression equations are fitted using each of the two models to test the significance of their respective regression coefficients.

5.1. Results of OLS Model

Both correlation and regression analysis are carried out between ROA and the explanatory variables using an OLS approach. Table 12 exclusively presents correlations between ROA and the main variables of WCM. Results from this analysis reveal that ROA has a significant negative correlation with DR. This would suggest that better returns may be associated with fast collection of receivables and undue length of DR negatively affect ROA. However such an assumption could be studied by using regression analysis to confirm any economic impact of DR on ROA.

CCE has a significant positive correlation with ROA, surprisingly this should suggest that keeping inventories longer improves profitability. But since this has a link with DP and it is significantly negatively correlated with ROA, this may suggest that textile firms prolong payments to their creditors and accumulate inventories when they are making less profits. A somewhat unexpected finding in Table 12 in this respect is the positive sign of DI which is contrary to theoretical settings. Average DP, expectedly has a negative sign, revealing that delaying payments due improves returns on employed assets.

Table 12: Correlation Coefficients

	ROA	CCC	DR	DI	DP
ROA	1				
CCC	0.098** (0.003)	1			
DR	-0.167** (0.000)	0.248** (0.000)	1		
DI	0.044 (0.183)	0.773** (0.000)	0.045 (0.177)	1	
DP	-0.132** (0.000)	-0.648** (0.000)	0.026 (0.427)	0.022 (0.503)	1

Note: ** indicates correlation is significant at 0.01 level (two-tailed).

According to Table 13, there is a significant positive correlation at 1 percent between ROA and firm size. That ROA moves significantly and positively in relation to sales seems to be a straightforward finding. The GR is, however, negatively correlated with ROA, which could be attributed to chance since it is an insignificant negative relationship.

Additionally, capital asset turnover and the ratio of current assets to total assets are insignificantly correlated with ROA. Other interesting relationships reported in the table are that ROA is significantly and positively correlated with the operating profit margin; and that the ratio of stock to current assets and that of debtors to current assets are significantly and negatively correlated with ROA.

Table 13 exhibits problems of multicollinearity, and many variables indicate spurious relationships. An OLS regression model is fitted on the data next, using the approach discussed in the methodology. The results are summarized in Table 14. Four regression equations are fitted, using one each for the core variable of WCM as an independent variable, i.e., CCC, DI, DR, and DP. While testing the significance of $\beta = 0$, we find that the coefficients for firm size, DI, DR, and DP are significantly different from 0 ($|t| > 2$). However, CCC is insignificant and has a positive sign, which is unexpected.

These findings, however, have little credence since the R^2 term reveals the weak explanatory power of the four models, even though they are supported by the results of the F-test at 1 percent, and do a good job of accounting for most variations in the dependent variable (the results of the F-test are significant for all four OLS models).

Table 13: Correlation Matrix for 160 Textile Firms

		ROA	OPM	AT	STCA	DTCA	SAPOS	GR	CATA	CLTA	CCC	DR	DI	DP
ROA	Pearson correlation	1												
	Sig. (two-tailed)													
	N	960												
OPM	Pearson correlation	0.268**	1											
	Sig. (two-tailed)	0.000												
	N	954	954											
AT	Pearson correlation	0.010	0.000	1										
	Sig. (two-tailed)	0.660	0.970											
	N	947	943	947										
STCA	Pearson correlation	0.010	0.010	-0.034	1									
	Sig. (two-tailed)	0.770	0.730	0.300										
	N	945	939	932	944									
DTCA	Pearson correlation	-0.009	0.030	-0.010	0.697**	1								
	Sig. (two-tailed)	0.790	0.370	0.690	0.000									
	N	944	938	931	944	944								
SAPOS	Pearson correlation	0.204**	0.050	0.067*	0.267**	-0.268**	1							
	Sig. (two-tailed)	0.000	0.120	0.040	0.000	0.000								
	N	954	954	943	938	938	954							
GR	Pearson correlation	-0.020	0.010	-0.020	-0.010	0.010	0.040	1						
	Sig. (two-tailed)	0.560	0.810	0.600	0.880	0.880	0.290							
	N	860	858	853	847	847	858	860						
CATA	Pearson correlation	0.010	0.000	0.970**	0.010	-0.010	0.065*	-0.020	1					

