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An Analysis of the Cost Structure of Food Industries in Pakistan: An Application of the Translog Cost Function

Sajid Hussain,* Uzma Nisar and Waseem Akram*****

Abstract

Given the importance of food industries in Pakistan, this study analyzes their cost structure by estimating the transcendental logarithmic cost function. The study also considers elasticity of substitution along with own-price elasticity and cross-price elasticity. Four factor inputs, i.e., labor, capital, energy, and materials, are used to estimate the cost function. The results indicate that materials account for the highest share of the cost. The elasticity of substitution of materials for capital and energy is also weak. The own-price elasticities indicate that the demand for materials is least responsive to a change in its own price while the demand for other inputs varies with price. The cross-price elasticities show that labor, capital and energy are substitutes for each other. The output elasticity of cost demonstrates the presence of economies of scale.

Keywords: Translog cost function, elasticity of substitution, cross-price elasticity, Allen's partial elasticity.

JEL Classification: D24, Q11.

1. Introduction

Pakistan's manufacturing sector plays an important role in the country's economic development, having contributed 13.5–13.8 percent to GDP during the last decade. Large-scale manufacturing has a 78 percent share in manufacturing and a 10.2 percent share in GDP. The food-processing sector contributes 12.37 percent of the total gross value addition of large-scale manufacturing (Pakistan, Ministry of Finance, 2019). Along with value addition, this sector also procures and processes enough food to meet the demand of the country. This makes it essential to identify the underlying factors involved in food production so that the social planners

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can find a balance among the factor inputs—such as labor, capital and energy— required. It is also important from the perspective of a developing country with an abundance of labor and a dearth of capital.

A better understanding of the food sector's cost structure can help reduce the cost of production and maximize output. Input price responsiveness and substitutability among inputs can also enable a better understanding of the optimal factor inputs. Accordingly, this study analyzes the cost structure of food industries in Pakistan and computes the elasticities of substitution among factor inputs, own-price elasticities, and cross-price elasticities.

Single-output production functions can take a variety of functional forms. The most widely used is the Cobb-Douglas production function, which works under certain restrictions: it is homogeneous of degree 1 and elasticities of substitutions (ES) are restricted to 1. ES measures the percentage change in factor proportions due to a one-percent change in their relative prices (Banda & Verdugo, 2007). In contrast, the constant elasticity of substitution (CES) production function allows the elasticity of substitution to vary between 0 and infinity. However, the ES remains constant at various levels of outputs and inputs.

A difficulty in using CES is that we cannot compute the ES for more than two inputs (McFadden, 1963). Diewert (1971) introduced a functional form that incorporates N inputs and permits the ES to change at varying levels of inputs. Christensen, Jorgenson and Lau (1973) developed a more flexible functional form known as the translog production function. This allows many inputs and varying ES for different combinations of inputs and imposes no prior restrictions on the function. It is possible to compute homogeneity, homotheticity, CES, and variable elasticity of substitution (VES) using the translog function through appropriate restrictions. We have therefore analyzed cost structure by estimating the translog cost function for Pakistan's food industry. The findings indicate that materials have the highest share in the cost structure. The ES of material for labor and for capital is also low. The own-price elasticities indicate that the demand for materials is least responsive to a change in its own price, while demand for other inputs varies with price. The cross-price elasticities show that labor, capital and energy are substitutes for each other. The output elasticity of cost demonstrates the presence of economies of scale.

The rest of the article proceeds as follows: Section 2 discusses relevant studies in the literature and their findings. Section 3 describes the methods used to estimate the translog cost function and different types of elasticities. It also discusses the data and defines the variables used for the analysis. Section 4 presents and discusses the study's results. Section 5 concludes the study and discusses policy implications.

2. Literature Review

Costantini and Paglialunga (2014) conduct a comprehensive study of the cost structure of 10 manufacturing sectors in 21 OECD economies. The study aims to probe the factors affecting cost and focuses on measuring energy-output and capital-energy substitution over the period 1970–2008. They employ the translog production (KLEM) function and compute Allen elasticity of substitution (AES) for different subperiods to analyze the transition over time. The capital-energy substitution is lower than 1 and differs by sector. It remains consistent in subperiods for the food sector only, while the textiles (0.44 and 0.47) and wood sectors (0.13 and 0.16) increase over time. Some industries follow U-shaped trends over time.

Berndt and Wood (1975) study the possibility of substitution between energy and nonenergy inputs in US manufacturing. The translog cost function is estimated using time-series data (1947–71). They use an iterative three-stage least squares estimator. Own-price and cross-price elasticity are also estimated for energy. The results indicate that energy is own-price-elastic (–0.47), and that energy and labor are slightly substitutable (0.65). The cross-price elasticity between energy and labor, and labor and capital, is relatively small (0.18 and 0.05, respectively). It is evident that energy and capital are complementary since the elasticity of substitution is –3.2. Krishnapillai and Thompson (2012) also study the translog production function for the US manufacturing industry. They estimate own-price elasticity, cross-price elasticity, and Morishma elasticity of substitution using cross-section data for 2007. The study finds that capital, labor, and electricity are substitutes for each other, but electricity is a weaker substitute for labor and capital, and labor and capital are stronger substitutes for electricity. Erickson et al. (2003) estimate the US agriculture sector's translog cost function. The study uses time-series data to estimate static and dynamic functions. The short-run and long-run cost functions are estimated using concentrated maximum likelihood estimation. The AES is computed to determine substitutability. For inputs and capital, capital and labor, and inputs and labor, the AES is 0.52, -0.58 and 0.489, respectively. The study concludes that static long-run results are not consistent with the concavity restriction, while the dynamic model obeys production theory.

The translog cost function for Mexican manufacturing is estimated by Banda and Verdugo (2007), who compute own-price elasticity, cross-price elasticity and the ES of input demand. They also estimate economies of scale and the average cost function. The study uses the full information maximum likelihood method to analyze cross-section data for three different years (1996, 2000, and 2003), based on four inputs—labor, capital, electricity and transport. The Allen-Uzawa elasticity is estimated to check for substitutability among inputs. The study concludes that there are substitutable alternatives between considered inputs. Sterner (1989) also examines ES and factor demand for the Mexican manufacturing industry. The study uses data for a four-yearly census for 1968–81, which covers all the major industries. The average price elasticity of capital (–0.2) and material (–0.3) are least elastic among the five inputs, while the value is more elastic for labor (–0.5), fuel (–0.6), and electricity (–0.4).

Abdullah and Osman-Rani (1989) measure the AES using the translog cost function. The AES is calculated at mean-cost-share. The study's primary objective is to estimate the ES between labor and capital in the Malaysian manufacturing industry. A study to compute the ES for the years 1968, 1989, and 1984 shows that there is limited evidence of substitutability between labor and capital for Malaysian manufacturing industries.

Khalil (2005) estimates the translog cost function for the Jordanian manufacturing industry, using cross-sectional data for 2002. The study utilizes cost-shares, factor inputs, factor prices, and output and uses the iterative Zellner-efficient technique to achieve its objective. The results show that the Allen partial ES is constant but significant. The substitutability between capital and materials and between labor and materials is less than the substitutability for capital-labor. Heshmati and Haouas (2013) investigate scale economies in Tunisian industries, using time-series data and considering the restriction of increasing returns to scale and imperfect competition. Estimating a translog cost function, their results indicate that most industrial sectors have increasing returns to scale.

Kemal (1981) computes the ES between labor and capital for Pakistan's manufacturing sector. This study employs data from the Census of Manufacturing Industries (CMI) for Pakistan. The iterative maximum likelihood technique is used to calculate estimates. The ES between capital and labor is limited in most industries when computed through the VES model, and is significant for only three of sixteen industries in the case of the CES model. The study also provides a comparison of ES among the manufacturing sectors of different countries. The ES for Argentina's manufacturing sector is lower than that of Pakistan, while the ES for Chile and Israel is higher.

Chishti and Mahmood (1991) estimate energy demand for the industrial sector in Pakistan, including price and substitution elasticities between energy and nonenergy inputs. The study uses aggregate-level data for 1960–80. The translog production function is estimated using Zellner's iterative procedure for the cost equation. The results show that the ES between energy and employment is high, while the substitutability between employment and capital is limited. The ES between energy and capital is negative. These results indicate that the higher price of energy negatively affects investment in capital goods.

Zafar and Ahmed (2005) discuss allocative efficiency and ES in the manufacturing sector in Pakistan. They focus on the sector's cost structure and employ the translog cost function, using the CMI. The study uses the iterative Zellner-efficient technique to compute the parameters, and finds that raw materials contribute 85 percent to total cost. The results further indicate that the intensity of labor use decreases as the level of output increases, whereas this is not true for capital and raw material. The elasticities show that labor and raw material are substitutes while labor and capital have a complementary relationship.

Mahmood, Ghani and Din (2006) investigate the efficiency of large-scale manufacturing industries in Pakistan, using cross-sectional data for 1995/96 and 2000/01 and applying the stochastic production frontier approach. The results show that most industrial groups gained technical efficiency while some industries faced a deterioration in efficiency. Several factors may have caused this decline in firms' technical efficiency, including external competition and the trade policy environment.

The literature review above discusses studies on the agriculture and industrial sectors of different countries. Meta-analyses, like Costantini and Paglialunga (2014) for 21 OECD economies, and another by Berndt and Wood (1975) show weaker substitutability between energy and capital and between energy and labor. Similarly, Krishnapillai and Thompson (2012) have shown that electricity is a weaker substitute for labor and capital. In the case of the US agriculture sector, Erickson et al. (2003) demonstrate complementarity between capital and labor. Abdullah and Osman-Rani (1989) show limited capital and labor substitutability for Malaysia's industrial sector. For the Jordanian economy, Khalil (2005) finds relatively greater substitutability between labor and capital than between labor and material, and capital and material.

Like other developing countries, Pakistan has scarce capital and materials, but abundant labor (Zafar & Ahmed, 2005), and inadequate energy. Rushdi (1982) focuses on material and energy in a study of ES. ES has an interesting relationship with the type of data used to compute it—time-series data always yields a lower value than cross-section data (Kemal, 1981). This could be a result of cyclical phenomena and simultaneity between inputs and outputs (Kemal, 1981), while the ES between capital and labor remains limited (Diwan & Gujarati, 1968; U. A. Kazi, 1980). Zafar and Ahmed (2005) find a negative ES between labor and capital. However, this was statistically insignificant.

Studies on Pakistan's industrial sector by Kemal (1981) and Zafar and Ahmed (2005) show limited substitutability between labor and capital, while Chishti and Mahmood (1991) find a stronger ES between energy and employment.

Battese and Malik (1987) estimate the ES for selected manufacturing industries in Pakistan and compare their estimates with those of previous studies, claiming that their weighted least squares analysis yields more precise results of elasticities than S. Kazi et al. (1976) and Kazmi (1981), as both these studies use ordinary least squares (OLS) regression. Battese and Malik (1987) estimate that the ES between labor and capital is 1.31 for all industries. A further classified analysis shows that the ES for food industries is 1.38, assuming constant returns to scale (CRS). Thus, the literature suggests that the substitutability between labor and capital is not as strong in Pakistan's food processing industries.

3. Data and Methodology

This section describes the data and variable used and specifies the estimation model.

3.1. Data and Variables

The data used was obtained from the Pakistan Bureau of Statistics, specifically the five-yearly CMI. We have used the CMI 2005/06 for data for the food, beverages and tobacco sectors. The CMI provides microdata on all industrial units within these sectors.

The variables used are the price of labor, the price of capital, the price of energy, the price of material, and total output. Capital comprises total land area, dwellings, structures other than dwellings (buildings for machinery installation, etc.), machinery and equipment, and intellectual property as of 30 June every year. Depreciation is deducted from gross capital to calculate net capital. The total cost of capital is the sum of depreciation and opportunity cost. The opportunity cost is the best alternative forgone, which is considered the loss of interest earned. The CMI 2005/06 provides the amount of net capital as on 1 July 2005. The cost of capital or the price of capital (P_k) is computed using the following formulation:

$$C_k = K*(r+\delta) \tag{1}$$

where K is the amount of capital, r is the real interest rate, and δ is the rate of depreciation. The real interest rate for 2005/06 was 1.91 percent (Pakistan, Ministry of Finance, 2006). The CMI 2005/06 also provides the amount of depreciation, but about 45 percent of the observations are missing. Therefore, we calculate the amount of depreciation for different capital goods at the prescribed rates. The Federal Board of Revenue (2014) provides the rates of depreciation for different types of assets (Table 1).

Table 1: Rate of asset depreciation

Machinery and equipment	Buildings	Furniture	Office equipment
15%	10%	15%	30%

After calculating depreciation, the total user cost of capital is calculated using equation (1). The per-unit cost of capital is calculated by dividing the total user cost of capital by the total amount of capital:

$$P_k = C_k / K \tag{2}$$

Energy represents the consumption of gas, fuels and electricity by a firm during the year 2005/06. The CMI 2005/06 provides information on quantities used and expenditures made on petrol, diesel, gas and electricity separately. Since the energy used by firms falls under different categories and units of measurement, the price of each category of energy fuel is calculated by dividing cost by quantity. For the translog cost function, one price index is required. This price index is calculated through the weighted price of each energy type. The individual price is weighted by share of cost:

$$P_e = \sum P_{ei} * S_{ej} \quad i = j \tag{3}$$

where P, C, and S represent price, cost, and share of cost for petrol, diesel, gas, electricity, and other.

Material includes all inputs and raw material used during the year 2005/06. The variable is constructed similarly on the basis of cost-shares. Different materials with varying units of measurement are not weighted equally. Since the per-unit prices of a material with the lowest share of the total material cost and a material with a larger share of cost are not equally important, the price of each material input is weighted by its share of the total material cost:

$$P_m = \sum P_{mi} * S_{mj} \quad i = j \tag{4}$$

Labor comprises regular employees, casual employees, contractual employees, family members, and partners. Labor cost is the sum of all payments to these workers.

The CMI 2005/06 dataset contains information on the total number of days a firm operated, the average number of shifts per day, and the average number of employees differentiated by gender and by category—production workers, nonproduction workers, unpaid/paid family members, and active partners—for every production unit. This information is provided quarterly. The payment made against labor is annual and categorized by wages and salaries, other cash payments and payments in kind, and by labor type (production workers, nonproduction workers, unpaid/paid family members, and active partners).

The CMI 2005/06 segregates output into two categories: (i) main production activities and (ii) other activities. The dataset provides the value of production during FY2005/06 for each product.

3.2. Model Specification and Estimation

Our objective is to estimate cost as a function of factor prices and output. Both factor prices and output have a direct effect on total cost. The functional relationship is given below:

$$C = c(P_i, Q), \; i = \text{K, L, E, M} \tag{5}$$

Various functional forms have been developed to estimate the cost function. The functional form most commonly used is the transcendental logarithmic (translog) form developed by Christensen et al. (1973), which we use here for its flexibility and ease of computation.

The KLEM model is given below:

$$\begin{aligned}\ln C &= a_0 + a_q \ln Q + a_k \ln P_k + a_l \ln P_l + a_e \ln P_e + a_m \ln P_m + \tfrac{1}{2} a_{qq} (\ln Q)^2 + \tfrac{1}{2} a_{kk} (\ln P_k)^2 \\ &+ \tfrac{1}{2} a_{ll} (\ln P_l)^2 + \tfrac{1}{2} a_{ee} (\ln P_e)^2 + \tfrac{1}{2} a_{mm} (\ln P_m)^2 + \tfrac{1}{2} \gamma_{kl} \ln P_k \ln P_l + \tfrac{1}{2} \gamma_{ke} \ln P_k \ln P_e \\ &+ \tfrac{1}{2} \gamma_{km} \ln P_k \ln P_m + \tfrac{1}{2} \gamma_{le} \ln P_l \ln P_e + \tfrac{1}{2} \gamma_{lm} \ln P_l \ln P_m + \tfrac{1}{2} \gamma_{em} \ln P_e \ln P_m \\ &+ \gamma_{qk} \ln Q \ln P_k + \gamma_{ql} \ln Q \ln P_l + \gamma_{qe} \ln Q \ln P_e + \gamma_{qm} \ln Q \ln P_m \end{aligned} \quad (6)$$

C, Q, K, L, E, and M are cost, output, capital, labor, energy, and material, respectively, while the α and γ terms are the parameters of the model. To estimate these parameters, we impose symmetry and linearity restrictions on the model. According to Young's theorem, cross-partial derivatives are always equal.

$$\frac{\partial C}{\partial P_i \partial P_j} = \frac{\partial C}{\partial P_j \partial P_i}, \; ij = \text{K, L, E, M} \quad (7)$$

Linear homogeneity restrictions are imposed on equation (6) (Berndt & Wood, 1975) as follows:

$$\begin{aligned} &\alpha_k + \alpha_l + \alpha_e + \alpha_m = 1 \\ &\gamma_{kk} + \gamma_{kl} + \gamma_{ke} + \gamma_{km} = 0 \\ &\gamma_{ll} + \gamma_{lk} + \gamma_{le} + \gamma_{lm} = 0 \\ &\gamma_{ee} + \gamma_{el} + \gamma_{ek} + \gamma_{em} = 0 \\ &\gamma_{mm} + \gamma_{ml} + \gamma_{mk} + \gamma_{me} = 0 \end{aligned} \quad (8)$$

Closely following Banda and Verdugo (2007), the following models are estimated and tested for the significance for each category: (i) unrestricted model, (ii) homothetic cost model, (iii) homogeneous cost model, and (iv) CRS model. Next, we estimate models A1, B1 C1, and D1 by imposing a unitary ES restriction on models A, B, C, and D.

A number of other restrictions can be imposed on the translog cost function to identify the function's form. This applies whether the function is unrestricted, homothetic, homogeneous in output, or CRS. If a cost function is written as a separable function of factor prices and output, it is termed a homothetic cost function. The necessary and sufficient condition for homotheticity is:

$$\gamma_{qi} = 0 \tag{9}$$

A homothetic cost function becomes homogeneous in output if the cost elasticity of output is invariant of production. For estimation purposes, we impose the following restriction:

$$\gamma_{qq} = 0 \tag{10}$$

When a homogeneous cost function is further restricted with $\alpha_q = 1$, it becomes a CRS model. The translog cost function reduces to a Cobb-Douglas function when the CRS is subject to the following restriction:

$$\gamma_{ij} = 0 \tag{11}$$

The factor share equation S_i is the partial derivative for each factor input (Shephard's lemma). The sum of the shares is 1.

$$\frac{\delta \ln C}{\delta \ln P_k} = S_k = \alpha_k + \gamma_{qk} \ln Q + \gamma_{kk} \ln P_k + \gamma_{kl} \ln P_l + \gamma_{ke} \ln P_e + \gamma_{km} \ln P_m + \varepsilon_k \tag{12}$$

$$\frac{\delta \ln C}{\delta \ln P_l} = S_l = \alpha_l + \gamma_{ql} \ln Q + \gamma_{lk} \ln P_k + \gamma_{ll} \ln P_l + \gamma_{le} \ln P_e + \gamma_{lm} \ln P_m + \varepsilon_l \tag{13}$$

$$\frac{\delta \ln C}{\delta \ln P_e} = S_e = \alpha_e + \gamma_{qe} \ln Q + \gamma_{ek} \ln P_k + \gamma_{el} \ln P_l + \gamma_{ee} \ln P_e + \gamma_{em} \ln P_m + \varepsilon_e \tag{14}$$

$$\frac{\delta \ln C}{\delta \ln P_m} = S_m = \alpha_m + \gamma_{qm} \ln Q + \gamma_{mk} \ln P_k + \gamma_{ml} \ln P_l + \gamma_{me} \ln P_e + \gamma_{mm} \ln P_m + \varepsilon_m \tag{15}$$

We compute the Allen partial ES between inputs i and j using Uzawa's (1962) formulation. These are necessary to analyze the degree of substitutability and complementarity between inputs, and are computed as follows:

$$\sigma_{ij} = \frac{\gamma_{ij}}{S_i S_j} + 1 \tag{16}$$

Own-price and cross-price elasticities can be calculated using the following construction:

$$\eta_{ii} = \frac{\gamma_{ii}}{S_i} S_i - 1 \tag{17}$$

$$\eta_{ij} = \frac{\gamma_{ij}}{S_i} S_j \quad \text{and } i \neq j \tag{18}$$

The cost elasticity of output is the percentage change in the cost of production in response to a one-percent change in output. It is computed as a partial derivative of the translog cost function for output:

$$\frac{\delta \ln C}{\delta \ln q} = a_q + \gamma_{qq} \ln Q + \sum \gamma_{qi} \ln P_i \tag{19}$$

It is not possible to estimate the overall model because it yields biased estimates due to the multicollinearity problem. This problem can, however, be resolved through shared equations (12–15). The joint estimation of shared equations along with the general model cannot be carried out using OLS, and therefore, we use Zellner's iterative technique (Banda & Verdugo, 2007). Since the sum of shares is 1, the problem of singularity arises (Zafar & Ahmed, 2005). This difficulty is resolved by dropping one of the share equations (Christensen et al., 1973) and using only N – 1 share equations in the estimation (Barten, 1969; Kmenta & Gilbert, 1968). Zellner's iterative estimates are invariant to which equation is dropped (Barten, 1969).

Among these eight models, one best-fit model is selected using Akaike's information criterion (AIC) and the Bayesian information criterion (BIC). A model that produces fewer AIC indices is likely to be an adequate best-fit model (Everitt, 1998). The index is computed as follows:

$$AIC = -2L_m + 2m \tag{20}$$

where m represents the number of parameters in the model and L_m is the maximized log likelihood value.