	Sig. (two-tailed)	0.650	0.970	0.000	0.690	0.690	0.050	0.600						
	N	947	943	947	931	931	943	853	947					
CLTA	Pearson correlation	0.010	0.000	0.972**	0.010	-0.010	0.060	-0.020	0.998**	1				
	Sig. (two-tailed)	0.700	0.970	0.000	0.720	0.710	0.060	0.640	0.000					
	N	947	943	947	931	931	943	853	947	947				
CCC	Pearson correlation	0.098**	-0.133**	-0.029	0.300**	0.020	0.245**	-0.060	-0.028	-0.031	1			
	Sig. (two-tailed)	0.000	0.000	0.380	0.000	0.600	0.000	0.080	0.400	0.340				
	N	946	945	935	931	931	945	852	935	935	946			
DR	Pearson correlation	-0.167**	-0.634**	-0.020	0.000	0.098**	-0.130**	-0.030	-0.020	-0.020	-0.248**	1		
	Sig. (two-tailed)	0.000	0.000	0.430	0.910	0.000	0.000	0.400	0.510	0.490	0.000			
	N	959	953	946	944	944	953	859	946	946	946	959		
DI	Pearson correlation	0.040	0.000	-0.238**	0.421**	-0.013	-0.114**	-0.053	-0.070*	-0.144**	0.773**	0.050	1	
	Sig. (two-tailed)	0.180	0.920	0.000	0.000	0.700	0.000	0.130	0.000	0.910	0.000	0.180		
	N	899	896	891	884	883	896	829	891	935	896	898	899	
DP	Pearson correlation	-0.132**	-0.027	-0.028	0.030	-0.003	-0.511**	0.020	-0.026	-0.023	-0.648**	0.030	0.020	1
	Sig. (two-tailed)	0.000	0.400	0.400	0.400	0.940	0.000	0.600	0.430	0.480	0.000	0.430	0.500	
	N	948	946	936	933	932	946	853	936	946	946	947	898	948

Notes: * and ** indicate correlation is significant at 0.05 level (two-tailed) and 0.01 level (two-tailed), respectively. See Appendix for definition of variables.

Table 14: Results of OLS Model

Dependent variable = ROA

	Model 1			Model 2			Model 3			Model 4		
Variable	**Coefficient**	**t-value**	**Sig.**	**Coefficient**	**t-value**	**Sig.**	**Coefficient**	**t-value**	**Sig.**	**Coefficient**	**t-value**	**Sig.**
Ln_sales	1.859	4.992	0.000	1.708	4.044	0.000	1.785	4.497	0.000	1.579	4.010	0.000
GR	-0.001	-0.794	0.427	-0.001	-0.858	0.391	-0.001	-0.816	0.415	-0.001	-0.793	0.428
CA_turn	0.089	0.924	0.356	0.017	0.158	0.874	0.138	1.382	0.167	0.071	0.742	0.458
CA/TA	0.001	0.018	0.986	0.002	0.061	0.952	1.653	1.426	0.154	-0.009	-0.018	0.986
Inv_days							0.004	1.965	0.050			
AR_days				-0.037	-4.932	0.000						
AP_days										-0.009	-2.067	0.039
CCE	0.002	1.035	0.301									
R^2	0.031			0.056			0.034			0.035		
Durbin-Watson	1.674			1.713			1.679			1.675		
Model significance (F-test)	5.267		0.000	9.820		0.000	5.580		0.000	5.927		0.000

Note: Ln_sales = natural log of sales as a proxy for firm size, GR = gearing ratio, CA_turn = capital assets turnover or gross working capital ratio. CA/TA = current assets/total assets, Inv_days = days in inventory, AR_days = days receivable, AP_days = days payable, CCE = cash conversion efficiency.