Next, we calculate the bordered Hessian determinant. A well-behaved translog cost function must be concave. The cost function's concavity requires the bordered Hessian determinant to be negative semidefinite, while all estimated cost-shares must be positive. One of the limitations of the translog cost function is that it cannot assure global concavity. The formulation of the bordered Hessian determinant is given below (Segal, 2003):

$$|H| = \begin{bmatrix} 0 & \frac{S_k}{P_k} & \frac{S_l}{P_l} & \frac{S_e}{P_e} & \frac{S_m}{P_m} \\ \frac{S_k}{P_k} & \frac{1}{P_k^2(\gamma_{kk}+S_k(S_k-1))} & \frac{1}{P_kP_l(\gamma_{kl}+S_kS_l)} & \frac{1}{P_kP_e(\gamma_{ke}+S_kS_e)} & \frac{1}{P_kP_m(\gamma_{km}+S_kS_m)} \\ \frac{S_l}{P_l} & \frac{1}{P_kP_l(\gamma_{kl}+S_kS_l)} & \frac{1}{P_l^2(\gamma_{ll}+S_l(S_l-1))} & \frac{1}{P_lP_e(\gamma_{le}+S_lS_e)} & \frac{1}{P_mP_l(\gamma_{ml}+S_mS_l)} \\ \frac{S_e}{P_e} & \frac{1}{P_kP_e(\gamma_{ke}+S_kS_e)} & \frac{1}{P_lP_e(\gamma_{le}+S_lS_e)} & \frac{1}{P_e^2(\gamma_{ee}+S_e(S_e-1))} & \frac{1}{P_mP_e(\gamma_{me}+S_mS_e)} \\ \frac{S_m}{P_m} & \frac{1}{P_kP_m(\gamma_{km}+S_kS_m)} & \frac{1}{P_mP_l(\gamma_{ml}+S_mS_l)} & \frac{1}{P_mP_e(\gamma_{me}+S_mS_e)} & \frac{1}{P_m^2(\gamma_{mm}+S_m(S_m-1))} \end{bmatrix} \quad (21)$$

3.2.1. Zellner's Iterative Estimation Technique

Using OLS, a single equation can be estimated efficiently, but it produces inefficient and biased results for a system of equations. Zellner developed a procedure to estimate a system of equations in 1962, based on Aitken's generalized least squares and is asymptotically efficient. The procedure can be applied to microdata, cross-section data, and time-series data.

Suppose we have M equations and T observations. This can be written in equation form as:

$$Y_m = X_u b_u + \mu_u \quad (22)$$

The matrix form is given below.

$$\begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_m \end{bmatrix} = \begin{bmatrix} X_1 & 0 & 0 \\ 0 & X_2 & 0 \\ \vdots & \vdots & \vdots \\ 0 & 0 & X_m \end{bmatrix} \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_m \end{bmatrix} + \begin{bmatrix} \mu_1 \\ \mu_2 \\ \vdots \\ \mu_m \end{bmatrix} \quad (23)$$

The disturbance is an MT × 1 matrix, which is computed as:

$$\Sigma = \sum_C \otimes I \tag{24}$$

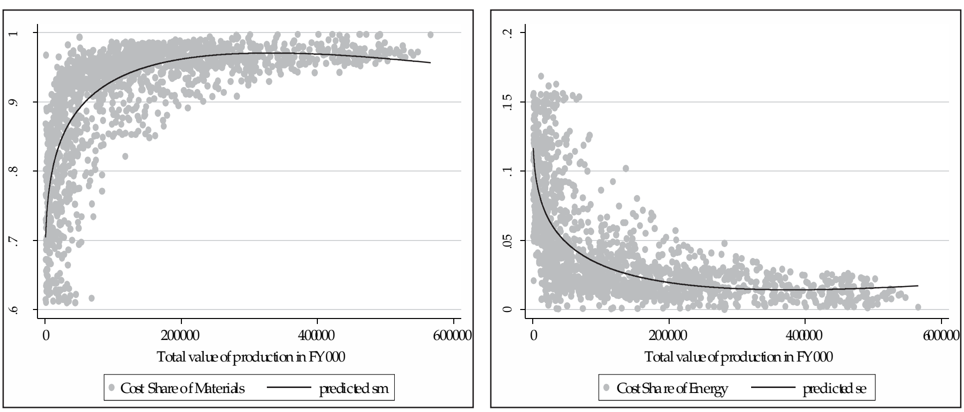
where Σ represents the variance-covariance matrix of the disturbance vector, Σ_c is the variance matrix, and I represents a unit matrix of T × T order. T represents time in the time-series data and assumes no autocorrelation between disturbance terms. In cross-sectional data, T represents the number of observations and follows the same assumptions.

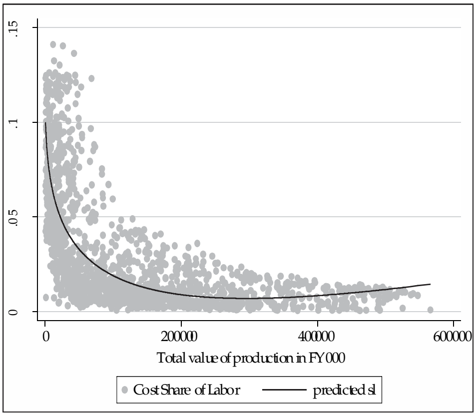
The estimation procedure uses weighted deviations. In the presence of heteroskedasticity, this weights the square of each deviation by the reciprocal of its variance instead of giving equal weights as in the case of OLS. In simple words, observations with a higher variance are given lower weights. Therefore, this procedure generates asymptotically efficient results.

4. Results and Discussion

The total number of observations is 1,710. The mean cost-share of labor, capital, energy, and material is 0.031, 0.026, 0.043, and 0.90, respectively. Material has the largest share of total cost and the share of capital is smallest. Manufacturers of cotton linter appear most frequently (540) in the dataset. The cost-share relationship with output for all input prices is presented in Figure 1 (see also Table 2). The cost-share of labor, capital and energy fall as production rises. Conversely, the cost-share of material increases as output rises.

Figure 1: Cost-shares of labor, capital, energy, and material





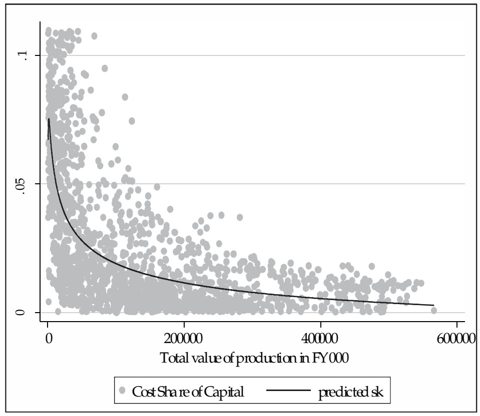


Table 2: Descriptive statistics

Variable	Obs.	Mean	SE	Minimum	Maximum
Price of capital	1,710	151.092	0.751	5.2	238.5806
Price of labor	1,710	282.1773	4.24	13.92157	895.5499
Price of material	1,710	18.04708	0.336	0.010754	64.88484
Price of energy	1,710	5.045733	0.0545	0.0009506	13.72417
Quantity	1,710	134,249.1	3,052.5	10	566,256
Total cost	1,710	130,756.8	3,003.899	493.5935	512,881

4.1. Results of Nonhomothetic Model

Table 3 presents the AIC and BIC values for eight models based on the CMI 2005/06 data. Of these eight models, one model with no prior restrictions represents the best-fit model for the data. This selection is based on the AIC and BIC as the model with lower AIC and BIC values is the better model (Everitt, 1998). The translog cost model is a well-behaved concave function because the estimated input cost-shares are positive and the bordered Hessian determinant is negative (Table 4).

Table 3: Model selection criteria

Criteria	Model-A	Model-B	Model-C	Model-D
AIC	-21,221.95	-20,538.868	-20,512.214	-19,526.904
BIC	-21,140.286	-20,473.537	-20,452.327	-19,472.461

Table 4: Symmetric bordered Hessian determinant

$$|H| = \begin{vmatrix} 0 & & & & \\ 0.00045705 & -0.00072799 & & & \\ 0.00025542 & 0.00192687 & -0.00054347 & & \\ 0.02365284 & 0.15858417 & 0.14690765 & -2.2158804 & \\ 0.08093242 & 0.02102324 & 1.1440833 & 5.4867258 & 0.04512649 \end{vmatrix} = -0.000003$$

Model-A is unrestricted and generates the lowest AIC value (–21,221.95). Therefore, the nonhomothetic model best represents the cost structure of the food, beverages and tobacco sectors in Pakistan for the year 2005/06. The CRS, homothetic and homogeneous structures are not true representations of the cost structure of Pakistan's food industries.

This section describes the results of the nonhomothetic model (Table 5). The estimates for nonhomotheticity (output-input *i*, *i* = K, L, E, M) and nonhomogeneity (squared output) are statistically significant, thereby endorsing the model selection criteria. The coefficients on output-input *i* indicate a change in the use of input intensity resulting from a variation in output (Zafar & Ahmed, 2005). The negative sign of the estimates indicates a reduction in the factor input share as output rises. Here, the estimates for nonhomotheticity with respect to capital, energy and labor are negative, which means that the intensities of these inputs fall at higher levels of output. The positive sign on the materials variable depicts the increasing intensity of materials with an increase in output and greater cost-share. This means that, to produce more food, beverages and tobacco items, firms need more raw materials than they do capital, energy and labor.

Table 5: Estimates of nonhomothetic model

Variable	Estimate	Variable	Estimate	Variable	Estimate	Variable	Estimate
Material	0.492136	Capital-energy	0.001567	Capital-material	-0.01197	Sq-energy	0.00206
t-value	30.07	t-value	4.57	t-value	-40.88	t-value	5.25
Capital	0.126956	Labor-energy	0.001737	Output-labor	-0.01432	Sq-material	0.03549
t-value	15.61	t-value	5.11	t-value	-23.76	t-value	43.13
Labor	0.143799	Output	-0.07117	Output-energy	-0.01804	Cons.	4.0775
t-value	18.94	t-value	-0.35	t-value	-32.89	t-value	3.69
Energy	0.237196	Sq- output	0.043052	Output-capital	-0.01162		
t-value	33.87	t-value	4.62	t-value	-20.95		
Sq-capital	0.003464	Material-labor	-0.01817	Output-material	0.043972		
t-value	3.41	t-value	-59.46	t-value	30.87		
Sq-labor	0.009493	Material-energy	-0.00536	Capital-labor	0.006936		
t-value	17.49	t-value	-13.78	t-value	13.98		

The demand for three inputs—capital, labor and energy—is fairly low in this sector. This also indicates the reduced cost-shares of capital, labor and energy at higher levels of output. These results support the nonhomotheticity of the cost function. The parameters estimated for material-input *i* (*i* = K, L, E) are negative, which means that the demand and cost-shares of labor, capital and energy decline as the price of material rises. These estimates are consistent with that of nonhomotheticity. The fixed cost-shares of each input are represented by labor, capital, energy, and materials. The fixed cost-shares of material and energy are greater than that of capital and labor due to energy crises and uncertainty in the supply of materials. Energy crises compel firms to invest in energy production, while inconsistent supplies encourage firms to stock more material inputs. On the other hand, firms need not pay labor unnecessarily to bind them contractually because high unemployment makes it easier to hire new, qualified, and skilled workers.

The fixed cost-share of capital is lowest among the four inputs because there are fewer capital-intensive industries. All other parameters, *i*, *j* (*i*, *j* = K, L, E, M) in the cost-share equations are positive, which implies expanding cost-shares of the four inputs as input prices rise. The price of material is the largest contributor to the cost-share of material. All four cost-share equations show positive second derivatives. Therefore, cost-shares change in the direction of price and output changes.

4.2. Elasticities

The elasticities measured here are AES, cross-price elasticity, own-price elasticity, and the cost elasticity of output. AES measures the substitutability or complementarity between two factor inputs (Uzawa, 1962). This describes the degree of substitution or complementarity between input factors and is measured in percentage terms. Specifically, we define it as the 'percentage change in factor proportion' in response to a one-percent variation in their 'relative prices' (Banda & Verdugo, 2007). A positive (negative) value of elasticity indicates substitution (complementarity).

Cross-price elasticity is the percentage change in the quantity demanded of a commodity as a result of a one-percent change in the price of its substitute or complement, while own-price elasticity depicts the percentage change in the quantity demanded of a good due to a one-percent variation in its own price. The output elasticity of cost is defined as the responsiveness of total cost resulting from a change in total output. It is also measured in percentage terms and is the ratio of average cost to marginal cost. A small value for the output elasticity of cost shows that the average cost lies above the marginal cost and vice versa. The average cost curve declines while the marginal cost curve has a positive slope (Besanko & Braeutigam, 2013).

4.2.1. *Own-Price Elasticities*

Own-price elasticities are presented in Table 6. Own-price elasticities and cost-shares have a very close relationship. An input that has a smaller share of the total cost becomes more elastic and vice-versa. In this study, material has a 90 percent share of the total cost and its own-price elasticity is very low (–0.08663), while energy has a lower share of the total cost and its elasticity approaches 1. Here, all four elasticities are negative, indicating a negative relationship between the quantity demanded and own prices. Capital and labor have marginal shares in the total cost and both inputs' elasticities are significantly higher than the own-price elasticity of material.

Table 6: ES and own-price elasticities

ES		Own-price elasticity	
Variable	**Value of elasticity**	**Variable**	**Value of elasticity**
Material-energy	0.8570	Labor	-0.6510
Material-capital	0.4877	Capital	-0.84029
Capital-energy	2.4578	Energy	-0.9089
Material-labor	0.3233	Material	-0.08663
Labor-capital	10.011		
Labor-energy	2.4064		

4.2.2. *Elasticities of Substitution*

Table 6 presents six values of ES between inputs. In the food sector, there is a high level of substitution between labor and capital (10.011). This indicates that labor is still important in the food sector and that, during a shortage of capital, labor is a good alternative. This supports a developing country because the sector can absorb more labor.

However, it is worrying that the country's capitalization process is still very slow. Earlier studies on food processing industries (see Battese & Malik, 1988; S. Kazi et al., 1976; Kazmi, 1981; Kemal, 1981) show very low values (less than unity) of ES of labor for capital. The ES for material indicates substitutability with energy because it approaches 1 (0.8570). The small estimates of elasticities of material with respect to labor (0.3233) and capital (0.4877) indicate a tendency toward complementarity instead of substitution. Energy can be substituted with capital (2.4578) and labor (2.4064) by a greater amount if the relative price changes. The results indicate that labor is a good substitute for capital and energy.

4.2.3. Cross-Price Elasticities

Cross-price elasticities are presented in Table 7. All the cross-price elasticities are less than 1. A change in the price of material produces no significant variation in the demand for labor (0.009), capital (0.012) and energy (0.035). Labor and capital are almost equally responsive to variations in each other's prices (0.25 and 0.29). The demand for material varies with a change in the prices of labor, capital and energy. The price of energy has the highest effect on demand for material (0.77) and then capital (0.44).

Table 7: Cross-price elasticities

Variable	Value of elasticity	Variable	Value of elasticity
Material-energy	0.03559	Energy-material	0.7737
Material-capital	0.01262	Capital-material	0.4403
Capital-energy	0.06362	Energy-capital	0.10208
Material-labor	0.00961	Labor-material	0.29189
Labor-capital	0.2591	Capital-labor	0.2977
Labor-energy	0.09994	Energy-labor	0.07156

4.2.4. Output Elasticity of Cost

The value of the output elasticity of cost is 0.3329, which shows that the rise in total cost is less than the increase in total output. Firms do not operate at a minimum level of cost; instead, they produce at a lower level of output than the optimal production level. The average cost curve of the industry lies above the marginal cost curve. The average cost is higher than the minimum level, which indicates the presence of economies of scale. In such circumstances, profitability rises with an increase in production.

5. Conclusion and Policy Recommendations

The study estimates the transcendental logarithmic cost function by applying Zellner's iterative methodology to Pakistan's food industry. We estimate Allen's partial ES, cross-price elasticities, own-price elasticities, and output elasticities of cost, which show strong substitution between labor and capital. Contrary to earlier studies (see Battese & Malik, 1988; S. Kazi et al., 1976; Kazmi, 1981; Kemal, 1981), the substitution of labor for capital has increased in food-processing industries. Capital and energy are good substitutes, but the substitutability between material and capital and between material and energy is significantly lower.

The share of materials in cost is as high as 90 percent. The own-price elasticities indicate that material input is the least responsive to a change in its own price, while the other three inputs vary in terms of own prices with a change in demand. The cross-price elasticities show that labor and capital are substitutes. The cost elasticity of output demonstrates the presence of economies of scale. Our analysis indicates that the intensity of capital, labor and energy declines as the level of production increases. The intensity of material use increases as output rises.

These findings imply that the strong substitutability between labor and capital can help a country such as Pakistan substitute labor for capital. This, in turn, can have a significant impact on reducing unemployment and poverty. Similarly, that materials have the highest share in costs suggests that its productivity should be enhanced. The major share of the input 'materials' to food industries comes from the agriculture sector. Hence, the cost of food industries depends largely on productivity in the agricultural sector. The cost of food industries and the cost of food could be reduced significantly by adopting modern technologies and making agricultural production more efficient.

References

Abdullah, M., & Osman-Rani, H. (1989). A translog cost estimation of capital-labour substitubility in Malaysian manufacturing sector. *Jurnal Ekonomi Malaysia*, *20*, 43–60.

Banda, H. S., & Verdugo, L. E. B. (2007). *Translog cost functions: An application for Mexican manufacturing* [Working paper]. Banco de México.

Barten, A. P. (1969). Maximum likelihood estimation of a complete system of demand equations. *European Economic Review, 1*(1), 7–73.

Battese, G. E., & Malik, S. J. (1987). Estimation of elasticities of substitution for CES production functions using data on selected manufacturing industries in Pakistan. *Pakistan Development Review, 26*(2), 161–177.

Battese, G. E., & Malik, S. J. (1988). Estimation of elasticities of substitution for CES and VES production functions using firm-level data for food-processing industries in Pakistan. *Pakistan Development Review, 27*(1), 59–71.

Berndt, E. R., & Wood, D. O. (1975). Technology, prices, and the derived demand for energy. *Review of Economics and Statistics, 57*(3), 259–268.

Besanko, D., & Braeutigam, R. (2013). *Microeconomics* (5th ed.). Wiley.

Chishti, S., & Mahmood, F. (1991). The energy demand in the industrial sector of Pakistan. *Pakistan Development Review, 30*(1), 83–88.

Christensen, L. R., Jorgenson, D. W., & Lau, L. J. (1973). Transcendental logarithmic production frontiers. *Review of Economics and Statistics, 55*(1), 28–45.

Costantini, V., & Paglialunga, E. (2014). *Elasticity of substitution in capital-energy relationships: How central is a sector-based panel estimation approach?* [Working paper]. http://www.sustainability-seeds.org/papers/RePec/srt/wpaper/1314.pdf

Diewert, W. (1971). An application of the Shephard duality theorem: A generalized Leontief production function. *Journal of Political Economy, 79*, 481–507.

Diwan, R. K., & Gujarati, D. N. (1968). Employment and productivity in Indian industries – Some questions of the theory and policy. *Artha Vijnana, 10*(1), 29–67.

Erickson, K. W., Moss, C. B., Nehring, R., & Ball, V. E. (2003). A translog cost function analysis of US agriculture, 1948–1999. *Western Agricultural Economics Association, 64*(3), 490–498.

Everitt, B. S. (1998). *The Cambridge dictionary of statistics*. Cambridge University Press.

Heshmati, A., & Haouas, I. (2013). Economies of scale in the Tunisian industries. *International Journal of Economics and Finance, 5*(1), 48–64.

Kazi, S., Khan, Z. S., & Khan, S. A. (1976). Production relationships in Pakistan's manufacturing industries. *Pakistan Development Review, 15*(4), 406–423.

Kazi, U. A. (1980). The VES production function: A case study for Indian manufacturing industries. *Oxford Economic Papers, 32*(1), 163–175.

Kazmi, N. (1981). *Elasticities of substitution in the small-scale manufacturing industries of the Punjab* (Research Report Series No. 122). Pakistan Institute of Development Economics.

Kemal, A. R. (1981). Substitution elasticities in the large-scale manufacturing industries of Pakistan. *Pakistan Development Review, 20*(1), 1–36.

Khalil, A. (2005). A cross section estimate of translog production function: Jordanian manufacturing industry. *Topics in Middle Eastern and North African Economies, 7,* 1–14. http://www.luc.edu/orgs/meea/volume7/khalil.pdf

Kmenta, J., & Gilbert, R. F. (1968). Small sample properties of alternative estimators of seemingly unrelated regressions. *Journal of the American Statistical Association, 63*(324), 1180–1200.

Krishnapillai, S., & Thompson, H. (2012). Cross section translog production and elasticity of substitution in US manufacturing industry. *International Journal of Energy Economics and Policy, 2*(2), 50–54.

Mahmood, T., Ghani, E., & Din, M. (2006). Efficiency of large-scale manufacturing in Pakistan: A production frontier approach. *Pakistan Development Review, 45*(4), 689–700.

McFadden, D. (1963). Constant elasticities of substitution production functions. *Review of Economic Studies, 30*(2), 73–83.

Pakistan, Federal Board of Revenue. (2014). *Taxpayer's facilitation guide.* Government of Pakistan.

Pakistan, Ministry of Finance. (2006). *Pakistan Economic Survey 2005/06*. Government of Pakistan.

Pakistan, Ministry of Finance. (2019). *Pakistan Economic Survey 2018/19*. Government of Pakistan.

Rushdi, A. A. (1982). Factor substitutability in the manufacturing industries of Bangladesh: An application of the translog cost model. *Bangladesh Development Studies, 10*(2), 85–105.

Segal, D. (2003). A multi-product cost study of the US life insurance industry. *Review of Quantitative Finance and Accounting, 20*, 1–33.

Sterner, T. (1989). Factor demand and substitution in a developing country: Energy use in Mexican manufacturing. *Scandinavian Journal of Economics, 91*, 723–739.

Uzawa, H. (1962). Production functions elasticities of substitution. *Review of Economic Studies, 29*(4), 291–299.

Zafar, S., & Ahmed, E. (2005). Evidence on allocative efficiency and elasticities of substitution in the manufacturing sector of Pakistan. *Pakistan Development Review, 44*(4, Part 2), 795–803.

Zellner, A. (1962). An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. *Journal of the American Statistical Association*, *57*(298), 348–368.

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Regional Economic Integration and Productivity Convergence: Empirical Evidence from East Asia

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Abstract

The study attempts to seek evidence on regional economic integration in driving labor productivity convergence in low- and middle-income East Asian states towards Japan, the country assumed to be the regional technology leader. The labor productivity convergence of low- and middle-income East Asian countries towards their rich neighbor is modelled against their national levels of innovation, technology spill-overs from the regional economic leader and their productivity differential with the frontier country. The hypothesized relationship is empirically verified for seven East Asian states, using a robust econometric approach. The time-series test estimates under Error Correction Representation yield absolute support in favor of valid productivity convergence occurring between Japan and its low-and middle income neighbors. However, panel data estimates generated with better statistical power outperform the time-series test findings and these results reject the significance of Japan as the regional productivity growth driver for its regional developing states.

Keywords: Regional economic integration, productivity convergence, growth spill-over, time-series error correction model, panel cointegration estimators

JEL Classification: E24, F15.

1. Introduction

The region of East Asia has seen unprecedented growth rates over the last four decades. Episodes of financial crisis, such as that which erupted in 1997-98 temporary slowed regional economic growth. After this crisis, not only did the high- and average- income regional states recover speedily but also those with low income levels overcame this financial set back with considerable speed, showing sustained rates of economic growth in the post-crisis period. Low-income countries like Cambodia, Lao Republic and Vietnam outpaced their pre-crisis growth performance in the

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post-crisis period (IMF, 2007). A number of studies attribute this region wide post-crisis financial stability towards the heightened intra-regional trade and investment linkages, primarily carried out under the economic cooperation agreement of ASEAN and various other multilateral agreements (Fukuda & Toya, 1995; Hsiao & Hsiao, 2004; Mutaqin & Ichihashi, 2012; Solarin et al., 2014).

The proponents of regional economic integration advocate enhanced economic linkages for regions where there are sharp income differences across member states. With the prospect of spillover effects of technology transfer, economic integration through trade, capital exchange and labor migration between developed and developing neighbor states is found to serve as a growth driver at the regional level. Presumably, such economic connections tend to bridge the income disparities amongst the neighbor countries, besides benefitting poorer states with the growth inducing effects of technological advancements and research and development taking place in developed countries. For a set of 24 advanced and developing economies, Coe and Helpman (1995) and Coe at al. (2009) establish significant and measurable impacts of domestic and foreign research and development (R&D) capital stocks for total factor productivity (TFP) growth in catching-up countries. Griffith et al. (2004) investigate the (presumed) role of R&D in enhancing technology transfer for a set of 12 OECD member states and find R&D to be a statistically signficiant determinant in the catch-up process as well as in the direct stimulation of innovation. Cameron (2005) finds significant connections between technology transfer (from the U.S.) and TFP for manufacturing sector industries in the UK. For Turkish manufacturing firms, a positive long-run association between total factor and labor productivity is found by Yasar and Morrison (2008), which is induced by foreign direct investment, exports and imports. Xu (2000) investigates U.S. multinational enterprises (MNEs) as a channel of international technology diffusion in 40 countries and finds that the technology transfer provided by them significantly contributes to productivity growth in developed countries, though not in less developed ones. This is because a country needs to reach a minimum human capital threshold level in order to benefit from said technology transfer, and most less developed economies do not meet this requirement.

In this study, we investigate the role of developed East Asian economies In the growth of national productivity in developing regional economies. Considering Japan as the regional economic leader, we aim to verify the country's research and development spillover effects in inducing productivity (income) convergence to low income countries of East Asia.

A vast number of studies have empirically verified the role of labor productivity growth in determining the trend patterns of a country's economic performance. During the last two and half decades, the high income states of the region have shown tremendous growth in their national per worker productivity levels. Before the period of 1990s, Japan's average labor productivity level was substantially higher than its neighbor states. However, in the early 1990s, Hong Kong and Singapore caught up and outpaced Japan in their national levels of average labor productivity. Starting in 2000, Singapore overtook both Japan and Hong Kong with national labor productivity levels of 75.6 percent, 90.2 percent and 92 percent (with 2010 as reference year) during the years 2000, 2009 and 2011, respectively (Asian Productivity Organization, 2013).

Nevertheless, the impressive rates of labor productivity catch up in East Asia is only evident for high income regional states. Looking at the middle and lower tier countries, their national labor productivity levels remained alarmingly low, relative to Japan, Hong Kong and Singapore despite their visible growth performance,. The three classic examples are Indonesia, Philippines and Thailand: With 2010 as the base year, the three countries report growth in per worker productivity levels of 2.5 to 9.5 percent, 6.8 to 9.2 percent and 3.6 to 15.4 percent (respectively) for the years 1970 to 2011. These statistics for low-income East Asian states not only reflect serious stagnation in their national labor productivity levels but also highlight their overwhelmingly large gaps relative to the above referred high-income neighboring economies.

2. Literature Review

A primary impetus in establishing regional economic linkages between countries is to reduce income disparities and encourage inclusive growth, so that the benefits of enhanced economic relationships could be reaped by all. Owing to the importance of outward orientation (i.e., openness to trade and foreign direct investment), and human capital investment, Lim and MacAleer (2000) conduct a robust econometric analysis to investigate the degree of output convergence and technology catch-up for South East Asian countries amongst each other and also with U.S. The study finds no concrete evidence in support of significant productivity convergence of the ASEAN-5 countries twith the technology leaders i.e., United States as well as High Performing Asian Economies (HPAEs). For a group of ten East Asian economies, Zhang (2001) attempts to establish a connection between income convergence, regional trade and FDI flows but finds no significant association between the variables. Joian (2002) under the theoretical predictions of neoclassical growth models shows that there remain sharp income disparities between high and low-income East Asian countries. Similarly, Michelis and Neaime (2004) obtain partial support in favor of real per capita GDP convergence amongst APEC -17 countries and East Asian countries; rather, income divergence is empirically evident in the case of ASEAN countries.

Mahmood and Afza (2008) reveal two interesting observations on East Asian total factor productivity (TFP) growth dynamics. (i) region-wide TFP growth is primarily driven by technology improvements at the country level, rather than improvement in production efficiency or any other factor, and (ii) trade openness and foreign direct investment are not found to be significant determinants of TFP growth and its components.

Franks et al. (2018) examine the extent of economic integration taking place in the European Union (EU) region across multiple dimensions of the macroeconomy. Their results reveal that since the adoption of the common currency, nominal convergence of inflation and interest rates has taken place. Nevertheless, real convergence in the form of real per capita income has been negligible. This is particularly true for original euro area member states, where income convergence remained stagnant during the early years and turned into divergence in the times of global financial crisis. The study advocates adoption of measures effective for boosting productivity growth in lagging countries, so that income convergence at an at least modest rate might be ensured. Grabner et al. (2019) reveal the significance of country-specific characteristics for understanding how economic and financial openness to shocks cause path-dependent development trajectories in the context of European integration, confirming the lack of a sufficient degree of convergence. The non-convergence is more pronounced in terms of technological capabilities, which otherwise are expected to serve as key for determining future development paths of the regions.

Considering the studies cited above, it appears that findings of deficient convergence is common when convergence is measured using national aggregates. In contrast, a few recent studies investigating the convergence patterns of real output and technical efficiencies at sectoral/industry level yield more encouraging results. Studying the magnitude of convergence in technical efficiency and productivity levels of the health care systems of twenty-six EU members, Kasman et al. (2019) find valid convergence for sample countries. Measuring technical efficiency scores for the health care systems through DEA, a non-parametric production frontier approach, and productivity through TFP, their estimates (acquired through both and convergence measures) confirm significant existence of cross-country sectoral (health care) convergence in terms of technical efficiency as well as productivity. In gauging the degree of economic integration for the corporate sector of the U.S. and the European states, Valsan and Druica (2020) test convergence in terms of economic performance, institutional arrangements, and market valuation along industry lines. They conduct an industry-driven cluster analysis, relying on six measures of economic coherency pertaining to operating performance, ownership, and market valuation and find European candidates better at persuing convergence (relative to the U.S.), yielding clusters with higher degree of stability.

Given the considerably sluggish labor productivity growth performance of low-income East Asian countries, it is of critical importance to investigate which of macroeconomic factors can (potentially) boost the productivity (income) convergence of the poorer states towards their richer counterparts. Focusing such factors in the perview of macroeconomic policy actions may facilitate the lower tier East Asian economies in their efforts to catch up their high income neighbors.

3. Theoretical Framework

The world economy is comprised of two countries only, $i \in (1, 2)$. Each country produces n number of differentiated commodities (p_i), $i = 1, \cdots\cdots\cdots, n$. For both countries, production patterns are analogous to the neoclassical production function:

$$Q_{it} = A_{it}F(L_{it}, K_{it}) \tag{1}$$

Q = National output

A = Index of technical efficiency – the part of output unexplained by labor and capital, also known as TFP. A may vary across countries.

L = Employed labor

K = Capital stocks

Function F is linearly homogenous and is subject to diminishing marginal returns to the stocks of both labor and capital.

It is assumed that at time t, one of the two countries i will outperform the other in terms of productivity growth. This country is titled as the *technological frontier* and is symbolized by *F*. The other country, lagging behind the frontier country, is indexed by *H*. For this study, Japan will serve as the frontier country (*F*) and rest of the East Asian states (individually) are taken as its less developed counterparts (*H*).

Bernard and Jones (1996a, 1996b), Cameron et al., (2005) and Kutan and Yigit (2009) prescribe the following patterns of productivity growth in country H, induced by domestic innovation and technology spillovers from the frontier economy,

$$q_{Ht} = \vartheta_H + \rho_H \left(\frac{q_{Ft-1}}{q_{Ht-1}}\right), \qquad \vartheta, \rho \geq 0 \tag{2}$$

ϑ_H = measure of domestic (country-specific) rate of innovation in the less developed country (*H*)

ρ_H = measure of technology transfer from country *F* to country *H*

The small letters are representative of the fact that model variables are subject to logarithmic transformation. In equation (2), $\left(\frac{q_{Ft-1}}{q_{Ht-1}}\right)$ is the distance variable[1], parameterizing the rate of technology transfer from country F to country H. Productivity convergence, induced by the technology transfer from country F to country H, of each less developed East Asian state is directly determined by the size of this distance variable. The farther the country H lies from country F, the larger is the productivity differential between the two countries. Resultantly, the ratio (of productivity of H to that of F) becomes smaller, yielding larger value on part of distance variable (where the series is considered in absolute form).

Equation (2) holds valid for less developed East Asian states only. For the frontier country, the sole source of productivity growth is its time varying levels of domestic innovations. Accordingly, the productivity growth patterns for frontier country (*F*) can be given as:

$$q_F = \vartheta_F, \qquad \vartheta \geq 0 \tag{3}$$

Where ϑ_F is the measure of domestic (country-specific) rate of innovation in the frontier country (*F*).

[1] Whilst estimating the model empirically, the distance variable will be measured by the absolute of natural logarithmic ratio of productivity of each East Asian country to the productivity of Japan.

To see the trend movements of relative productivity of country *F* and country *H*, as determined by domestic levels of innovation and cross-country technological transfers, equation (2) and (3) are combined as follows:

$$\frac{q_{Ht}}{q_{Ft}} = (\vartheta_H - \vartheta_F) - \rho_H \left(\frac{q_{Ht-1}}{q_{Ft-1}}\right), \qquad (4)$$

For the purpose of estimating the proposed model empirically, equation (2) will be tested under the Error Correction (EC) representation of productivity growth. The EC process will model the self-induced corrections of relative productivity (between country *H* and country *F*) movements, making the series converge to its long-run or steady-state levels. The steady-state or long-run equilibrium level of relative productivity series necessitates that the productivity of country *H* should lag an equilibrium distance behind its counterpart in the frontier country. Only then, the productivity growth in country *H*, induced by domestic innovation and technology transfer from country *F*, can be exactly equal to productivity growth in country *F*, induced by country's domestic levels of innovation. Mathematically, this condition of steady-state relative productivity between two countries is analogous to $\frac{q_H^*}{q_F^*} < 0 <=> \vartheta_F > \vartheta_H$. Thus, from equation (4), the above discussed steady-state or (long-run) equilibrium level of relative productivity ($\tilde{q}^*$) between country *H* and country *F* can be obtained as follows:

$$\tilde{q}^* \equiv \frac{q_H^*}{q_F^*} = \frac{\vartheta_H - \vartheta_F}{\rho_H} \qquad (5)$$

Where

q_H^* =Steady-state level of country *H*'s productivity

q_F^* =Steady-state level of country *F*'s productivity

Equation (5) implies that steady state level of relative productivity between country *H* and country *F* is a function of their domestic innovation differential (gap) and the rate of technology transfer from country *F* to country *H*.

Until now, ϑ_i is used to parameterize the domestic innovation level at country *H* and *F*. Nevertheless, a vast amount of theoretical and empirical literature attributes the domestic innovation levels of a country to the levels of its R&D. It is also evident from literature that R&D levels enhance the "absorptive capacity", hence, can be a potential determinant of technology transfer from more developed to less developed countries. Theoretical and empirical literature on endogenous growth models also raise the importance of international trade (exports and imports more prominently) and human capital in triggering innovation and/or technology transfer effects whilst explaining trend growth patterns of economies (Aghion et al., 1998; Ben-David & Loewy, 1998; Griliches & Litchnberg, 1984; Lawrence & Weinstein, 2001). It is thus legitimate to model both domestic innovation (ϑ_i) of country H and technology transfer (ρ_H) from country F to country H against country H's R&D, international trade, and the levels of human capital:

$$\vartheta_{Ht} = \mu_H + \gamma X_{Ht} \tag{6A}$$

$$\rho_H = \delta + \tau X_{Ht} \tag{6B}$$

Where X measures $R\&D$, international trade, and human capital. Incorporating equation (6A) and (6B) into equation (2), the (econometrically) long-run estimable version of our productivity convergence model for less developed country (H) is given as:

$$q_{Ht} = \mu_H + \gamma X_{it-1} + \delta\left(\frac{q_{Ft-1}}{q_{Ht-1}}\right) + \tau X_{it-1}.\left(\frac{q_{Ft-1}}{q_{Ht-1}}\right) + \varepsilon_t \tag{7}$$

From equation (7), the level term (γX_{it-1}) captures the direct relationship between country H's R&D, international trade, and human capital with its productivity through domestic innovation. On the other hand, the interaction term ($\tau X_{it-1}.\left(\frac{q_{Ft-1}}{q_{Ht-1}}\right)$) establishes the same above stated linkage through technology transfer from country F to country H. It is noticeable that the model suggests heterogeneous or country-specific levels of domestic innovation and technology transfer, conditional upon national R&D, international trade, and human capital levels.

4. Empirical Estimation Framework

The rate of productivity convergence induced by domestic innovation levels and technology transfer from the frontier country to less developed states of East Asia is measured through the Error Correction Model (ECM), using a Newey-West (NW) HAC OLS estimator. A number of cointegration-based methods are suggested by related studies for empirically verifying the phenomenon of convergence (Aubyn, 1999; Giles, 2005; Lluís Carrion-I-Silvestre & German-Soto, 2007). Among these, the class of residual-based cointegration tests hold a special place, being simple in computation with straightforward interpretations using economic theory. Under the residual-based cointegration approach, the existence of cointegration between two or more time-series implies that they have a meaningful association: It is this association which prevents the residuals from becoming larger and larger in the long-run. The model estimates the speed of adjustment of regressors from short-run disequilibrium to long-run equilibrium. The lagged residuals from equation (7) (in static form) will be modelled against q_{Ht} (along with lagged values of model parameters) under a dynamic representation. In the context of productivity convergence dynamics (proposed in equation (7)), the error correction process (if statistically significant) estimates the speed of convergence/correction made by q_{Ht} from its short-run misalignments to converge to a long-run equilibrium (steady-state), through its own periodic movements as well as the periodic movements of other model parameters.

Like any other conventional cointegration model, the ECM is equally efficient in capturing the plausible presence of long-run association between variables, if there exists any. According to the Granger representation theorem, if q_{Ht} and the model determinants (of equation (7)) are cointegrated, only then, there will exist a valid error correction process relating these variables and vice versa.

The long-run regression given in equation (7) may be used in the following ECM, with the remaining parameters being consistently estimated by the NW HAC OLS estimator.

$$q_{Ht} = \mu'_H + \sigma\left[q_{Ht-1} - \gamma X_{it-1} - \delta\left(\frac{q_{Ft-1}}{q_{Ht-1}}\right) - \tau X_{it-1}.\left(\frac{q_{Ft-1}}{q_{Ht-1}}\right)\right]_{t-1} + \sum_{j=1}^{m}\Delta q_{Ht-j}\sum_{j=0}^{k}\Delta\gamma' X_{it-j} + \sum_{j=0}^{k}\Delta\tau' X_{it-j}.\left(\frac{q_{Ft-1}}{q_{Ht-1}}\right) + \varepsilon'_t, \quad (8)$$

In equation (8), the augmented version of the ECM is established, where difference-lagged terms of q_{Ht} and explanatory variables are allowed to contribute to the short run dynamics of the model. Note that a valid error correction (convergence towards long-run steady-state) process necessitates that the estimated coefficient ρ in the ECM equation (8) should bear a negative sign ($\hat{\sigma} < 0$) and be statistically significant.

Once a statistically significant error correction process is established, a cointegration regression estimator can be used to obtain long-run slope coefficients of model variables. For this purpose, the study employs Fully Modified OLS (FMOLS), devised by Phillips and Hansen (1990). FMOLS is shown to perform better in small samples. The usefulness of the estimator can be gauged from its ability to correct for endogenity bias and serial correlation using a semi-parametric regression, thus allowing for standard normal inference. The test can identify long-run parameters from static level regressions when the variables are first-order integrated.

5. Data Description and Sample Countries

For estimating the model parameters in equation (8), the data is taken primarily from (a) World Development Indicators (WDI) database, (b) United Nations Educational, Scientific and Cultural Organization (UNESCO) Statistical Year Book (statistical tables), and (c) United Nations Conference on Trade and Development (UNCTAD). The sample period varies from country to country, ranging from 1980 to 2017 and sample countries including China, Hong Kong[2], Korea, Malaysia, the Philippines, Singapore, and Thailand as less developed neighbor economies of Japan, serving as the developed frontier country of the region. As per the definition of WDI and UNESCO Statistical Year Book, the model variables[3] can be described as follows.

i. *National Productivity*: This is the model regressand (with its lagged values and its ratio with its counterpart in frontier country (the distance variable) serve as model explanatory variables). It is measured as the average annual productivity of labor (Baumol, 1986; Kang and Peng, 2018; Quintana-Romero et al., 2019) and formulated as GDP at constant market prices (2010) from WDI as a ratio of the total employed labor force of the country taken from UNCTAD.

ii. *National Rate of Innovation*: For this study, rate of innovation (one of the model regressors) in less developed East Asian counties is analogous to country’s annual R&D expenditures. The variable is measured through annual expenditures on R&D as a percentage of that year’s GNP, sourced from UNESCO Statistical Year Book. This follows a number of studies measuring technological growth similarly (Cameron et al., 2005; Cincera, 2005; Terleckyj, 1980; Zachariadis, 2003;).

iii. *National Levels of Human Capital Formation*: Following Schultz (1960), Khaemba (2014) and de Pleijt, (2018), this l explanatory variable is measured through the total (annual) number of secondary education

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[2] For Hong Kong and Malaysia, the sample data period ranges from 1996 to 2017. For China, the sample data set is for 1987 to 2017.

[3] The variables are used for model estimation after undergoing a natural logarithmic transformation.

pupils enrolled in public and private schools and colleges. The series is taken from the WDI database.

iv. National Levels of Net Exports: This is another model regressor accounting for the degree of openness of the home country towards international goods and services market. The variable is composed of the difference between country's total annual exports and imports measured at 2010 constant market prices. The export and import series are taken from the WDI database.

6. Results for Individual Country Analysis

Before discussing our main estimations, we estimate a correlation matrix of residuals and model regressors of equation (7), the model regressors being an obvious suspect for introducing endogenity bias. This is particularly true for international trade, in the context of the trade-growth connection. Existing literature has paid much attention to detecting and dealing with the problem of endogenity (Cameron et al., 2005; Kutan & Yigit, 2009). A strong covariance (correlation) between model regressors and the residuals of equation (7) can be taken as an evidence in support of plausible presence of endogenity in regressors (Wooldridge, 2015).

From the estimated correlation matrix, a correlation coefficient of value of 1 or -1 (or sufficiently far from zero) will be taken as an evidence in favor of significant endogenity bias in the explanatory variables, and vice versa.

Table 1: Correlation Matrix of Residuals from Equation (7) and Model Regressors

	$\hat{\varepsilon}$ Hong Kong	$\hat{\varepsilon}$ China	$\hat{\varepsilon}$ Korea	$\hat{\varepsilon}$ Malaysia	$\hat{\varepsilon}$ Philippines	$\hat{\varepsilon}$ Singapore	$\hat{\varepsilon}$ Thailand
Residuals ($\hat{\varepsilon}$)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
R&D	0.00	-0.02	-0.25	-0.02	-0.01	-0.19	-0.01
Human Capital	0.01	-0.06	0.02	-0.07	-0.16	-0.11	-0.15
International Trade	-0.04	-0.05	-0.51	-0.01	-0.09	0.09	-0.23
Productivity Differential	0.01	-0.03	-0.40	0.02	0.02	-0.09	-0.10

Notes: *(i) All the model variables of equation (7) are integrated of order one, as proven by DF-GLS unit root test.*
(ii) are the residuals obtained from estimating equation (7) (in first differenced form) through Newey-West HAC OLS regression.
(iii) Other than , all the variables in matrix are considered in first-differenced form.

The estimated correlation coefficients are reported in Table 1. One sees that for all model regressors, the value of the correlation coefficient is close to zero. Even for those cases where the coefficient value significantly deviates from zero (i.e., Korean international trade (-0.51) and its productivity differential against Japan (-0.40)) it is still not sufficiently close to -1 (or 1). These findings militate against the presence of endogenity bias in the model regressors, which potentially could prevent us from estimating the subject relationship under a single equation error correction representation. Thus, there is enough statistical evidence to legitimately estimate equation (7) with the ECM, which necessitates weak exogeneity of regressors.

Estimates from equation (8) are reported in Table 2. Error correction coefficients, accounting for productivity convergence towards steady-state long-run equilibrium levels, are reported for each individual country[4]. The subsequent long-run coefficients of the model's parameters, estimated through FMOLS cointegration regression estimators, are also given in the same table.

Before discussing the two types of estimates and the associated inferences, it is worth noting that (a) all of the five sample countries display statistically significant productivity convergence processes towards long-run equilibrium, and (b) initially, the model is estimated with level variables only, with no interaction terms involved. However, for the second specification, an augmented version of the model is estimated, by incorporating the interaction terms, primarily responsible for measuring technology transfer from the frontier (Japan) economy to less developed East Asian states. For example, in case of Korea, column KI reports FMOLS test estimates (against equation (8)) with level variables only but column K2 holds estimates for the augmented version of equation (8).