5.2. Results of FEM

Since our OLS estimates have shown some common statistical problems, their coefficients are not considered fully reliable. Therefore, we apply the Hausman test to decide between using an FEM or REM. The null hypothesis of the test is rejected at 5 percent, which confirms our choice of an FEM. Next, we fit an FEM on the data according to the methodology discussed earlier, and regress ROA on the explanatory variables of WCM, along with four control variables. To capture the firm effect in this balanced panel of 960 firm-year observations, 159 dummies are inserted into the model. Since our data only spans six years, we ignore the time effect on the assumption that six years is too short a time to induce large changes that could have had a significant impact on profitability performance or working capital performance.

Table 15 presents four regression equations: one each for the core variables of WCM, along with the control variables of firm size, leverage ratio, current asset turnover, and ratio of current assets to total assets. The strategy to capture the firm effect works in improving the predictability of the regression models, with a much-improved R^2. Modifying the OLS model to an FEM by including dummy variables to capture the firm effect removes the problem of multicollinearity fully, and of autocorrelation partially. Each adapted model now explains variations in ROA better.

Interestingly, while testing for significance, it is found that the coefficients for firm size, DI, and DR, are significantly different from 0 ($|t| > 2$) at 1 percent. DP and CCC are found to be statistically insignificant at all levels. GR has a negative impact on ROA; this coefficient has a negative sign and is significant at 5 percent. Applying the F-test suggests that the four models should be used for estimation purposes.

Table 15: Results of FEM

Dependent variable = ROA

	Model 1			Model 2			Model 3			Model 4		
Variable	**Coefficient**	**t-value**	**Sig.**	**Coefficient**	**t-value**	**Sig.**	**Coefficient**	**t-value**	**Sig.**	**Coefficient**	**t-value**	**Sig.**
Ln_sales	3.155	2.525	0.012	4.637	3.768	0.000	3.964	2.858	0.004	3.257	2.83	0.005
GR	-0.008	-2.180	0.030	-0.007	-2.133	0.033	-0.007	-1.800	0.072	-0.007	-2.171	0.03
CA_turn	0.085	0.765	0.444	0.124	1.097	0.273	0.089	0.695	0.487	0.090	0.813	0.417
CA/TA	-0.023	-0.354	0.724	-0.300	-0.126	0.900	-0.034	-0.449	0.654	-0.024	-0.364	0.716
Inv_days				0.009	2.963	0.003						
AR_days							-0.049	-5.843	0.000			
AP_days										-0.003	-0.331	0.741
CCE	-0.001	-0.331	0.741									
R^2	0.419			0.425			0.398			0.419		
Durbin-Watson	2.256			2.252			2.280			2.258		
Model significance (F-test)	3.151		0.000	3.185		0.000	2.883		0.000	3.154		0.000

Note: Ln_sales = natural log of sales as a proxy for firm size, GR = gearing ratio, CA_turn = capital assets turnover or gross working capital ratio. CA/TA = current assets/total assets, Inv_days = days in inventory, AR_days = days receivable, AP_days = days payable, CCE = cash conversion efficiency.

6. Summary and Conclusion

The existing literature suggests that there are links between the profitability and efficiency of working capital. This study endeavors to lend credence to this theory on the basis of data on 160 textile firms in Pakistan for the period 2000–05. We investigate empirically the main variables of WCM, i.e., CCE, DWC, and DOC, and identify the best performers on the basis of absolute comparison. Following Anand and Gupta (2001), we formulate a weighted average index by normalizing the absolute variables and ranking all the textile firms in terms of overall working capital performance in order to identify the 20 best performers.

The study also examines the relationship between WCM and profitability. For this purpose, it develops a profitability benchmark based on four variables: ROA, ROE, EVA, and PMS. All the textile firms sampled are ranked according to each of these measures in order to identify the top ten performers in the industry. The profitability indices are normalized and we establish a PPR model by using a weighted average approach. The 20 best performers on the basis of this model are identified in terms of overall profitability performance. The ranked firms are tested for rank correlation using the Spearman's rho, Kendall tau_b, and Pearson's correlation coefficients.

We find that the textile firms show insignificant and weak positive rank correlation between the two ordinal scales devised for WCM and profitability. According to Pearson's correlation coefficient, there is insignificant positive correlation between ROA and DI. Both DR and DP are significantly and negatively correlated with ROA, while CCC is significantly and positively correlated with ROA.

In the regression analysis that follows, ROA is taken as dependent on the main WCM variables: CCC, DI, DR, and DP. We use OLS and fixed effect models to find causation for ROA by estimating regression coefficients. The models use firm size, GR, current assets turnover, and the ratio of current assets to total assets as control variables. The OLS model reveals that textile firms could improve their returns by adopting sound strategies for collection, since DP has an established significant economic impact on the assets employed by firms. This model also lends credence to the assumption that the less profitable firms rely on credit from their suppliers and prolong their due payments.

We capture the firm effect using dummy variables. The findings of the fixed effect model reveal that firm size is significant along with the variables DI and DR in all the four models fitted at a 1 percent level. Both DP and CCC, however, are insignificant at all levels. The sign of the DI coefficient remains a matter of concern, while CCC has the expected negative sign that suggests that firms could add value by improving their cash cycles.

To conclude, we infer that the textiles industry has established a weak positive rank correlation between working capital performance and profitability performance. The finding is still limited by the insignificance of the relationship, and could be attributed to chance. Another limitation is the study's design, which relies on the weighted average concept of developing working capital and profitability models, using subjective weights. A different weighting criterion might have produced contrary results.

The study establishes that the inventory conversion period, receivables' collection period, payables' deferral period, and CCC all have an economic impact on the ROA of textile firms in Pakistan. Statistical reasoning shows that the components of WCM affect these firms' returns. The issue has scope for further research to improve the weighting criterion used to rank firms by WCM and profitability, and to search for causal relationships by identifying other management practices in the industry that could improve profitability.

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Appendix

List of Abbreviations

N_{cce}	Normalized cash conversion efficiency	N_{roa}	Normalized return on assets
h_{comr}	Highest overall cash operating margin ratio	h_{roa}	Highest overall return on assets
c_{comr}	Company cash operating margin ratio	c_{roa}	Company return on assets
l_{comr}	Lowest overall cash operating margin ratio	l_{roa}	Lowest overall return on assets
N_{doc}	Normalized days operating cycle	N_{roe}	Normalized return on equity
l_{doc}	Lowest overall days operating cycle	h_{roe}	Highest normalized return on equity
c_{doc}	Company days operating cycle	c_{roe}	Company normalized return on equity
h_{doc}	Highest overall days operating cycle	l_{roe}	Lowest normalized return on equity
N_{dwc}	Normalized days working capital	N_{npms}	Normalized net profit margin on sales
l_{dwc}	Lowest overall absolute days working capital	h_{npms}	Highest normalized net profit margin on sales
c_{dwc}	Company absolute days working capital	c_{npms}	Company normalized net profit margin on sales
h_{dwc}	Highest overall absolute days working capital	l_{npms}	Lowest normalized net profit margin on sales
NCFFOA	Net cash flow from operating activities	N_{eva}	Normalized economic value added
EBIT	Earnings before interest and taxes	h_{eva}	Highest normalized economic value added
D	Depreciation	c_{eva}	Company normalized economic value added
T	Tax	l_{eva}	Lowest normalized economic value added
SR	Sales revenue	NOPAT	Net operating profit after interest and taxes
LnS	Natural log of sales	DI	Days in inventory
GR	Gearing ratio	DR	Days receivable
GWCTR	Gross working capital turnover ratio	DP	Days payable
Ct1	Current assets divided by total assets	CCC	Cash conversion cycle = days in inventory + days receivable – days payable
Ct2	Current liabilities divided by total assets	ExWC	Denotes days in inventory, days payable, days receivable, and cash conversion cycle subsequently

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