China, Korea, Philippines, Singapore and Thailand all generate valid ($\hat{\sigma} < 0$) and statistically significant error correction coefficients. For the set of sample countries, the speed of convergence ranges from -0.69 (Thailand) to -2.04 (Singapore). A valid and significant error correction coefficient provides support for a regional convergence process. In the short-run, while productivity departs from its steady state, the series still trends in such a way that it self-adjusts (in each period) towards the long-run steady state (corrections) against those misalignments (errors) which are responsible for keeping it away from its long-run equilibrium. This process of error(s) correction is significantly supported by the lagged values of all model parameters. Thus, on the whole, the periodic

[4] ECM is not estimated for Hong Kong and Malaysia due to small size of available sample data for these two countries.

productivity movements of less developed East Asian countries display a valid and significant tendency of attaining their long run equilibrium levels, as explained by their productivity differential with Japan, domestic innovation level and the rate of technology transfer from Japan. These results are in sharp contrast with earlier empirical work conducted on the region, which found inconsequential the role of world as well as regional technology leaders for in bringing income or output convergence for poorer East Asian states (Lim & MacAleer, 2000; Xu, 2000; Zhang, 2001; Joian, 2002). Such a disparity might be (largely) attributed to the sample study period employed under previous studies, primarily comprising pre-Global Financial Crisis (GFC) period. Nevertheless, it is evident that the catch up potential for low-income Asian countries evolved at a very pronounced pace in post-GFC years (Asian Development Outlook, 2016; Michelis & Neaime, 2004).

Having established the validity of error correction process, let us now evaluate the individual contribution of each of the model parameters towards productivity movements through the FMOLS cointegration regression estimator, using the model given in equation (8). As stated above, the model is estimated under both its unaugmented (with level terms only) as well as augmented (with level plus interaction terms) version.

Beginning with the productivity differential, it imparts a positive and statistically significant convergence effect on the productivity of subject East Asian states (except Singapore). For China, Korea, the Philippines, and Thailand, the long-run coefficient on the productivity differential ranges from 0.40 to 0.63. This magnitude is largest for the Philippines, which had the largest initial productivity gap with Japan. However, upon the inclusion of interaction terms, the productivity differential tends to lose its statisitical significance in determining the domestic long-run productivity movements. This is particularly true for China and Korea. For the Philippines and Singapore, the productivity differential, while remaining statistically significant as a determinant of long-run productivity, counterintuitively becomes negative. These findings are in line with those of Kutan and Yigit (2009).

Table 2: Estimating the Speed of Productivity Convergence and Long-Run Model Parameters – Individual Country Results

Speed of Convergence *Error Correction Model*	**China**		**Korea**		**Philippines**		**Singapore**		**Thailand**	
σ=EC Coefficient	-1.18 [-5.67]		-1.45 [-2.38]		-0.87 [-5.95]		-2.04 [-3.90]		-0.69 [-2.25]	
LR Coefficients - FMOLS	**C1**	**C2**	**K1**	**K2**	**P1**	**P2**	**S1**	**S2**	**T1**	**T2**
prod_difft-1	0.62 [12.86]	*1.28 [0.66]*	0.56 [1.84]	*-1.22 [-0.17]*	0.63 [7.63]	*-9.77 [-2.94]*	0.15 [0.67]	*-24.67 [-3.50]*	0.40 [4.56]	*7.98 [4.83]*
r&dt-1	-0.02 [-0.62]	*-0.55 [-2.01]*	0.14 [2.02]	*-0.06 [-0.42]*	0.00 [0.04]	*0.31 [0.79]*	0.08 [1.29]	*-0.05 [-0.98]*	-0.04 [-2.80]	*0.40 [2.67]*
hcapt-1	-0.02 [-0.62]	*-0.23 [-0.90]*	0.05 [0.31]	*-0.01 [-0.02]*	0.30 [2.08]	*-5.87 [-2.24]*	-0.03 [-0.18]	*0.89 [3.31]*	-0.17 [-3.50]	*-2.12 [-3.84]*
itt-1	0.20 [9.58]	*0.37 [5.57]*	0.10 [2.15]	*0.12 [2.64]*	0.04 [1.17]	*2.55 [3.35]*	0.14 [3.61]	*0.12 [4.76]*	0.18 [15.66]	*0.37 [3.70]*
r&dt-1*prod_difft-1	-	0.32 [2.61]	-	-0.17 [-1.39]	-	0.12 [0.91]	-	-0.35 [-2.02]	-	0.16 [2.77]
hcapt-1*prod_difft-1	-	0.23 [1.88]	-	0.17 [0.46]	-	-2.00 [-2.24]	-	2.27 [4.15]	-	-0.75 [-3.61]
itt-1*prod_difft-1	-	-0.09 [-2.70]	-	-0.02 [-0.54]	-	0.85 [3.25]	-	-0.06 [-0.97]	-	0.08 [2.12]

Notes

v.

(1) Due to insufficiently available data for R&D for Hong Kong, Indonesia and Malaysia, these countries are dropped from the sample.
(ii) From 1980-95, due to some missing observations, R&D data is interpolated for each country.
(iii) Lag length is determined by automatic selection based on the SIC, subsequently adjusted to produce white noise in the residuals, if necessary

Next, looking into the determinants of domestic innovation i.e., national R&D expenditures and human capital formation, these variables have had mixed effects on the long-run productivity patterns of the subject economies. Only for Korea do R&D expenditures carry a positive long-run coefficient. For China, Philippines and Singapore, this effect is statistically insignificant, whereas for Thailand, country's R&D expenditures tend to impart negative effects on domestic productivity levels. Human capital formation, measured as secondary school enrollments, is largely found to have either a negative or statistically insignificant long-run association with productivity (except Philippines). For Singapore, positive and statistically significant coefficients are also obtained, but that only with the inclusion of interaction terms into the model.

Finally, we consider the role of international trade, the variable responsible for channelling technology growth from the frontier economy to subject countries. This series maintains a positive and statistically significant long-run relationship with productivity. Our estimates on the role of international trade conform to the findings of Michelis and Neaime (2004) and Zhang (2001). Either in level form or with interaction terms, the variable in almost all cases imparts a positive long-run effect on productivity for all sample states, with a slope coefficient of value ranging from 0.04 to 1.71. Nevertheless, the case of Philippines (without interaction terms) is an exception.

7. Evidence from Panel Data Estimates

Panel data analysis has a potential advantage over the analysis of individual country data because it allows the pooling of data, providing better statistical power. Most time-series suffer from the problem of small numbers of observations. This issue results in insignificant t-ratios or F-statistics, raising concerns about the validity and power of both short-run and long-run estimates. This issue is common in annual data studies where it is rare to find economic data series covering more than fifty years. In this respect, panel data estimation methods are preferred since data series can be pooled into panels of different countries.

Here we seek evidence on productivity convergence in East Asian states by estimating a Panel Error Correction Model (PECM). We employ Westerlund's (2007) error correction approach to long-run cointegration for unbalanced panels. Unlike the conventional residual-based time-series and panel error correction representations, Wasterlund's model encompasses structural rather than residual-based dynamics. This saves his model from the complexity of common-factor restrictions, a feature inherent to conventional residual based tests, whose failure can cause a significant loss of power for residual-based cointegration models. Under the conditional error correction representation, Wasterlund's model tests the null of no valid cointegration between model variables by inferring if the error correction coefficient is zero. This test holds a meaningful application for our proposed model of productivity convergence owing to the following reasons: (a) heterogeneity amongst panels is admissible to a fairly large extent, both in long-run cointegration vectors and short-run model dynamics and, (b) the test is fairly robust against cross-sectional dependence, an issue common to other panel cointegration estimators. Wasterlund's PECM comprises four newly developed panel cointegration estimators, which follow a normal distribution, and are efficient enough to control for unit-specific short-run to long-run dynamics, unit specific slope and trend parameters, and cross-sectional dependence. The model follows the following data generating process:

$$q_{Hi,t} = \mu'_{Hi} d_t + \varphi \left[q_{Hi,t-1} - \gamma_i X_{Hi,t-1} - \delta_i \left(\frac{q_{Ft-1}}{q_{Ht-1}} \right) - \tau_i X_{Hi,t-1} . \left(\frac{q_{Ft-1}}{q_{Hi,t-1}} \right) \right]_{t-1} + \sum_{j=1}^{mi} \Delta q_{Hi,t-j} \sum_{j=-qt}^{pi} \Delta \gamma'_i X_{i,t-j} + \sum_{j=-qt}^{pi} \Delta \tau'_i X_{i,t-j} . \left(\frac{q_{Ft-1}}{q_{Hi,t-1}} \right) + \varepsilon'_t \quad (9)$$

In Equation (9), the time-series and cross-sectional units are indexed $t = 1, \dots \dots \dots, T$ and $i = 1, \dots \dots \dots, N$, respectively. μ' is the heterogeneous constant term and d_t constitutes the deterministic component. All the model regressors are assumed to be a pure random walk in levels, and absolutely mean reverting in first differences. φ is the speed coefficient of adjustment/correction the system makes towards long-run equilibrium, after a short-run fluctuation. The null hypothesis of no cointegration between q_{Hi} with model regressors is analogous to $\varphi_i = 0$ (Persyn & Westerlund, 2008). The alternative hypothesis of valid error correction process necessitates that $\varphi_i < 0$ i.e., a statistically valid convergence of the system towards long-run equilibrium. The coefficient value of φ_i is also critical for the occurrence of alternative hypothesis. Two of four tests, called the panel tests, assumes the homogeneity of φ_i for all i i.e., $H_1 = \varphi_i = \varphi < 0$ i.e., the panel is cointegrated as a whole. The other pair of tests, called the group-mean tests, does not require φ_i to be homogenous (and thus cointegrated) for all cross-sectional units of the panel and assumes that at least one unit is cointegrated.

$$Panel\ Statistics: H_0: \varphi_i = 0\ against\ H_1: \varphi_i < 0\ \forall\ i \quad (10a)$$

$$Group\ Statistics: H_0: \varphi_i = 0\ against\ H_1: \varphi_i < 0\ for\ at\ least\ one\ i \quad (10b)$$

8. Results from Panel Error Correction Model

Prior to estimating the Westerlund's PECM, it is important to seek statistical evidence on the presence of cross-sectional dependence amongst panel entities. Cross-sectional independence is an important assumption of panel cointegration models. This assumption necessitates the independence of errors across the different cross-sections of the panel. The issue of cross-sectional dependence is likely to occur in regional panel studies. This is because if the regional states are affected by common economic shocks, this may result in contemporaneous correlations i.e., cross-sectional dependence amongst the entities (cross-sections) included in the panel. Owing to the fact that the size of the panel unit root tests is sensitive to the presence of cross-sectional dependence, the testing of this assumption serves the purpose of identification rather than bringing in any descriptive accuracy.

We test the cross-sectional independence amongst panel countries for each of the individual model variables using the Pesaran Cross-Sectional Dependence test (CD). The method tests for the contemporaneous correlations in individual panel regression errors under the null hypothesis of zero covariance between errors.

$$H_0 = \omega_{ij} = \omega_{ji} = Cov(\varepsilon_{it}, \varepsilon_{jt}) = 0, \forall\ t, i \neq j \quad (11a)$$

$$H_1 = \omega_{ij} = \omega_{ji} = Cov(\varepsilon_{it}, \varepsilon_{jt}) \neq 0, \forall\ t, i \neq j \quad (11b)$$

Amongst all other tests popular for the identification of cross-sectional dependence, the Pesaran CD test is regarded to be most robust for both stationary and non-stationary panels in addition to its small sample properties. The test is fairly consistent against single and/or multiple structural breaks in slope coefficients of panel regression and the error variance of individual regressions.

Table 3 contains the test statistics for Pesaran (2004) CD test. Except for R&D, the null hypothesis of cross-sectional dependence cannot be rejected for all model variables. On the contrary, R&D displays somewhat different results and does not reject the null hypothesis (up to a 7 percent level of statistical significance). Nevertheless, there is enough evidence in favor of cross-sectional dependence and thus the errors from panel regression tend to be contemporaneously correlated across the cross-sections of the panel.

Table 3: Pesaran (2004) Pre-Estimation Test Results for Cross-Sectional Independence[5]

	CD-Test Statistics	p-value	Average Correlation Coefficient	Absolute Correlation Coefficient
Domestic Productivity	15.37	0.00	0.865	0.865
R&D	1.80	0.07	0.112	0.586
Human Capital	4.02	0.00	0.232	0.723
International Trade	17.67	0.00	0.991	0.991
Productivity Differential	9.66	0.00	0.552	0.729

Note: The Pesaran (2004) CD test is distributed standard normal and is estimated through the Stata routine xtcd.

With statistical evidence on the non-stationarity of all panel series, the next step is to estimate the (plausible) long-run linear cointegrating relationship between domestic productivity and model regressors using Westerlund's panel error correction model. The test estimates are found to be sensitive to the choice of deterministic regressors, leads, lags and the width of Bertlett kernel window (Abdullah et al., 2017; Burret et al., 2014). For this reason, the test is conducted under three different specifications in error correction relation: i) no deterministic regressors, ii) constant only, and iii) constant and trend. Also, cointegration is established under both unrestricted and restricted approaches, relative to the choice of leads and lags. The unrestricted case allows for automatic selection of optimal lags and leads through Akaike Information Criterion (AIC), allowing for a maximum of 1 lag, thus imposing no uniformity on short-run model dynamics. Under the restricted case, a single lead and lag is permissible, thus assuming uniform short-run dynamics for all the panel series. For both specifications, a (relatively) shorter kernel window of width 2 is chosen, owing to small data set (T is ranging from 29 to 33). Since cross-sectional dependence has been established by the Pesaran (2004) CD test, the test is run under bootstrapping sampling method, allowing for 400 re-estimations of each cointegration test.

[5] In the previous section, Hong Kong and Malaysia were dropped out of time-series estimation of ECM. However, both countries are included in the panel data estimations.

Table 4: Test Results for Wasterlund Panel Cointegration Test

Unrestricted Case	**No Deterministic Regressors** (*Average Lead & Lag Length = 1 & 0.2*)				**Constant Only** (*Average Lead & Lag Length = 1 & 0.4*)				**Constant and Trend** (*Average Lead & Lag Length = 1 & 0.6*)			
	Value	*Z-Value*	*p-value*	*Robust p-value*	*Value*	*Z-Value*	*p-value*	*Robust p-value*	*Value*	*Z-Value*	*p-value*	*Robust p-value*
G_t	-1.162	1.776	0.962	0.833	-0.943	3.517	1.000	0.975	-1.063	4.440	1.000	0.998
G_a	-1.716	2.567	0.995	0.918	-1.515	3.339	1.000	0.988	-1.263	4.165	1.000	0.993
P_t	-2.138	1.166	0.878	0.855	-4.477	0.302	0.619	0.765	-3.425	2.452	0.993	0.985
P_a	-1.488	1.415	0.922	0.908	-4.005	1.563	0.941	0.835	-2.389	2.987	0.999	0.995
Restricted Case	**No Deterministic Regressors** (*Average Lead & Lag Length = 1 & 1*)				**Constant Only** (*Average Lead & Lag Length = 1 & 1*)				**Constant and Trend** (*Average Lead & Lag Length = 1 & 1*)			
	Value	*Z-Value*	*p-value*	*Robust p-value*	*Value*	*Z-Value*	*p-value*	*Robust p-value*	*Value*	*Z-Value*	*p-value*	*Robust p-value*
G_t	-0.822	2.386	0.992	0.778	-0.982	3.427	1.000	0.940	-1.085	4.385	1.000	0.973
G_a	-1.445	2.652	0.996	0.835	-1.341	3.390	1.000	0.985	-1.242	4.170	1.000	0.990
P_t	-1.981	1.290	0.902	0.682	-2.820	1.831	0.967	0.677	-4.310	1.566	0.941	0.500
P_a	-1.489	1.414	0.921	0.590	-2.037	2.144	0.984	0.760	-2.412	2.981	0.999	0.833

Note: The Westerlund's Panel Error Correction test is estimated through the Stata routine ***xtwest.***

The sole purpose of such an extensive empirical practice is to obtain robust p-values for our test statistics, which would be hindered by the significant cross-correlations (dependence) amongst the panel entities.

The panel ECM results are reported in Table 4. Starting with the unrestricted case, the null hypothesis of no cointegration cannot be rejected at any meaningful statistical significance. This is true for all three model specifications, varying with respect to the inclusion of deterministic regressors in the cointegration equation. As decided by AIC, for all model specifications, the AIC always picks a lead of value 1 and lags less than 1 (between 0 and 1). There is strong evidence of no valid long run co-movement between panel series, irrespective of panel or group test estimates.

Looking at the test results of the restricted case of panel ECM yields results that are no different. The alternative hypothesis of a valid error correction process is again rejected at a high level of statistical significance (both for the whole integrated panel as well as for the cointegration of at least one cross-sectional unit). These findings are not supported by our time-series error correction test estimates, suggesting substantially high and statistically significant error correction adjustments of home productivity from short-run misalignments towards long-run equilibrium. Moreover, our estimates confirm the results yielded through many earlier and recent studies on regional income (productivity) catch up for East and South East Asian economies, advocating either absolutely no or conditional convergence to their intra- and ex-regional trading partners (Chowdhury & Mallik, 2011; Haider et al., 2010; Masron & Yusop, 2008; Zhao & Serieux, 2019)

9. Are the Panel Estimates Robust?

The results yielded through panel ECM are suprising and contradict those of the earlier time-series ECM estimates, which had suggested convergence. To gather additional evidence, we employ another two panel data estimators: (i) Pedroni residual based test of cointegration, efficient against the problem of cross-sectional dependence in panels, and (ii) Fisher-Johansen combined maximum likelihood based rank test of cointegration.

10. Pedroni Residual Based Test of Cointegration

Pedroni's (1999) heterogeneous panel cointegration test allows cross-sectional interdependence with individual effects. Provided the data series are unit root in levels, that is, I(1), the Pedroni residual-based cointegration test is an extensively used tool to investigate if a long-run cointegrating association exists between model variables. The following time series panel formulation is proposed by Pedroni:

$$q_{Hi,t} = \alpha_i + \gamma_{it}t + \beta_i X_{Hi,t-1} + \varepsilon_{it} \quad (12a)$$

$$\hat{\varepsilon}_{it} = \sigma_i \hat{\varepsilon}_{it-1} + \mu_{it} \quad (12b)$$

Here $i = 1, \dots \dots \dots, N$ identifies the panels and $t = 1, \dots \dots \dots, T$ represents time periods. The parameters α_i and $\gamma_{it}t$ are responsible for capturing country-specific effects and deterministic trend effects, respectively. $\hat{\varepsilon}_{it}$ represents the calculated residual deviations from the long-run association between *rer* and $\tilde{a}$. In order to test the null hypothesis of "no cointegration" in a panel, that is, $\sigma_i = 1$, Pedroni developed test statistics with asymptotic and finite sample properties. The Pedroni model allows heterogeneity among every member of the panel. Not only this, the model also allows heterogeneity in long-run cointegrating vectors as well as long-run dynamics.

There are actually two sets of residual based tests in the Pedroni cointegration model,. The first set of tests consists of pooling the residuals obtained from within-group regressions. The statistics of the tests are standard, normal and asymptotically distributed. This first set of tests includes panel *v*-statistics, panel $-\rho$ statistics, panel PP-statistics (or t-statistics, non-parametric) and panel ADF-statistics (or t-statistics, parametric). The other group of tests are also standard, normal and asymptotically distributed, but unlike the first set of tests, these tests involve pooling the residuals between the groups. This set consists of group $-\rho$ statistics, group PP-statistics (or t-statistics, non-parametric) and group ADF-statistics (or t-statistics, parametric). All of these seven tests involve estimators that average the estimated coefficients of individual members of the panel. Each of these tests is capable of accommodating individual specific short-run dynamics, individual specific fixed effects and deterministic trends, and individual specific slope coefficients (Pedroni, 2004).

In the event of rejection of the null hypothesis by all seven tests, one may easily draw a conclusion. However, unfortunately, this does not often happen. One frequently confronts a situation where there is a mix of evidence. If this happens, there is a need to look for a test that will explain the power of the cointegration model. As elaborated by Pedroni (2004), in case of a sufficiently large panel, where the issue of size distortion is of little importance, panel *v*-statistics display the best power in comparison to the other six tests. The panel *v*-statistics is a one-sided test where the large positive values tend to reject the null hypothesis (Pedroni, 2004). On the other hand, in the case of very small sized panels, group - ρ statistics are likely to reject the null hypothesis. One can be confident enough of the group - ρ statistics as the tests are purposely built for smaller samples and they are regarded as the most conservative of all the seven tests. The rest of the five tests lie somewhere in between the two extreme cases of panel v-statistics and group - ρ statistics. However, they have advantages over a range of large, medium or small sized samples. One noticeable characteristic is that other than panel v-statistics, the remaining six tests diverge to negative infinity, that is, the large negative values tend to reject the null hypothesis.

11. Fisher-Johansen Combined Maximum Likelihood Based Estimator of Cointegration

Fisher (1932) derived a combined test that uses the results of individual independent tests. Maddala and Wu (1999) use Fisher's result to propose an alternative approach to testing cointegration in panel data by combining tests from individual cross-sections to obtain a test statistic for the full panel. If p_i is the p-value from an individual cointegration test for cross-section i, then under the null hypothesis for the panel:

$$-2\sum_{i=1}^{N}\log(pi) \rightarrow \chi^2(2N) \quad (13)$$

Maddala and Wu proposed two statistics: the Fisher statistic from the trace test and the Fisher statistic from the Maximum Eigenvalue test. By default the χ^2 value based on the MacKinnon-Haug-Michelis (1999) p-value is used for Johansen's cointegration Trace test and Maximum Eigenvalue test. Following Johansen's Cointegration approach, cointegration requires the rank to be less than the number of variables in the long-run equation.

For the test, the valid cointegration between model parameters necessitates that the rank of the test, representing the number of cointegrating vectors, must meet the following condition:

$$0 < rank(r) < n,$$

where n is the number of model parameters. If there are n parameters and there are n cointegrating vectors, then the panels are likely to be stationary in levels, hindering the establishment of reliable a long-run cointegrating relationship.

12. Results from Two Panel Cointegration Estimators

The upper panel of Table 5 displays the test results for the Pedroni residual based cointegration test. The test requires incorporating an appropriate number of lag(s) for each cross-section. The lag length selection is done through panel VAR, using the Schwarz Information Criterion (SIC). SIC suggests two lags to be included whilst estimating the cointegration model. Discussing the statistics obtained from Pedroni cointegration test, five out of the seven tests unanimously failed to reject the null hypothesis of no cointegration between productivity and its proposed determinants. The only exception are panel *v-statistics* and group PP statistics, suggesting cointegration between model parameters at five and ten percent statistical significance, respectively. However, on part of panel *v*-statistics, which tends to reject the null hypothesis, the evidence yielded is of trivial importance as the test is best suited for sufficiently large panels, a feature nonexistent for our sample data. Given that 5 of the 7 tests fail to reject the null of no cointegration, the test results should be interpreted in favor of nonexistence of productivity convergence between Japan and its middle- and low income neighbors. These results are in line with those obtained through Panel ECM estimated in the preceding section of the paper.

As regarding the test results obtained from the Fisher-Johansen panel cointegration test, similar to the Pedroni cointegration test, the results are once again not supportive of a valid long-run association between the model variables. However, the empirical evidence generated in this respect are of a different nature. Similar to the Pedroni cointegration estimator, this test also involves the inclusion of an appropriate number of lag(s) in estimation. Once again following the suggestion of SIC, the test is estimated using two lags of each model variable. The specification of deterministic regressors in the Johansen test is very important. EViews allows five specifications of deterministic regressors. We choose to employ specifications 3 and 4 of the test as these allow a reasonable degree of generality in incorporating trending behavior in the data. Thus, the existence/nonexistence of cointegration between productivity and its long-run determinants will be decided on the test results of Case 3 and Case 4.

Table 5: Summary of Test Results for Pedroni Cointegration and Fisher Johansen Combined Cointegration Estimators

Pedroni Panel Cointegration Test Results								
Common AR Coefficients (Within Dimension)					*Individual AR Coefficients (Between Dimension)*			
Dependent Variable	Panel v Statistics	Panel Statistics	Panel PP Statistics	Panel ADF Statistics	Group Statistics	Group PP Statistics	Group ADF Statistics	Does Valid Cointegration Hold?
q_{Hit}	1.66**	1.60	-0.45	0.99	2.22	-2.94*	1.49	No

Johansen-Fisher Panel Cointegration Test Results			
No of Cointegrating Vectors-Case 3: Intercept (no trend) in cointegrating equation and VAR			
Dependent Variable	Fisher Stat (From Trace Stat)	Fisher Stat (From Max-Eigen Stat)	Does Valid Cointegration Hold?
q_{Hit}	5***	5***	No
No of Cointegrating Vectors-Case 4: Intercept and trend in cointegrating equation-no trend in VAR			
q_{Hit}	5***	5***	No

The Trace and the Maximum Eigenvalue statistics of both specification 3 and 4 of the test found no evidence of a valid cointegrating vector for the estimated model. The two test statistics under both test specifications commonly produce a rank of 5, implying that the rank of the test (number of cointegrating vectors, r) is exactly equal to the number of model variables (n). These results challenge the panel unit root test findings, proving the model variables to be integrated of order 1. Thus, parallel to the panel ECM and Pedroni cointegration tests findings, the Fisher-Johansen panel cointegration test could also not find a statistically significant long-run association between the productivity growth of Japan and the growth in its regional neighbors.

13. Conclusion

Regional economic linkages between countries aim to reduce income disparities and promote inclusive growth. The economic cooperation between East Asian countries under the ASEAN agreement is considered to be one of the finest examples of successful regional economic integration. However, in terms of region-wide productivity growth spillovers, the degree of inclusivity of this regional cooperation has always remained in question.

Following the footsteps of Cameron et al. (2005) and Kutan and Yigit (2009), the productivity convergence of low- and middle-income East Asian countries towards their rich neighbor(s) is modelled against their national levels of innovation, technology spillovers from the regional economic leader and their productivity differential with the frontier country. Overall, we find no significant productivity convergence in East

Asia. Japan doesn not serve as the regional productivity growth driver for its poorer neighbor states.

Initially the study empirically had verified the above stated channels of regional productivity convergence for each country individually, using a time-series econometric estimator. Under the error correction representation, the per period speed of productivity convergence of five low- and middle-income regional states (towards Japan) was found highly significant as well as substantial. In each period, the productivity convergence is occurring at an abnormally high speed, ranging from 69 percent (Thailand) to 204 percent (Singapore) annually. However, of these results were not robust. This discrepancy can be attributed towards the small size of the study sample for each country, since the error correction model like many other time-series estimators is deemed asymptotically efficient (Engle & Granger, 1987). In order to address this, we re-estimated the regional productivity convergence model using a panel data estimator. Based on structural dynamics (rather than a residual-based approach), Westerlund's (2007) restricted panel error correction estimator of long-run cointegration is used, investigating the (plausible) presence of productivity convergence for a panel of the seven East Asian countries. The results yielded contradicted those earlier obtained from the error correction model, suggesting no valid long-run association between the productivity of low-and middle income regional economies with that of Japan. These latter findings are robust to two different versions of Wasterlund's estimator (subject to the selection of leads and lags), each version offering three different variants (based on deterministic regressors included in the model). Thus, contrary to the initial time-series test findings, the panel data estimates strongly reject productivity catch up between low income East Asian states and Japan.

To confirm the panel finding of no convergence, we test it further through (a) Pedroni residual-based model of panel data cointegration and, (b) Fisher-Johansen combined maximum likelihood-based estimator of panel cointegration. These two estimators also support the findings of Wasterlund's panel error correction test results, confirming the lack of productivity convergence for East Asia.

Nevertheless, the empirical model estimated in this paper is limited in the sense that it does not take into account inter-country disparities pertaining to organizational and institutional capacities, which may plausibly explain productivity convergence channels in a more pronounced way. This may be taken as a future line of research.

Differentiated levels of productivity can largely be attributed to heterogeneity, typically present in the form of technical efficiency and disparities in organizational and institutional capacities, hampering cross-border commodity trade, labor mobility and knowledge transfer. It is therefore critically important to control for these factors, while gauging growth performance of developing and transition economies. In addition to making regional economy less prone to global macroeconomic shocks, policies should be directed to eradicate technical and institutional disparities existing among regional member states. Investments that eliminate structural rigidities and the barriers to inter-country factor mobility may induce greater speeds of productivity convergence, particularly for middle- and low-income regional players.

References

Abdullah, S., Siddiqua, S., & Huque, R. (2017). Is health care a necessary or luxury product for Asian countries? An answer using panel approach. *Health Economics Review, 7*(1), 4.

Aghion, P., Howitt, P., Brant-Collett, M., & García-Peñalosa, C. (1998). *Endogenous growth theory*: MIT press.

Asian Development Bank. (2016). Asian Development Outlook 2016: Asia's Potential Growth.

Aubyn, Miguel S. (1999). Convergence across Industrialised Countries (1890–1989): New Results using Time-Series Methods. *Empirical Economics,* 24(1), 23-44.

Baumol, W. J. (1986). Productivity Growth, Convergence, and Welfare: What the Long-Run Data Show. *The American Economic Review*, 1072-1085.

Ben-David, D., & Loewy, M. B. (1998). Free Trade, Growth, and Convergence. *Journal of Economic Growth, 3*(2), 143-170.

Bernard, A. B., & Jones, C. I. (1996a). Comparing Apples to Oranges: Productivity Convergence and Measurement Across Industries and Countries. *The American Economic Review*, 1216-1238.

Bernard, A. B., & Jones, C. I. (1996b). Productivity across Industries and Countries: Time-Series Theory and Evidence. *The Review of Economics and Statistics*, 135-146.

Burret, H. T., Feld, L. P., & Köhler, E. A. (2014). Panel Cointegration Tests on the Fiscal Sustainability of German Laender.

Cameron, G., Proudman, J., & Redding, S. (2005). Technological Convergence, R&D, Trade and Productivity Growth. *European Economic Review, 49*(3), 775-807.

Chowdhury, K., & Mallik, G. (2011). Pairwise output convergence in selected countries of East Asia and the Pacific: an application of Stochastic Unit Root test. *ASEAN Economic Bulletin*, 1-15.

Cincera, M. (2005). Firms' Productivity Growth and R&D Spillovers: An Analysis of Alternative Technological Proximity Measures. *Economics of Innovation and New Technology*, *14*(8), 657-682.

Coe, D. T., & Helpman, E. (1995). International R&D Spillovers. *European Economic Review*, *39*(5), 859-887.

Coe, D. T., Helpman, E., & Hoffmaister, A. W. (2009). International R&D spillovers and institutions. *European Economic Review*, *53*(7), 723-741.

Pleijt, A. M. (2018). Human Capital Formation in the Long Run: Evidence from Average Years of Schooling in England, 1300–1900. *Cliometrica*, *12*(1), 99-126.

Engle, R. F., & Granger, C. W. (1987). Co-integration and Error Correction: Representation, Estimation, and Testing. *Econometrica: Journal of the Econometric Society*, 251-276.

Franks, J. R., Barkbu, B., Blavy, R., Oman, W., & Schoelermann, H. (2018). Economic Convergence in the Euro Area: Coming together or Drifting Apart? *IMF Working Paper WP/18/10.*

Fukuda, S.-i., & Toya, H. (1995). Conditional Convergence in East Asian Countries: The Role of Exports in Economic Growth. *Growth Theories in Light of the East Asian Experience, NBER-EASE Volume 4* (pp. 247-265): University of Chicago Press.

Gräbner, C., Heimberger, P., Kapeller, J., & Schütz, B. (2019). Structural Change in Times of Increasing Openness: Assessing Path Dependency in European Economic Integration. *Journal of Evolutionary Economics*, 1-29.

Giles, D. E. (2005). Output Convergence and International Trade: Time-Series and Fuzzy Clustering Evidence for New Zealand and Her Trading Partners, 1950–1992. *The Journal of International Trade & Economic Development*, *14*(1), 93-114.

Griffith, R., Redding, S., & Reenen, J. V. (2004). Mapping the Two Faces of R&D: Productivity Growth in a Panel of OECD Industries. *Review of Economics and Statistics*, *86*(4), 883-895.

Griliches, Z., & Lichtenberg, F. R. (1984). R&D and Productivity Growth at the Industry Level: Is there Still a Relationship? *R&D, Patents, and Productivity* (pp. 465-502): University of Chicago Press.

Haider, A., Hameed, S., & Wajid, A. (2010). Income Convergence Hypothesis: A Regional Comparison of selected East and South Asian Economies.

Hsiao, F. S., & Hsiao, M. C. W. (2004). Catching Up and Convergence: Long-run Growth in East Asia. *Review of Development Economics, 8*(2), 223-236.

Kang, L., & Peng, F. (2018). Economic Reform and Productivity Convergence in China. *Arthaniti: Journal of Economic Theory and Practice*, *17*(1), 50-82.

Kasman, S., Kasman, A., & Gökalp, G. (2019). Efficiency and Productivity Convergence in Health Care Systems: Evidence from EU Member Countries. *METU Studies in Development*, *46*(2), 227-250.

Khaemba, B. W. (2014). Relationship between Education Financing and Human Capital Investment: A Survey of Public Secondary Schools in Kimilili-Bungoma Sub-County. *International Journal of Academic Research in Business and Social Sciences*, *4*(4), 148.

Kutan, A. M., & Yigit, T. M. (2009). European Integration, Productivity Growth and Real Convergence: Evidence from the New Member States. *Economic Systems, 33*(2), 127-137.

Lawrence, R. Z., & Weinstein, D. E. (2001). Trade and Growth: Import-Led or Export-Led? Evidence from Japan and Korea. *Rethinking the East Asian Miracle*, 379-408.

Lim, L. K., & McAleer, M. (2000). Convergence and Catching Up in South-East Asia: A Comparative Analysis. Paper presented at the Econometric Society World Congress.

Lluís Carrion-I-Silvestre, J., & German-Soto, V. (2007). Stochastic Convergence amongst Mexican States. *Regional Studies*, *41*(4), 531-541.

Maddala, G. S., & Wu, S. (1999). A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test. *Oxford Bulletin of Economics and statistics, 61*(S1), 631-652.

Mahmood, A., & Talat, A. (2008). Total Factor Productivity Growth in East Asia: A Two Pronged Approach. *European Journal of Economics, Finance and Administrative Sciences, 14*(14), 93-111.

Masron, T. A., & Yusop, Z. (2008). AFTA, income growth, and income convergence in ASEAN. *The International Trade Journal*, *22*(3), 290-314.

Michelis, L., & Neaime, S. (2004). Income Convergence in the Asia-Pacific Region. *Journal of Economic Integration*, 470-498.

Mutaqin, Z., & Ichihashi, M. (2012). Real Convergence in ASEAN and the Eurozone: Demographic and Maastricht Criteria Roles. Paper presented at the Proceedings 2nd International Conference on Economics, Trade and Development.

Pedroni, P. (1999). Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. *Oxford Bulletin of Economics and statistics, 61*(S1), 653-670.

Pedroni, P. (2004). Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time-Series Tests with an Application to the PPP Hypothesis. *Econometric theory, 20*(3), 597-625.

Persyn, D., & Westerlund, J. (2008). Error-Correction-based Cointegration Tests for Panel Data. *Stata Journal, 8*(2), 232-241.

Quintana-Romero, L., Correa-Quezada, R., Ramón-Mendieta, M. G., & Álvarez-García, J. (2019). Sectoral Regional Growth and Convergence in Ecuador: An Analysis of the Intra-Distributive Dynamics of Productivity. *Symmetry*, *11*(4), 461.

Schultz, T. W. (1960). Capital Formation by Education. *Journal of Political Economy*, *68*(6), 571-583.

Solarin, S. A., Ahmed, E. M., & Dahalan, J. (2014). Income Convergence Dynamics in ASEAN and SAARC Blocs. *New Zealand Economic Papers, 48*(3), 285-300.

Terleckyj, N. E. (1980). What Do R&D Numbers Tell Us about Technological Change?. *The American Economic Review*, *70*(2), 55-61.

Vâlsan, C., & Druică, E. (2020). Corporate Performance and Economic Convergence between Europe and the U.S.: A Cluster Analysis along Industry Lines. *Mathematics*, *8*(3), 451.

Westerlund, J. (2007). Testing for Error Correction in Panel Data. *Oxford Bulletin of Economics and statistics, 69*(6), 709-748.

Wooldridge, J. M. (2015). *Introductory Econometrics: A Modern Approach*: Nelson Education.

Xu, B. (2000). Multinational Enterprises, Technology Diffusion, and Host Country Productivity Growth. *Journal of Development Economics*, *62*(2), 477-493.

Yasar, M., & Morrison Paul, C. J. (2008). Foreign technology transfer and productivity: Evidence from a matched sample. *Journal of Business & Economic Statistics*, *26*(1), 105-112.

Zachariadis, M. (2003). R&D, Innovation, and Technological Progress: A Test of the Schumpeterian Framework without Scale Effects. *Canadian Journal of Economics/Revue canadienne d'économique*, *36*(3), 566-586.

Zhang, Z. (2001). Trade Liberalization, Economic Growth and Convergence: Evidence from East Asian Economies. *Journal of Economic Integration*, 147-164.

Zhao, J., & Serieux, J. (2019). Globalization, Regionalization and Convergence in East Asia. *The Journal of International Trade & Economic Development*, *28*(4), 486-507.

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Pakistan's Balance-of-Payments Crisis and Some Policy Options

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Abstract

Neoclassical price theory, and its extension to IMF country advice, argues that balance-of-payments crises such as Pakistan's are better resolved by depreciating the exchange rate, making exports cheaper and imports dearer. We argue that a partial equilibrium analysis of just the tradeable goods market on the current account side ignores the capital market on the capital account side, where an increase in outflows allows no equilibrium value for the exchange rate, through a phenomenon dubbed 'depreciationary expectations', akin to inflationary expectations. This phenomenon will not allow the exchange rate to settle at an equilibrium level, leading to a vicious downward cycle. In such a case, capital controls may well be needed to counter the downward cycle, allowing a return to growth.

Keywords: Balance of payments, exchange rates, equilibrium analysis, Pakistan.

JEL Classification: D51, F38.

1. The Urgency of the Balance-of-Payments Crisis in 2018 and Our Theoretical Argument

In 2018, Pakistan looked desperately to turning its back on spendthrift growth and development because, at the end of the fiscal year 2017/18, the profligacy of the *ancien regime* had spawned a current account (CA) deficit of 5.6 percent of GDP and a budget deficit of 6.6 percent of GDP. A due balance of payments (BOP) of USD18 billion, a pressured exchange rate, the halving of reserves to USD9.8 billion, and capital outflows of USD6 billion in the previous year alone required by then the classic recourse to the International Monetary Fund (IMF). Without this multilateral bailout, external payments could not have been met, nor confidence restored in the macro-fundamentals of the economy to allow faltering investment and growth to resume.

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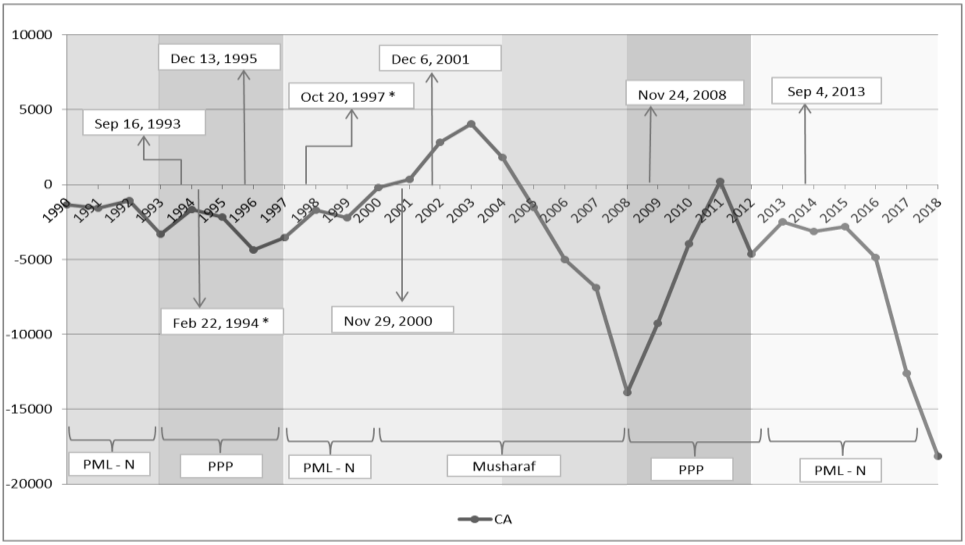
Pakistan's BOP crises have increased in frequency, duration, and intensity since 1990, as Figure 1 shows.

Figure 1: Long-run trend and cyclical variation in CA



Source: Authors' calculations, based on data from the State Bank of Pakistan.

There have been important preceding diagnostics of these BOP crises. Theoretically, the gap between government revenues and expenditures has to be met by external resources, through a CA deficit (Obstfeld & Krugman, 2003). Amjad (2019) highlights this link between the CA deficit and budget deficit for Pakistan. In theory, such a framework involves two markets—for domestic goods and tradeable goods.

This article seeks to bring into the analytical framework a third market—for global capital flows. This is done by examining not just the CA, which is the left-hand side of the BOP equation, but also the capital account (KA), which is the right-hand side of the equation.

Thus we have:

$$CA = KA \tag{1}$$

The BOP always balances as a macro-identity (Obstfeld & Krugman, 2003). The CA comprises flows of goods, services, and asset incomes in and out of the country for the year. If there is a deficit in the CA on the left-hand side of the equation, it has to be paid for in that year from the KA on the right-hand side of the equation. The KA comprises the change in assets—of domestic assets held by foreigners and foreign assets held domestically. Consequently, if there is a CA deficit in a particular year, it must be paid for by a change in capital assets on the KA side. This usually implies liquidating foreign assets held domestically and/or borrowing from foreign sources, public or private. In Pakistan's case, this has usually meant running down the reserves of foreign currencies held by the State Bank of Pakistan (SBP), plus borrowing from foreign sources, contracting multilateral, bilateral, and private debt. Foreign inflows of capital to buy Pakistani assets—foreign direct investment (FDI) and portfolio—could help, but have been meagre.[1]

Here, we aim to systematize in general equilibrium (GE) some of these macro-behavioral relationships.

2. The Essential Argument

Confronted by an unsustainable BOP deficit, the standard price solution is to depreciate the exchange rate *e*. This should cheapen exports X, raising them, and make imports M more expensive, lowering them. However, we argue that this standard price solution is based on a partial equilibrium analysis, that is, an analysis of just the left-hand side of equation 1, the CA. A full GE analysis involves also examining the right-hand side of the equation, which is the KA, used to pay for the CA deficit.

A GE framework shows that the price solution of depreciating the exchange rate *e* will not work on its own for the following reason: we posit that the depreciation of the exchange rate *e* works analogous to the concept of inflationary expectations. As the exchange rate *e* depreciates, the CA deficit may persist, according to the growing literature that shows exports to be less price-responsive. A primary argument for this is that exports are usually priced in terms of the foreign buyer's currency, for example, US dollars. So, depreciation of the local currency unit (LCU) with respect to the US dollar will tend not to lower the price of the export because it has already been designated and marketed in US dollars (Gopinath, 2017, 2019).

A second argument for the US dollar prices of exports to remain constant, despite depreciation of the LCU, for a small exporter such as Pakistan, is the immense competition. This makes the country a price taker in the global market rather than a price leader (Rahim, 2020), which will

[1] Significant foreign investment in Pakistan and other countries with weak currencies is domestic capital that has fled and is returning in the guise of being foreign.

certainly tend to dampen the depreciation effect. What is essential for our argument is that, as the exchange rate depreciates, the persistence of a CA deficit is both theoretically feasible and, empirically, should be well-observable. So, a depreciation of the exchange rate, with the persistence of a CA deficit, will create an expectation of further depreciation.

The primary causal factor we are positing for these expectations of depreciation is that, as a result of the initial depreciation, there will be a drop in domestic profitability relative to foreign profitability. This will result, in turn, in an increase in net outflows. As net outflows increase, the exchange rate will depreciate further, leading to a vicious downward cycle, with depreciation and outflows spurring each other on.

2.1. Theoretical Argument for Depreciation Lowering Domestic Profitability

This primary causal factor for the phenomenon of expectations of depreciation—of a fall in domestic profitability relative to foreign profitability—can be argued as follows: the impact of depreciation of the exchange rate on domestic profitability can be captured through three effects, described below.

Effect 1

Beginning with a two-share case, of total income can be divided into a profit share and a wage share. So if total income remains constant, a depreciation of the real wage W by depreciation of the exchange rate *e* will raise the profit share $\frac{\pi}{Y}$.

Effect 2

However, if a depreciation reduces total income by the same amount as the decrease in in wage share, the profit share also falls. Thus, as a result of depreciation of the exchange rate, we have, in the two-share case, a constancy between the profit share and wage share.

Effect 3

Next, we introduce a third factor share for capital. The capital cost of imported plants and equipment will not decrease with the depreciation of the exchange rate; rather it will appreciate by the extent of the depreciation (assuming the same amount of capital is imported). The rise in the capital share by the depreciation of the exchange rate *e* will further reduce the profit share $\frac{\pi}{Y}$.

We propose that market participants understand and take into account this fall in the profit share before an expected depreciation. So an expected depreciation —dubbed here *depreciationary expectations*—lead to capital outflows from the country. There are three behavioral reasons for this outflow: (i) declining domestic profitability relative to foreign profitability, (ii) as a precautionary hedge against the expectation of further depreciation of the LCU, the Pakistani rupee, (iii) as a store of value hedge against the expectation of further depreciation of the LCU, the Pakistani rupee. This means that unaccompanied by any other policy instrument, the standard price solution of depreciation will not lead to an equilibrium of the exchange rate.

The policy option of depreciation on its own is self-contradictory because it triggers depreciationary expectations. The initial depreciation causes domestic profitability to drop compared to foreign profitability, leading to increased outflows. The policy option to counter this relative drop in domestic profitability is to raise the domestic interest rate, which raises the cost of borrowing for investment and therefore deters investment.

The resulting restoration of domestic profitability relative to foreign profitability will reduce net outflows, which in turn will reduce further depreciation of the exchange rate. An increase in domestic interest rates can contain the deflationary expectations triggered by an initial depreciation of the exchange rate. However, raising interest rates reduces investment and thus growth, especially for economies with an already very weak investment rate. Moreover, raising interest rates will further weaken growth. A third policy option is therefore implied to fix the BOP crisis, prevent outflows, prevent deflationary expectations, and maintain investment and growth: the option of capital controls, which now has an established policy history of efficacy.

2.2. Theoretical Argument for Deflationary Expectations in a Price-Led Equilibrium

The whole point of depreciation is to reduce the CA deficit and reduce pressure on the BOP. However, examining how the KA pays for the CA deficit brings up the role of capital flows. The argument being put forward here is that depreciation of the exchange rate acts like inflationary expectations in its impact on the decision of private agents' capital flows.

We have net outflows (CF) equal to capital outflows (CO) minus capital inflows (CI):

$$CF = CO - CI \tag{2}$$

CF is a negative function of the domestic interest rate:

$$\text{CF} = fn\ (\text{r}) \tag{3}$$

The domestic interest rate acts as a proxy for domestic profitability Π_d relative to foreign profitability Π_f.

$$CF = fn(\Pi_d - \Pi_f) \tag{4}$$

CF increases as domestic profitability Π_d falls below foreign profitability Π_f in relative terms, in period t_1 relative to period t_0.

$$\text{If } \Pi_d < \Pi_f, CO \uparrow, CI \downarrow, CF \uparrow \tag{5}$$

CF decreases as domestic profitability Π_d rises above foreign profitability Π_f in relative terms.

$$\text{If } \Pi_d > \Pi_f, CO \downarrow, CI \uparrow, CF \uparrow \tag{6}$$

An initial depreciation of the LCU relative to a foreign currency unit (FCU), for example, the US dollar, implies that demand for the LCU will fall and demand for the US dollar will rise.[2] This demand for the LCU is actually based on the relative profitability conditions set out in equations (5) and (6). As the LCU depreciates, domestic profitability Π_d will fall relative to foreign profitability Π_f. More LCUs now need to be earned to equal one US dollar's worth of profits in the domestic economy. According to equation (5), CO will increase to invest abroad to earn at a relatively higher foreign profitability Π_f. CI will fall again because of relatively higher foreign profitability Π_f. Thus, CF will increase. The relationship between CF and the exchange rate is given by the behavioral macroeconomic equation (Obstfeld & Krugman, 2003) below:

$$NX - fn\ (e) = CF - fn\ (r) \tag{7}$$

[2] This is a standard textbook behavioral postulate underlying the demand and supply of LCUs relative to forex, where domestic banks and currency exchanges become the markets.

In equation (7), CF is a negative function of the interest rate, as set out in equation (3), while net exports (NX) are a negative function of the exchange rate (*e*), as expected by the behavioral price equation. As the exchange rate (*e*) depreciates, exports should rise, along with NX. But what equation (7) does is to critically link the CA to the KA. NX(*e*) has to equal CF(*r*). The balance of the flows of goods, services and asset incomes in and out of the economy, on the left-hand side of the equation, has to equal the balance of the change in assets—domestic assets held by foreigners and foreign assets held domestically—on the right-hand side of the equation.

This is the textbook identity, that the BOP must always be balanced. A deficit on the CA side of the equation, for instance, in NX(*e*), has to be paid for by claims on domestically held assets abroad, net, of course, of foreign-held domestic assets in CF(*r*). That is, a deficit in the flow of goods, services and asset incomes has to be paid for through the balance of outflows and inflows of claims to assets domestically held abroad and foreign-held domestic assets.

In a comparative statics exercise, this would begin through equation (5). As the exchange rate *e* depreciates, domestic profitability falls below foreign profitability in relative terms, as discussed above. This will induce CO to increase and CI to decrease, increasing CF all in order to take advantage of the relative rise in foreign profitability.

As CF increases, it will depreciate the exchange rate in a vicious loop for two reasons. First, the demand for the LCU will fall relative to, for example, the US dollar. This will weaken the exchange rate of the LCU to the US dollar. Second, the increased CF will also reduce the demand for domestic assets and their price. The textbook argument is that, as the demand for domestic assets drops, so does their price level relative to the foreign price level—which is the exchange rate. This general reduction in the price level will also depreciate the exchange rate *e* further.

This argues that equation (7) morphs into:

$$CF = fn\ (e, r) \tag{8}$$

Our postulate is that CF becomes a negative function of both the exchange rate *e* and the interest rate *r*. Thus, equation (8) expects a vicious downward cycle of an initial drop in exchange rates, reducing profitability *r*, which leads to an increased CF, thereby reducing the demand for domestic assets, both of which in turn lower the exchange rate *e* further. The exchange rate e and the profitability rate r can fall endlessly downward, with no automatic solution of a price equilibrium. This illustrates the case for depreciationary expectations under ceteris paribus conditions, with no automatic solution in the form of a price equilibrium.

2.3. Countering Deflationary Expectations in a Price-Led Model

Reestablishing equilibrium then requires cutting through this vicious downward cycle by raising the profit rate through the interest rate r. A depreciation in the exchange rate e can be prevented from decreasing domestic profitability relative to foreign profitability, $\Pi_d < \Pi_f$, as in equation (5), by raising the interest rate r. The interest rate r here represents the base rate of domestic returns for a supply of investible funds, domestic or CI. This will raise domestic profitability relative to foreign profitability, $\Pi_d > \Pi_f$, as in equation (6), reducing CO, raising CI, and therefore reducing CF. As the demand for the LCU increases relative to, say, the US dollar, this will strengthen the exchange rate of the LCU to the US dollar. This is the logic of equation (7)—that the interest rate r and exchange rate e move together. Thus, raising the interest rate r will raise the exchange rate e, thereby preventing depreciationary expectations.

A cautionary note needs to be sounded in summing up this theoretical exercise. Equation (7) links the KA with the CA as a traditionally given identity, but that does not mean that the KA is not causally linked to the CA. In fact, the CA is a function of the exchange rate, while the KA is a function of the interest rate. The KA—primarily reserves and interest rates—is used to influence the CA's exchange rate. True, the interest rate is a monetary policy variable, but must be viewed as a major KA policy instrument. Reserves, of course, are an intrinsic KA instrument and are used critically to control the exchange rate on the CA side.

2.4. Pakistan's Case

This theoretical framework is applied to Pakistan's case. Pakistan's BOP crises have been compounded since 1990. Preceding diagnostics for Pakistan, such as Amjad (2019), highlight the link between the CA deficit and the budget deficit. The gap between government revenues and expenditures needs to be met by means of external resources, through a CA deficit (Obstfeld & Krugman, 2003). Such a framework involves two markets—for domestic goods and tradeable goods. This paper brings into the analytical framework, a third market—that for global capital flows. This is done by examining not just the CA, which is the left-hand side of the BOP equation, but also the KA, which is the right-hand side of the equation.

As seen above, the BOP always balances as a macro-identity (Obstfeld & Krugman, 2003). As explained above, the CA comprises flows of goods, services, and asset incomes in and out of the country for the year. If there is a deficit in the CA, on the left-hand side of the equation, it has to be paid for in that year from the KA, on the right-hand side of the equation. The KA comprises changes in assets—of domestic assets held by foreigners and foreign assets held domestically. If there is a CA deficit in a particular year, it must be paid for by a change in capital assets on the KA side. In Pakistan's case, this has usually meant running down reserves of foreign currencies held by the SBP plus borrowing from foreign sources, that is, contracting multilateral, bilateral and private debt.

Confronted by an unsustainable BOP deficit in Pakistan's case, the standard price solution has been to depreciate the exchange rate *e*. What is essential for our argument is that, as the exchange rate is depreciated, the persistence of a CA deficit is both theoretically feasible and empirically well-observed, especially in the case of Pakistan. A depreciation of the exchange rate with the persistence of a CA deficit will create an expectation of further depreciation.

Our theoretical framework argues that the policy option of depreciation on its own is self-contradictory, because it triggers depreciationary expectations. The initial depreciation causes domestic profitability to drop compared to foreign profitability, leading to increased outflows. The policy option to counter this relative drop in domestic profitability is to raise the domestic interest rate. The resulting restoration of domestic profitability relative to foreign profitability will reduce net outflows and, in turn, reduce further depreciation of the exchange rate.

An increase in domestic interest rates can contain the depreciationary expectations triggered by an initial depreciation of the exchange rate. However, raising interest rates reduces investment and thus growth, especially for an economy such as Pakistan's with an already very weak investment rate of 16 percent of GDP. Raising interest rates will further weaken growth below its already anemic 4 percent per annum. A third policy option is therefore implied to fix the BOP crisis, prevent outflows, prevent depreciationary expectations, and maintain investment and growth: the option of capital controls which, in Pakistan, has been neglected of late.

2.5. Hypotheses for Pakistan's Case

In Pakistan's case, we hypothesize that depreciationary expectations should be observable for the period 1990 to the fiscal year 2017/18, for which we have been able to build a consistent series for these variables, using SBP data and in collaboration with the central bank.

These hypotheses require two caveats—one theoretical, one empirical. The first caveat is a theoretical one, required for the conceptual framework posited above to be applicable to Pakistan's institutional context. The first, as argued earlier, is that depreciationary expectations would apply in a purely price-led equilibrium, giving market-determined exchange rates. In a country such as Pakistan, with its long history of managed pegs to the US dollar, prior to the float in the fiscal year 2018/19 (the period under examination), the market-determined exchange rate would be expected to pressure the SBP to adjust the managed peg accordingly, if not fully, but in that direction.

This assumption about the behavior of the SBP to adjust the peg in the same direction as a market-determined exchange rate, also allows us to posit the behavior of investors of capital as if they were operating in a purely price-led equilibrium giving market-determined exchange rates.

The second caveat is an empirical one, that a purely price-led equilibrium, giving market-determined exchange rates, rests on the required condition of ceteris paribus. Such a purely price-led equilibrium would not apply strictly to a real economy such as Pakistan's, which would have used interest rate (r) increases, and/or growth of money supply reductions, to counter exchange rate depreciation (e), as in Section 2.3 above.

Nevertheless, we would not expect interest rates to have been raised sufficiently in Pakistan's case to completely counter depreciationary expectations. Interest rates are the cost of borrowing, and thus too large an increase would dampen investment and growth in an already low-growth economy, as will be elaborated in the policy section below. Given such a policy environment, attempting to balance BOP concerns with growth tradeoffs, we would still expect to observe depreciationary expectations. Accordingly, our hypotheses will be the following:

H1: *Depreciationary expectations will be indicated by the long-run trend of depreciation of the exchange rate being positively correlated with capital outflows from Pakistan.*

Capital outflows can be defined behaviorally in two ways:

- A narrower definition will include all outflows abroad for investment to obtain financial yield, and for consumption motives. Therefore, a long-run trend of depreciation will be positively correlated with this narrow definition of capital outflows.
- A broader definition would add all outflows as hedges against expected depreciation for store-of-value and precautionary motives. These two motives require including all foreign currency holdings in Pakistan, that is, holders of rupee balances who exchange them for US dollars. The argument is that foreign currency deposits reduce the demand for rupees and increase the demand for foreign currency, which will reduce the exchange rate, leading in turn to higher capital outflows.

Therefore, a long-run trend of depreciation will be positively correlated with foreign currency deposits and the broader definitions of capital outflows.

H2: In a price-led equilibrium model, depreciation of the exchange rate will not find equilibrium. Equilibrium implies some cyclicality of the exchange rate, or at least some stationarity after downfalls. In Pakistan's case, lack of equilibrium will lead to a secular long-run decline in the exchange rate over time.

H3: Depreciationary expectations will increase capital outflows from Pakistan, which in turn will reduce domestic investment in Pakistan. Hence, in the long run, depreciation will be negatively correlated with the share of private investment in Pakistan.

H4: Deflationary expectations will increase capital outflows from Pakistan, which in turn will reduce domestic savings in Pakistan. Hence, in the long run, depreciation will be negatively correlated with the share of private savings in GDP in Pakistan.

Savings in Pakistan are not estimated empirically from national income accounts data, but as a residual from investment and capital inflows. Therefore, savings and investment may not be statistically independent and will be correlated. However, capital inflows are statistically independent, therefore making savings not perfectly correlated with investment. Therefore, H4 becomes worth testing for savings.

3. Estimation of Outflows

The key variable to be estimated is capital outflows from the KA. The narrow definition of this variable is the problematic one because the broader definition simply takes this narrower definition, and adds to it resident foreign currency accounts (RFCAs), which are estimated by the SBP. The narrow definition of capital outflows must be based on the theoretical framework. The argument is that domestic outflows are based on the relative profitability of investing in the country as opposed to investing abroad. Therefore, the definition of capital outflows must begin with domestic outflows for investment abroad.

- The components of domestic outflows for investment abroad all come from the KA. This is consistent with the theoretical framework adopted above, that depreciation on the CA side leads to outflows on the KA side, triggering further depreciation. It also causes domestic asset price deflation, triggering in turn further depreciation. This phenomenon, being posited here as depreciationary expectations, leads to lack of equilibrium in the exchange rate in a long-run vicious spiral downward of depreciation and capital outflows.
- A further case can be made for adding to capital outflows from the KA side, outflows of income from the CA side of the equation, which comprises foreign-held domestic asset yields being repatriated. This is called the primary income balance from the CA. Its repatriation abroad pressures the exchange rate downward and detracts from FDI and portfolio investment from abroad.

Then domestic plus foreign-held capital outflows capture more comprehensively all capital and income flows abroad. These comprise four major components according to the SBP's established accounting framework. These are:

Domestic outflows for investment from the financial account (FA)

=

Direct investment abroad

+ Portfolio investment abroad

+ Net incurrence of assets

+ Net outflows of primary income from the CA

= Primary income balance

= Total net outflows from Pakistan

Table 1 estimates total net outflows from Pakistan for the fiscal year 2018 at USD5.4 billion. This is well in keeping with the then SBP governor's pronouncement that approximately USD6 billion had flowed out of Pakistan in the fiscal year 2018.[3] The series for total net outflows, estimated from the SBP's database, and in collaboration with the bank, is given in Table 2. To estimate the broader definition of capital, RFCAs are added to domestic outflows for investment from the FA. These RFCAs and the broader definition of capital outflows are given in Table 3.

Table 1: Estimating total net outflows from Pakistan (USD million)

Year	2018
Total net outflows	5,454
Net outflows from FA	172
Direct investment abroad	10
Portfolio investment abroad	-48
Net incurrence of assets	210
Net outflows from CA	5,282

Source: Authors' calculations, based on data from the State Bank of Pakistan.

[3] Statement by the SBP governor, Tariq Bajwa, at the Lahore School of Economics board of governors meeting in 2018.

Table 2: Total net outflows (USD million)

Year	Direct investment abroad	Portfolio investment abroad	Net acquisition of financial assets	Net outflows from FA	Net outflow from CA (primary income)	Total net outflows
	(A)	(B)	(C)	(D=A+B+C)	(E)	(D+E)
1990	12	0	-272	-260	878	618
1991	7	0	-448	-441	941	500
1992	8	0	-291	-283	1,123	840
1993	-4	0	-702	-706	1,389	683
1994	-6	0	-181	-187	1,447	1,260
1995	3	0	-140	-137	1,359	1,222
1996	-4	0	140	136	1,804	1,940
1997	-18	0	64	46	2,203	2,249
1998	29	0	-367	-338	2,188	1,850
1999	44	0	-34	10	1,803	1,813
2000	-1	549	-449	99	1,972	2,071
2001	37	140	-291	-114	2,203	2,089
2002	2	491	236	729	2,207	2,936
2003	27	0	434	461	2,211	2,672
2004	45	-3	-546	-504	2,207	1,703
2005	66	-11	-1,235	-1,180	2,386	1,206
2006	71	-22	-209	-160	2,667	2,507
2007	114	5	-758	-639	3,582	2,943
2008	75	5	32	112	3,923	4,035
2009	25	1,073	560	1,658	4,407	6,065
2010	76	65	-11	130	3,282	3,412
2011	44	7	-920	-869	3,017	2,148
2012	77	32	-9	100	3,245	3,345
2013	198	99	314	611	3,669	4,280
2014	128	-23	-211	-106	3,955	3,849
2015	73	-41	-71	-39	4,599	4,560
2016	19	100	96	215	5,347	5,562
2017	86	-1	1,180	1,265	5,048	6,313
2018	10	-48	210	172	5,282	5,454

Source: Authors' calculations, based on data from the State Bank of Pakistan.

Table 3: RFCAs, investment and saving as a percentage of GDP, and exchange rates

Year	Exchange rate (PKR to USD1)	Dep base year 1990	RFCA (A)	Total net outflows (B)	∑ of total net outflows and RFCA (A+B)	Gross total investment as % of GDP	Domestic savings as % of GDP
1990	21.71	0%	0	618	618	18.9%	11.7%
1991	23.80	10%	399	500	899	18.5%	12.7%
1992	24.84	14%	1,731	840	2,571	19.9%	16.6%
1993	25.96	20%	2,360	683	3,043	20.5%	14.4%
1994	30.16	39%	3,054	1,260	4,314	19.4%	15.9%
1995	30.85	42%	3,406	1,222	4,628	18.6%	14.2%
1996	33.57	55%	4,348	1,940	6,288	19.4%	12.4%
1997	38.99	80%	5,716	2,249	7,965	18.1%	12.8%
1998	43.20	99%	6,449	1,850	8,299	17.9%	15.4%
1999	46.79	116%	2,584	1,813	4,397	15.7%	13.1%
2000	51.77	138%	2,173	2,071	4,244	15.8%	15.8%
2001	58.44	169%	2,638	2,089	4,727	17.2%	16.9%
2002	61.43	183%	2,563	2,936	5,499	16.6%	18.1%
2003	58.50	169%	2,156	2,672	4,828	16.7%	17.6%
2004	57.57	165%	2,531	1,703	4,234	16.6%	16.4%
2005	59.36	173%	3,038	1,206	4,244	19.1%	15.4%
2006	59.86	176%	3,266	2,507	5,773	22.1%	15.7%
2007	60.63	179%	3,419	2,943	6,362	22.9%	15.6%
2008	62.55	188%	4,212	4,035	8,247	21.6%	11.5%
2009	78.50	262%	3,572	6,065	9,637	17.5%	9.8%
2010	83.39	284%	4,142	3,412	7,554	15.8%	9.3%
2011	85.56	294%	4,382	2,148	6,530	14.1%	9.7%
2012	89.27	311%	4,930	3,345	8,275	14.9%	7.7%
2013	96.73	346%	5,324	4,280	9,604	14.2%	9.0%
2014	102.86	374%	5,827	3,849	9,676	14.6%	9.8%
2015	101.29	367%	5,901	4,560	10,461	15.7%	10.1%
2016	104.24	380%	5,634	5,562	11,196	15.7%	8.7%
2017	104.67	382%	6,261	6,313	12,574	16.1%	8.2%
2018	109.84	406%	7,551	5,454	13,005	16.4%	7.5%

Source: Authors' calculations, based on data from the State Bank of Pakistan.

4. Some Empirical Results

This section presents the study's empirical results for Pakistan's CA and KA, and depreciation and outflows.

4.1. Pakistan's CA Problems and Financing from the KA

Figure 1 and Table 4 show that, for the last 30 years, Pakistan's CA has been under pressure and in deficit for most of this period, except for five years, from 2001 to 2004, and 2011. 1990 to 1993 saw small but increasing CA deficits of under USD5 billion. Figure 1 shows that a succession of IMF support programs in 1993, 1994, 1995, and 1997, reduced the deficits short-term to near-balance by 2000. Another two IMF programs, in 2000 and 2001, appear to have contributed to the only CA surplus from 2000 to 2004.

Table 4: Decomposition of the CA (USD million)

Year	CA (A+B+C)	Balance on trade in goods and services (A)	Balance on primary income (B)	Balance on secondary income (C)	Change in reserves and related items	Accumulated reserves (SBP + banks + gold)	Accumulated reserves (SBP only)
1990	-1,353	-3,223	-878	2,748	377	1,451	-
1991	-1,578	-3,388	-941	2,751	6	1,390	-
1992	-1,049	-3,337	-1,123	3,411	130	1,761	-
1993	-3,327	-4,626	-1,389	2,688	-589	1,369	-
1994	-1,651	-2,908	-1,447	2,704	1,585	3,337	-
1995	-2,163	-3,562	-1,359	2,758	238	3,730	-
1996	-4,348	-5,149	-1,804	2,605	-431	3,521	-
1997	-3,557	-4,601	-2,203	3,247	-1,032	1,977	-
1998	-1,701	-2,943	-2,188	3,430	-306	1,737	935
1999	-2,235	-3,279	-1,803	2,847	824	2,922	1,673
2000	-217	-2,234	-1,972	3,989	72	2,766	997
2001	326	-2,208	-2,203	4,737	1,001	3,810	1,689
2002	2,833	-733	-2,207	5,773	2,792	7,065	4,337
2003	4,070	-361	-2,211	6,642	5,239	11,472	9,529
2004	1,811	-2,595	-2,207	6,613	904	13,155	10,564
2005	-1,534	-7,807	-2,386	8,659	-293	13,338	9,805
2006	-4,990	-12,871	-2,667	10,548	977	14,354	10,765
2007	-6,878	-13,881	-3,582	10,585	3,577	18,890	14,333
2008	-13,874	-21,427	-3,923	11,476	-5,365	13,436	8,745
2009	-9,261	-16,008	-4,407	11,154	-3,056	13,971	9,527
2010	-3,946	-13,226	-3,282	12,562	1,266	17,921	13,112
2011	214	-12,456	-3,017	15,687	2,492	20,941	15,662
2012	-4,658	-18,957	-3,245	17,544	-3,275	16,493	10,856
2013	-2,496	-16,919	-3,669	18,092	-1,992	10,831	6,047
2014	-3,130	-19,240	-3,955	20,065	3,858	14,141	9,098
2015	-2,795	-20,237	-4,599	22,041	2,646	18,699	13,526
2016	-4,867	-22,689	-5,347	23,169	2,652	23,098	18,143
2017	-12,621	-31,019	-5,048	23,446	-1,946	21,403	16,145
2018	-18,130	-36,385	-5,282	23,537	-6,118	16,407	9,789

Source: Authors' calculations, based on data from the State Bank of Pakistan.

After 2004, the CA deficits have recurred, and with much greater intensity. By 2008, the CA deficit had plunged to near USD14 billion. Two successive IMF programs in 2008 and 2013 lowered the CA deficits into the USD3 billion range till 2015. After that, the CA deficit has kept plunging to its current level of USD18 billion for 2018. With bilateral BOP support of USD5 billion and a new IMF agreement in early 2019 of USD8 billion. These widening deficits on the CA, flows of goods, services and asset incomes have been financed by the KA by changes in assets held domestically and abroad, as in equation (1).

The KA comprises the FA plus forex reserves held by the SBP, plus some adjustment:

KA = FA + reserves + (net errors and omissions + cap account) (8)

The FA in turn comprises net borrowing (B) plus net FDI plus net portfolio investment:

FA = B + FDI + portfolio (9)

Illustratively, Table 4 shows that, for the financial year 2017/18, the CA deficit plumbed –USD18.1 billion, amounting to –5.8 percent of GDP. This was based on a trade deficit in goods and services of –USD3.6 billion; a deficit in asset income, called a balance in primary income, of –USD5.3 billion; and a surplus in remittance income, called a balance on secondary income, of USD2.4 billion.

This CA deficit of USD18.1 billion had to be paid for in 2017/18. Table 5 shows that it was paid for largely by running down reserves by – USD6.1 billion, net borrowing from abroad of USD7.3 billion, and net FDI inflows of USD2.8 billion, plus net portfolio inflows of USD2.3 billion. The pattern of CA deficits from 1990 to 2018 has been observed to be small deficits till 2000, four years of surpluses till 2004, followed by much larger deficits to date. Table 5 shows that, till 2004, net FDI was largely under USD1 billion or negative. Net portfolio was also largely under USD1 billion over this period, often much smaller. After 2004, net FDI has been consistently positive and ranging between USD1 billion and USD5 billion. Net portfolio has been yoyoing between positive and negative since 2004, ranging up to USD3 billion. Given this small size of FDI and portfolio, relative to the KA needed to match the CA deficits, that has had to be met by borrowing from abroad and running down reserves.

As the CA deficits have mounted over time, borrowing and running down reserves have mounted with them. During the lower deficits of the 1990s, borrowing ranged up to USD3 billion. The CA surpluses of 2000 to 2004 actually saw repayment of borrowing for seven years around that period. Since then, borrowing has mounted to USD5 billion and then USD7 billion over the last three years. Reserves again were largely added to more regularly from 1990 till after the surpluses of 2000–04. After that, reserves have been run down more often, mounting to losses of more than USD8 billion over the last two years.

Table 5: Decomposition of the KA (USD million)

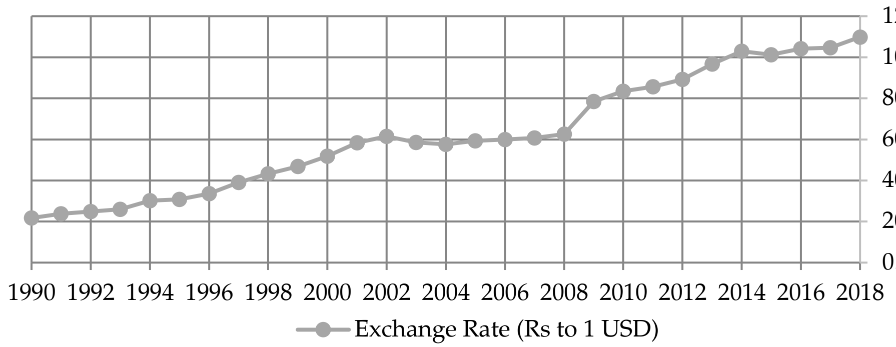
Year	CA deficit	Net borrowing	Net FDI	Net portfolio	Financial account	Change in reserves and related items	Net errors and omissions	Capital account balance
	(D-E+F+G)	(A)	(B)	(C)	(D=A+B+C)	(E)	(F)	(G)
1990	1,353	1,490	204	81	1,775	377	-45	0
1991	1,558	1,307	239	84	1,630	6	-66	0
1992	1,049	598	343	272	1,213	130	-34	0
1993	3,327	2,132	310	270	2,712	-589	26	0
1994	1,651	2,458	360	339	3,157	1,585	79	0
1995	2,163	757	445	1,274	2,476	238	-75	0
1996	4,348	2,703	1,106	159	3,968	-431	-51	0
1997	3,557	1,082	700	677	2,459	-1,032	66	0
1998	1,701	355	572	34	961	-306	434	0
1999	2,235	-2,469	428	142	-1,899	824	992	3,966
2000	217	-4,101	473	-549	-4,177	72	500	3,966
2001	-326	-788	286	-140	-642	1,001	625	692
2002	-2,833	-1,100	484	-491	-1,107	2,792	928	138
2003	-4,070	-1,019	771	-239	-487	5,239	523	1,133
2004	-1,811	-2,431	906	314	-1,211	904	222	82
2005	1,534	-1,516	1,459	620	563	-293	-7	685
2006	4,990	1,037	3,450	986	5,473	977	253	241
2007	6,878	1,663	5,026	3,283	9,972	3,577	179	304
2008	13,874	2,764	5,335	32	8,131	-5,365	257	121
2009	9,261	3,010	3,695	-1,073	5,632	-3,056	118	455
2010	3,946	3,087	2,075	-65	5,097	1,266	-60	175
2011	-214	172	1,591	338	2,101	2,492	16	161
2012	4,658	680	744	-144	1,280	-3,275	-80	183
2013	2,496	-735	1,258	26	549	-1,992	-309	264
2014	3,132	1,221	1,572	2,762	5,555	3,858	-422	1,857
2015	2,791	2,271	915	1,884	5,070	2,646	-8	375
2016	4,867	4,933	2,286	-429	6,790	2,652	456	273
2017	12,621	7,785	2,663	-250	10,198	-1,946	102	375
2018	18,130	7,279	2,760	2,259	12,298	-6,118	-662	376

Source: Authors' calculations, based on data from the State Bank of Pakistan.

4.2. Depreciation Has Been the Panacea

Over this period from 1990 to 2018, the run of CA deficits has been countered by the price policy of depreciation. Table 3 and Figure 2 show that the rupee has depreciated from PKR 22 to the US dollar in 1990, to PKR110 by 2018. Between mid-2018 and mid-2019 alone, the rupee further slumped to PKR160 to the US dollar. Figure 2 shows that the only plateau in this depreciation occurred between 2002 and 2007, which is wrapped around the four years that the CA was in surplus. The rupee's depreciation peaked at PKR61 to the US dollar in 2002. From 2002 to 2004, the CA posted the only large surpluses ever, of USD2 billion to USD4 billion. During this period, the rupee appreciated marginally to PKR58 to the US dollar by 2004, after which the rupee began depreciating again, to reach PKR61 to the US dollar by 2007.

Figure 2: Exchange rate trend (USD to PKR)



Source: Authors' calculations, based on data from the State Bank of Pakistan.

Thus, the pattern has been one of sharp depreciation of the rupee—183 percent between 1990 and 2002—with a hiatus and plateau between 2002 and 2004, down to 165 percent, when the CA ran a surplus. Subsequently, depreciation resumed at an even higher rate—to 406 percent by 2018.

Our theoretical argument is that such a policy of depreciation may or may not work on the CA side of the equation to bring about a price-led equilibrium between exports and imports. However, on the KA side of the equation, such a price-led policy of depreciation will certainly not bring about the equilibrium of the exchange rate. The argument is that a policy of depreciation will, in turn, generate expectations in agents of further depreciation—dubbed here depreciationary expectations, analogous to inflationary expectations. These depreciationary expectations will be triggered by the initial depreciation, causing a drop in domestic profitability vis-à-vis foreign profitability. This will cause net outflows to increase, to benefit from the relative increase in foreign profitability.

As net outflows increase on the KA side of the equation, this will reduce demand for domestic assets relative to the demand for foreign assets on the CA side, lowering domestic price levels and, in turn, depreciating the exchange rate further. The downward spiral is caused by an initial depreciation, resulting in relatively lower domestic profitability and thus an increase in net outflows, lower demand for domestic assets, and lower domestic prices, thereby depreciating the exchange rate further; this spiral will not allow an equilibrium of the exchange rate. Thus, a purely price-led policy of depreciation will, on its own, ceteris paribus, give rise to pernicious depreciationary expectations on the KA side of the BOP equation and not allow an equilibrium of the exchange rate.

This theory of depreciationary expectations now needs to be tested for Pakistan's data.

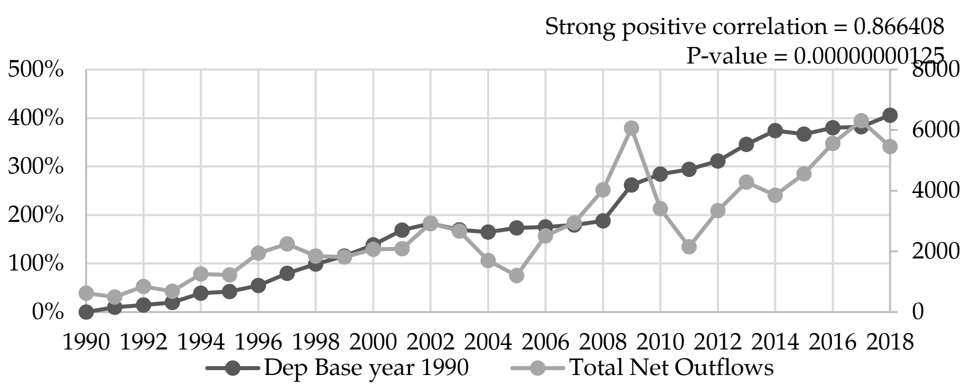
4.3. Depreciation and Outflows

Hypothesis 1: Depreciationary expectations will be indicated by the long-run trend of depreciation of the exchange rate being positively correlated with capital outflows from Pakistan.

H1a: This applies to a narrower definition of outflows, comprising domestic net total outflows for investment from the KA, plus the balance on primary income from the CA side, the argument being that both pressure—and so weaken—the exchange rate.

H1b: This applies to the broader definition of outflows, comprising the narrower definition of outflows plus RFCAs. The argument is that RFCAs are maintained not just for investment motives, but also for precautionary motives and store of value. Therefore, outflows are now considered to be motivated by speculation, precaution, and store of value. However, the net result expected of these outflows for all three purposes is to pressure and weaken the exchange rate.

Figure 3: Depreciation with total net outflows (USD million)

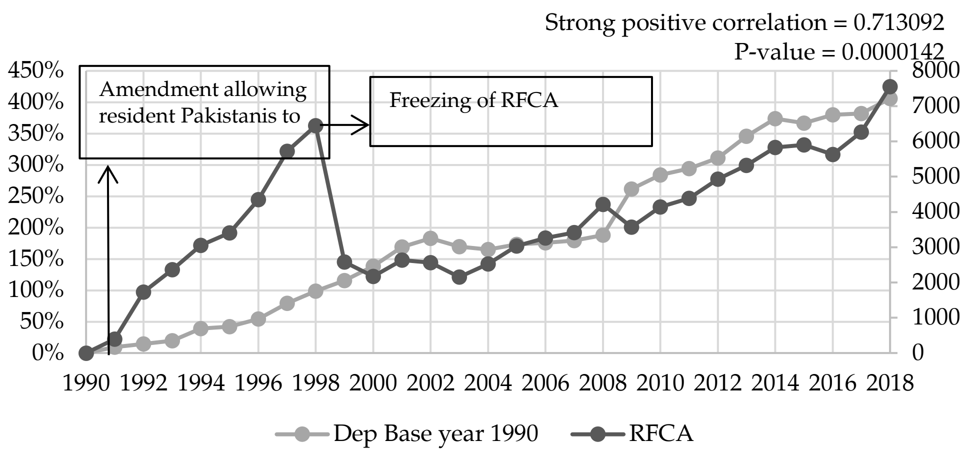


Source: Authors' calculations, based on data from the State Bank of Pakistan.

Table 2 and Figure 3 present the estimated series for the narrower definition of outflows, called total net outflows. This comprises the estimated net outflows from the KA side, plus net outflows of primary income from the CA side. Figure 3 shows that total net outflows have clearly increased on trend, from about USD1 billion in 1990, to peak at USD6 billion by 2017. There have been only two troughs in the outflows: (i) over 2003–05, when depreciation also plateaued; and (ii) over 2009–11, when depreciation continued. There appears to be only one episode of depreciation and outflows running contra-trend, against the expectation of the theoretical argument. Otherwise, depreciation and outflows move together positively, as expected in H1.

Figure 3 shows a strong positive correlation, with 87 percent of the variation in outflows explained by the variation in depreciation. The p-value shows the correlation to be highly significant, confirming H1a for the narrower definition of outflows. The broader definition of outflows comprises the narrower definition plus RFCAs. Table 3 and Figure 4 present the series for this data.

Figure 4: Depreciation with RFCA (USD million)



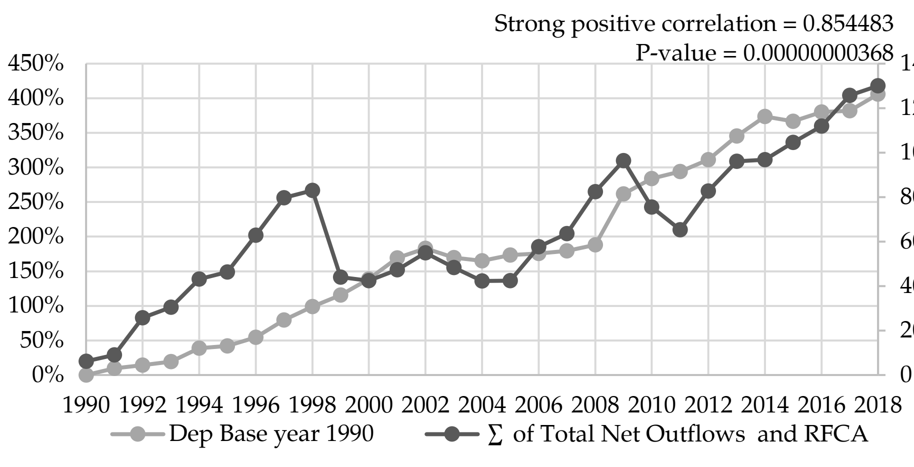
Source: Authors' calculations, based on data from the State Bank of Pakistan.

RFCAs were legally instituted in 1973, but with a fee charged for maintenance. Table 3 shows them to be negligible in volume till 1992 when the fee was removed. These RFCAs boomed till 1997 when the regime was confronted by peaking CA deficits, requiring unprecedented levels of foreign borrowing of USD4 billion a year as Table 5 shows, and the first major rundown of reserves of USD1 billion. In 1998, the regime finished off convertibility by freezing RFCAs, allowing only rupee withdrawals, with a host of administrative permissions and fees instituted for customers who wished to continue.

Table 3 shows that this government seizure of RFCA forex drove down their volume from a peak of USD6.5 billion in 1998 to USD2 billion for the next few years. The government allowed new RFCAs to be opened with restored convertibility, but it took several years for the disincentive of the 1998 freeze and seizure of forex to wear off. Since 2004, however, the volume in RFCAs has mounted to a high of USD7.5 billion by 2018. Our argument is that these RFCAs also constitute an increase in demand for forex and, therefore, a reduction in demand for rupees, which weakens the rupee. Accordingly, RFCAs should count as outflows. The hypothesis is that this broader definition of outflows is expected to be correlated with depreciation.

Figure 4 shows that RFCAs on their own have moved together with depreciation. With depreciation, agents will hedge against the rupee, especially for store of value. There is a strong positive correlation, with 71 percent of the variation in RFCAs being explained by the variation in depreciation. The correlation has a highly significant p-value. Table 3 and Figure 5 add RFCAs to total net outflows for the broader definition of outflows. These are seen in Table 3 to mount up from USD0.6 billion in 1990 to USD13 billion by 2018.

Figure 5: Depreciation with sum of total net outflows and RFCA (USD million)



Source: Authors' calculations, based on data from the State Bank of Pakistan.

Figure 5 shows that this wider definition of outflows and depreciation move together. There is a strong positive correlation, with 85 percent of the variation in the broader definition of outflows being explained by the variation in depreciation. The correlation has a highly significant p-value.

4.4. Depreciation Does Not Lead to an Equilibrium Exchange Rate

H2: In a price-led equilibrium model, depreciation of the exchange rate will not find equilibrium. Equilibrium implies some cyclicality of the exchange rate or at least some stationarity after downfalls. In Pakistan's case, lack of equilibrium will lead to a long-run secular decline in the exchange rate over time.

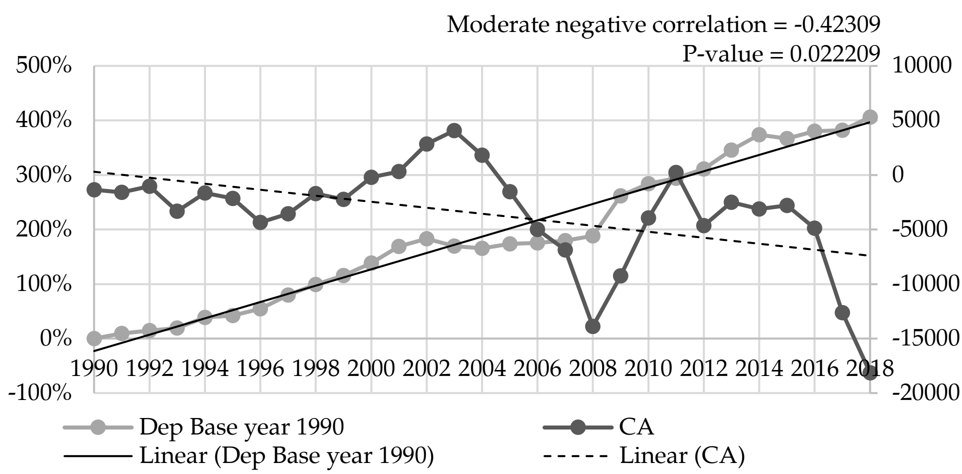
The ideal observation of price equilibrium is the cobweb theorem, where the price oscillates around a particular value. However, to depict a drop in price, leading to equilibrium between supply and demand, a better characterization would be stationarity after a fall—an L curve. Or, if we are depicting depreciation as an increase in the rupees needed per, say, US dollar, as we are here, then stationarity should describe a ρ curve—an increase in the number of rupees per USD, followed by stationarity or cyclicality around a new equilibrium value. Even if periodic depreciation is needed to obtain a cycle of disequilibrium and equilibrium, followed by another cycle of disequilibrium and equilibrium, then we should be able to observe periodic ρ curves.

Alternatively, if periodic depreciation is not leading to periodic equilibrium, then we should observe a secular depreciation over time, according to H2. What Figure 2 shows is a secular depreciation of the rupee against the US dollar over the very long period of 28 years, from 1990 to 2018. This decline is interrupted by one stationarity between 2002 and 2004, when the rupee appreciated from PKR61 to PKR57 against the US dollar, before depreciating again from 2005 onward. Surely, price policy to generate equilibrium is not meant to act over decades, allowing the 2002-to-2004 stationarity, or ρ, to be interpreted as oscillation around one equilibrium in 38 years. Rather, the interpretation of Figure 2 should be as a secular depreciation over the very long run of 38 years, with no periodic oscillations or ρ curves around periodic equilibriums. This lack of observation of periodic oscillations or ρ curves, as evidence of lack of periodic equilibriums, confirms H2—that a price-led equilibrium model does not allow depreciation of the exchange rate to find an equilibrium value.

Another test of whether depreciation can even theoretically lead to equilibrium of the exchange rate in Pakistan's case is afforded by observing whether depreciation leads to a reduction in the CA deficit. This should be the case according to textbook equation (7), where net exports are a negative function of the exchange rate. If depreciation does tend to lower the CA deficit, then we are, in theory, moving toward an equilibrium value of the exchange rate. If depreciation does not tend to lower the CA deficit, then we are not even headed toward finding an equilibrium value of the exchange rate.

Figure 6 plots the increasing value of the depreciation index, with the clear upward trend well observed by now. It also plots the CA, which shows a long-run downward trend over 38 years from 1990 to 2018. In the long run, even a gradual depreciation of the exchange rate has not lowered the CA deficit.

Figure 6: Depreciation with CA (USD million)



Source: Authors' calculations, based on data from the State Bank of Pakistan.

The only years for which depreciation plateaued, 2002 to 2004, was when the CA was also briefly in surplus in these 38 years. Apart from those four years, depreciation has not reduced the CA deficit between 1990 and 2018. This further supports the theory we have put forward of the pernicious nature of depreciationary expectations: that an initial depreciation of the exchange rate will lead to expectations of further depreciation. The trigger for these deflationary expectations is the loss in domestic profitability relative to foreign profitability, and increasing capital outflows to take advantage of relatively higher profits abroad. These outflows have been observed above to be well correlated to depreciation.

The outflows raise the demand for foreign assets, lowering the demand for domestic assets, inducing in turn further depreciation. This implies a vicious cycle of depreciation, relatively lower domestic profitability, increased outflows, and lower demand for domestic assets, resulting in further depreciation. This further implies that a price-led policy of depreciation will not result in equilibrium of the exchange rate.

We observe empirically evidence of the beginning and end processes of this lack of equilibrium. We observe depreciation leading to capital outflows, but discern no periodic stationarity or ρ curves, as evidence of periodic equilibrium. Ergo, the study so far supports the theory put forward of deflationary expectations preventing a price-led equilibrium in the exchange rate. We now need evidence of the major causal factor triggering the outflows, which is the depreciation-led fall in domestic profitability relative to foreign profitability. This should imply that outflows of capital reduce domestic investment and is tested next.

4.5. Depreciation Will Lead to Capital Outflows, Reducing the Share of Investment in GDP

H3: Depreciationary expectations will increase capital outflows from Pakistan, which in turn will reduce domestic investment in Pakistan. Hence the long-run trend of depreciation will be negatively correlated with the share of private investment in Pakistan.[4]

Expectations of depreciation by private agents—investors—can be expected to lead to increased capital outflows, to take advantage of increased profitability abroad compared to profitability in Pakistan. These increased outflows have been well observed to be correlated with increased depreciation, nor do depreciationary expectations allow an equilibrium in the exchange rate. Again, this has been well observed above. Increased capital outflows, comprising both domestic capital as well as repatriation of asset incomes earned by foreigners—both of which could have been invested in Pakistan—implies that the rate of domestic investment could drop in the long run. This underscores the expectation in H4, that

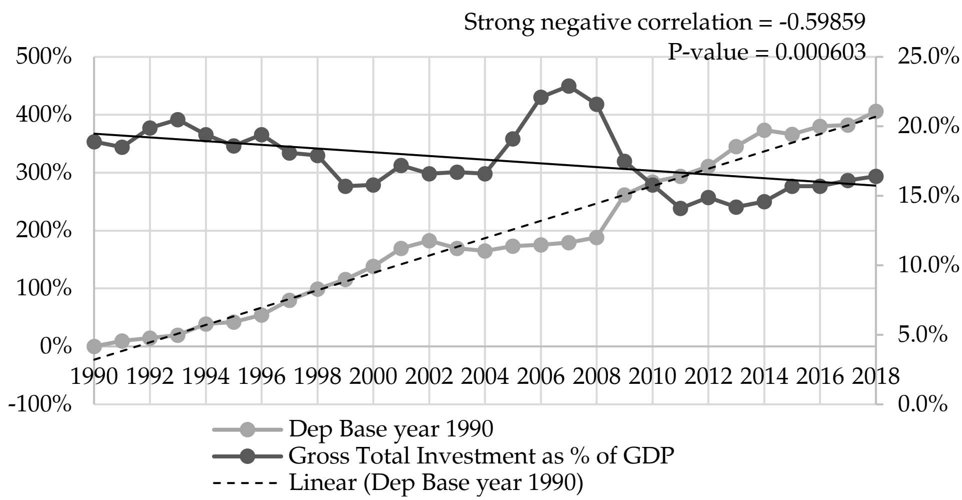
[4] The mechanism works through the availability of foreign exchange. Domestic banks can always provide credit even in the absence of savings, which means obtaining foreign saving, i.e., foreign borrowing.

depreciation will be negatively correlated with the share of private investment in Pakistan.

Table 3 and Figure 7 give the share of gross private investment in GDP from 1990 to 2018. Figure 7 shows a clear downward trend in the investment share, from 20 percent in 1990 to about 16 percent by 2018, while depreciation has been increasing on trend over this period. This gives a strong negative correlation between the investment share and depreciation. About 59 percent of the variation in the share of investment in GDP is explained by the variation in depreciation. The p-value is highly significant.

Depreciation cannot be the definitive and comprehensive causal factor for the declining long-run trend in the investment share. Figure 7 does not portray itself as the long-run investment function for the country. Obviously, a number of other factors have to be used to explain the declining investment share. However, the contribution of depreciation to the declining investment share is significant.

Figure 7: Depreciation with gross total investment as a percentage of GDP



Source: Authors' calculations, based on data from the State Bank of Pakistan.

The period 2002–07 is particularly illustrative of the observed negative correlation between the investment share and depreciation. This is the only period in Figure 7 when depreciation plateaus or lowers. It is also the only period when the investment share surges to 22 percent, contra the long-run declining trend. This is good evidence in support of our argument that the relative stability in the exchange rate over this period reduced expectations of further depreciation. This kept domestic profitability relative to foreign profitability constant, inspiring a surge in domestic investment.

4.6. Depreciation Will Lead to Capital Outflows, Reducing the Share of Savings in GDP

H4: Deflationary expectations will increase capital outflows from Pakistan, which in turn will reduce domestic savings in Pakistan. Hence, the long-run trend of depreciation will be negatively correlated with the share of private savings in Pakistan.

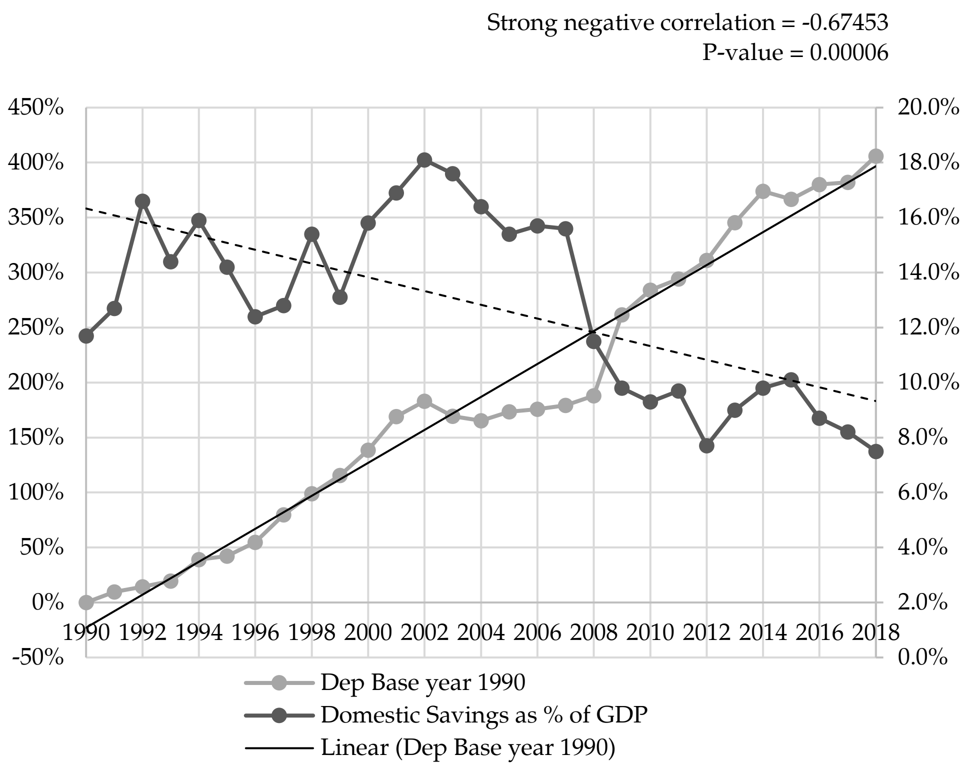
Underlying the declining share in private investment should be a declining share in private savings. Depreciation, followed by expectations of further deflation by private agents, can be expected to lead to capital outflows to invest domestic savings abroad, to benefit from the relative increase in profitability abroad compared to Pakistan. We have used two definitions of capital outflows. A narrower definition comprises just domestic outflows for investment, plus repatriation of foreign asset income. A broader definition adds to the narrower definition of capital outflows, RFCAs held in Pakistan, the argument being that both the narrower definition of capital outflows and the RFCAs pressure and weaken the exchange rate.

The motive for RFCAs was taken to be not speculative, but instead store of value and precaution. Thus, the addition of these two motives to the motive of speculation adds, of course, to the quantum estimation of capital outflows. However, the additional motives of store of value, precaution, and consumption, should raise consumption and lower savings. Therefore, the broader definition of capital outflows, because of its added motives of store of value and consumption, by raising the consumption share should have a greater impact on the savings share. That is, depreciation should have not only a negative impact on the savings share, but it should also be stronger than its impact on the investment share.

Table 3 and Figure 8 show the series for savings as a share of GDP from 1990 to 2018. The figure plots savings falling clearly on trend, from 17 percent of GDP in 1992 to 8 percent of GDP by 2018. With the well-observed increasing trend in the quantum of depreciation, this gives a strong negative correlation with the savings share. More than two thirds of the variation in the savings share is explained by the variation in depreciation.

The correlation for the savings share is stronger than the correlation for the investment share. The caveat for the investment result must be repeated for the savings result. Figure 8 cannot be a comprehensive savings function, which comprises other key macro aggregates. However, it is indicative of the impact of depreciation as a contributory factor explaining the declining trend in the savings share. Again, illustratively, as for the investment correlation, the period of plateauing in depreciation between 2002 and 2007 also shows a corresponding bump-up in the savings share, contra the declining long-run trend.

Figure 8: Depreciation with domestic savings as a percentage of GDP



Source: Authors' calculations, based on data from the State Bank of Pakistan.

5. Conclusions for Policy

This section concludes our paper with several key policy implications.

5.1. The Theory of Depreciationary Expectations

We have some statistical evidence to support the proposed theory of depreciationary expectations operating in Pakistan, observed over the long-run period of 1990 to 2018. The theory of depreciationary expectations put forward in this article argues that a significant and protracted CA deficit will not be closed through a purely price-based policy instrument of depreciation of the exchange rate. This is because such a price solution (depreciation of the exchange rate) is meant to operate on the CA by lowering the price of exports, raising their volume, while increasing the price of imports, but lowering their volume, thus reducing the CA deficit.

This is a partial equilibrium analysis, focusing solely on the CA side of the equation, whereas the BOP deficit on the left-hand side has to be paid for out of the KA given by the right-hand side of the equation. A BOP deficit only balances, since it is paid for by claims on assets given on this KA. The deficit on the CA is paid for on the KA by net capital inflows into the country, liquidating country assets owned abroad, running down forex reserved held by the SBP, and borrowing from abroad.

Depreciation of the exchange rate follows at least some logic of giving an equilibrium on the left-hand side of the equation, on the CA. However, depreciation will not lead to an equilibrium of the exchange rate on the right-hand side of the equation, on the KA. This is because depreciation of the exchange rate will lead to expectations by private agents, domestic and foreign investors, and domestic consumers, of further depreciation.

The causal factor for depreciationary expectations is that the initial depreciation of the exchange rate reduces domestic profitability relative to foreign profitability. We have demonstrated above axiomatically that, in a two-factor case, the depreciation of the exchange rate, working to reduce the real wage, will increase profitability, but be canceled out by the equal depreciation of rupee profits in, say, US dollar terms. Further, in a more realistic three-factor case where some plant and capital equipment is imported, depreciation will now raise this cost in US dollar terms, resulting in a net loss in domestic profitability relative to foreign profitability.

Investors, both domestic and foreign, will then increase capital outflows and reduce capital inflows, raising net capital outflows to benefit from the relative increase in profitability abroad. The increase in net capital outflows will further weaken and depreciate the exchange rate. The increased outflows also lower demand for domestic assets relative to an increased demand for foreign assets, which puts further downward pressure on the exchange rate.

Thus, depreciationary expectations characterize a vicious cycle of depreciation, falling domestic profitability compared to foreign profitability, rising net capital outflows, and falling demand for domestic assets, leading back in turn to further depreciation of the exchange rate, which implies that there will be no equilibrium of the exchange rate on the KA side of the equation. While a partial equilibrium analysis of just the CA may possibly give equilibrium on the left-hand side of the equation, it cannot give equilibrium of the exchange rate on the KA, on the right-hand side of the equation. That is, a GE analysis of both the CA and KA does not give a price-determined equilibrium of the exchange rate.

The increase in net capital outflows may be initiated by the speculative motive but is added to by motives of store of value, precaution and consumption. Savers and consumers will also want to increase their holdings of forex rather than rupees through RFCAs. The increased demand for forex rather than rupees will further weaken the latter. Thus, RFCAs also behave like net capital outflows in weakening the rupee and contributing to deflationary expectations. This model of depreciationary expectations captures Pakistan's current and indeed recurrent BOP crises. Evidence marshalled for the KA for Pakistan for the years 1990 to 2018 shows significant support for this theory of depreciationary expectations.

5.2. The Evidence Supporting Depreciationary Expectations

We have distilled the theory of depreciationary expectations into four hypotheses, each of which is supported by statistically significant evidence. One, depreciationary expectations imply that net capital outflows will increase with the quantum of depreciation of the rupee. A narrower definition of capital, comprising domestic outflows for investment plus repatriation of nonresident asset income earned domestically, shows a strong positive correlation that is highly significant. A broader definition of capital adds to the narrower definition RFCAs and, again, shows a strong positive correlation that is highly significant.

Further research could try to establish Granger causality between depreciation and outflows. However, our study establishes that both have been locked in a vicious cycle of spurring each other on in Pakistan over the last 30 years. This implies that the second hypothesis, that a purely price-based policy of depreciation on its own will not lead to an equilibrium in the exchange rate. Equilibrium implies that depreciation would result in some stationarity, if not cyclicality, around a new equilibrium value of the rupee. Over the period under observation, from 1990 to 2018, we would expect to see a number of these cycles. However, we observed just one period of stationarity of the rupee, over 2002–04, which coincided with the only CA surplus in these 30 years. Thus, while the rupee has been consistently devalued by some 400 percent over this long period, stationarity was achieved only once. This cannot be interpreted as equilibrium of the rupee. Rather, it must be interpreted as lack of equilibrium.

We therefore conclude on this evidence that a purely price-based policy of depreciation of the exchange rate has not led to an equilibrium value for the rupee because depreciationary expectations were consistently generated in the economy. These depreciationary expectations have induced increases in net capital outflows, which in turn have depreciated the rupee further, completing a pernicious cycle between depreciation and net capital outflows. The increase in net capital outflows triggered by continuous depreciation of the rupee can be expected to reduce domestic investment and savings, according to the third and fourth hypotheses. That has indeed been the case. Private investment shows a long-run trend downward over this period from 18 percent of GDP to 16 percent, strongly negatively correlated with the quantum of depreciation. Savings similarly drop from 17 percent of GDP to under half, to 7 percent—again, strongly negatively correlated with the quantum of depreciation.

While these are by no means comprehensive investment and savings functions, requiring other macro-aggregates to estimate them, they do show the major implication of a purely price-based policy of depreciation, working though depreciationary expectations, to induce an increase in capital outflows, so contributing to the secular decline in domestic investment and savings.

5.3. Policy Implications

Macro-policy in Pakistan must then tread the proverbial slippery slope. The policy option of depreciation on its own is self-contradictory because it triggers depreciationary expectations. The initial depreciation causes domestic profitability to drop compared to foreign profitability, leading to increased outflows. The policy option to counter this relative drop in domestic profitability is to raise the domestic interest rate. The resulting restoration of domestic profitability relative to foreign profitability will reduce net outflows, which in turn will reduce further depreciation of the exchange rate. An increase in domestic interest rates can contain the depreciationary expectations triggered by an initial depreciation of the exchange rate. However, raising interest rates reduces investment and so growth—especially for Pakistan's economy with an already very weak investment rate of 16 percent of GDP. Raising interest rates will further weaken growth below its already anemic 4 percent per annum.

A third policy option is therefore implied to fix the BOP crisis, prevent outflows, prevent deflationary expectations, and maintain investment and growth: the option of capital controls, with a now established history of efficacy.

5.4. Capital Controls

Capital controls to manage BOP crises are time-honored, to prevent the great mischief which the realm suffereth when gold and silver leave the country. So saying, Richard II imposed laws to make it difficult to export precious metals from England in 1381. These prohibitions were lifted only 150 years later under Henry VIII. Come the Great Depression and disruption of the gold standard, John Maynard Keynes argued successfully for permanent restrictions on cross-border capital flows, which in 1944 the Bretton Woods Conference baked in. Capital controls fell out of favor of the economic orthodoxy when the Bretton Woods system collapsed at the end of the 1960s, fixed exchange rates were abandoned, and over the next couple of decades, the IMF argued that capital should flow freely across borders (Bordo, 2017).

That reversal too has been overturned. With the Asian crisis, Malaysia under Prime Minister Mahathir spurned the IMF and imposed capital controls to great effect. Iceland followed when its banking crisis led investors to pull money out of the country. Cyprus used capital controls for two years for its banking crisis in 2013 (Weaver & Stothard, 2013). Greece's monumental debt crisis verging on default and near crashing out of the Euro, led to stringent capital controls to prevent outflows. These were sanctioned by the European Commission and the IMF as part of the USD200 billion-plus bailout from 2015 to date. The IMF shifted its stance and declared in 2010 that capital controls could be useful. China, with USD3 trillion in reserves, has a managed float of the yuan just breaking 7 to the US dollar, and strict capital controls on outflows, down to caps on ATMs abroad (Song, Storesletten, & Zilibotti, 2014; Clover & Weinland, 2017).

5.5. Macro-Policy for Pakistan

Pakistan should focus on just the need to maintain three macro-fundamentals: the exchange rate, already pressured downward in open markets; the inflation rate, stoking up with low growth; and the interest rate, which has to be raised to control inflation and keep the exchange rate peg from falling further. However, this rise in the interest rate is also the cost of borrowing and thus reduces investment and growth. This is the oft-cited Fleming trilemma of macro policy.

Most countries' economic regimens go to great lengths to control these macro-fundamentals, not allowing them to slip by default, except through planned policy. Otherwise, markets get spooked, the exchange rate slumps, inflation spikes, and a much higher cost has to be paid in raising the interest rate to counter these contrary movements. Thus, the new regime's first big misconception has been the thought that it had time on its side to search for bilateral support for its BOP. The bilateral support of USD5 billion parked temporarily with Pakistan has taken eight months and not eased the pressure on macro-fundamentals. If anything, the time taken has weakened these macro-fundamentals further.

The IMF stand-by arrangement should have been negotiated long before to avoid the valuable slipping in macro-fundamentals for which a much higher price now has to be paid. The higher price of the just-inked draft agreement with the IMF is the surrendering of the exchange rate. The peg of the rupee has been abandoned for a free float. This is bad economics for a country in Pakistan's fragile economic position because only a few high-income countries have full free floats, for instance, the US, the UK, Canada, and Argentina.

Predominantly, countries have pegs of some sort—also called managed floats—for three major reasons. One, for a beleaguered economy such as Pakistan's at the moment, a free float will set in expectations of further depreciation of the exchange rate. People will rationally bet against the rupee for motives of speculation and preserving real value with flight of capital abroad or into another currency, both weakening the rupee further. One could call them depreciationary expectations—analogous to inflationary expectations.

Two, a free float, with a depreciating exchange rate, will increase the rupee price of Pakistan's external commitments—payments that have to be made abroad, repayments of loans, debt, and future credit. The country will not be any forwarder.

Three, and perhaps even more fundamental, a free float brings complete uncertainty into the price environment that investors face. Investors need certainty in the prices of their inputs and outputs to determine their rate of return. However, downward pressure—more a free fall of the exchange rate—will import inflation into domestic prices and the rupee value of all imports will skyrocket. It is not just the upper classes that will have to forgo their French cheeses, but also the price of imported capital equipment, plant and machinery that will become prohibitive. Pakistan produces hardly any capital equipment domestically, and thus the rising cost of imported capital goods will further inhibit an already weak domestic investment and growth rate.

Additionally, the inflationary effect on domestic prices through a free float and depreciating exchange rates can be huge. Imagine the rising price of energy used to produce all goods, especially wage goods for the poor. The real wage will fall. What this is tantamount to is that the rupee is being depreciated to reduce the real wage to give exporters an easy way to increase their exports rather than through increased competitiveness and productivity. As such, this policy stands to raise poverty levels far more than any added welfare programs can ameliorate. Welfare programs too have to begin with getting the macro-policies right rather than just handouts, no matter how well intentioned.

What then are the alternatives? If anything needs revising in the agreement with the IMF, it is the free float of the exchange rate. A peg of the rupee to a foreign currency or basket of currencies must be sought as of yore. There should not be just binary reliance on one policy instrument to sort out Pakistan's predicament on its external account. A judicious use across three policy instruments would be better.

One, a peg with some depreciation can be negotiated, but not a further massive depreciation that ushers in all the expectations of further depreciation and the entailed problems of domestic and foreign speculators betting against the rupee, with outflows and moves into forex. Two, Pakistan could maintain the peg with some reliance on an interest rate hike—but, again, not a massive hike, to keep some growth in the economy. The currently envisaged 2 percent hike above the prevalent rate of 10.75 percent is quite reasonable, certainly compared to Turkey's hiking of interest rates to 25 percent (Pooley, 2018). In fact, in a tradeoff between depreciating the exchange rate and appreciating the interest rate, there could be more reliance on the interest rate. Three, and most importantly, some form of capital controls is needed to counter the deflationary expectations that have been set in, to counter the betting against the rupee and capital flight abroad. Certainly, if economies such as China with USD3 trillion in reserves or India with half a trillion dollars have resorted to capital controls, can Pakistan with barely USD10 billion afford not to?

References

Abdelal, R., & Alfaro, L. (2003). Capital and control: Lessons from Malaysia. *Challenge*, *46*(4), 36–53.

Amjad, R. (2019, March 27–28). *Breaking out of Pakistan's stop-go economic cycles: Does the fiscal deficit hold the key 1999–2019?* [Conference paper]. 15th Annual Conference on the Management of the Pakistan Economy, Lahore School of Economics.

Bordo, M. D. (2017). *The operation and demise of the Bretton Woods system; 1958 to 1971* (Working Paper No. 23189). National Bureau of Economic Research.

Borensztein, E., & De Gregorio, J. (1999). *Devaluation and inflation after currency*. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.202.925&rep=rep1&type=pdf

Chaudhry, A., & Andaman, G. (2014). The need for a coordinated industrial strategy to boost Pakistani exports: Lessons from Asia. *Lahore Journal of Economics*, *19*, 177–206.

Clover, C., & Weinland, D. (2017, January 8). China capital controls help slow cash outflows. *Financial Times*. https://www.ft.com/content/02ab9faa-d595-11e6-944b-e7eb37a6aa8e.

Dabrowski, M. (Ed.). (2012). *Currency crises in emerging markets* (pp. 36, 69, 77, 81–82). Springer.

Gopinath, G. (2017, October 12–13). *Rethinking macroeconomic policy: International economy issues* [Conference paper]. Rethinking Macroeconomic Policy, Peterson Institute for International Economics, Washington, DC.

Gopinath, G. (2019). Rethinking international macroeconomic policy. In O. Blanchard & L. H. Summers (Eds.), *Evolution or revolution? Rethinking macroeconomic policy after the great recession* (pp. 271–298). MIT Press.

Hamid, N., & Mir, A. S. (2017). Exchange rate management and economic growth: A brewing crisis in Pakistan. *Lahore Journal of Economics*, *22*, 73–110.

International Monetary Fund. (2009). *Balance of payments and international investment position manual* (6th ed.) http://www.imf.org/external/pubs/ft/bop/2007/bopman6.htm

International Monetary Fund. (2018). *International financial statistics* [Database]. https://data.imf.org/?sk=4c514d48-b6ba-49ed-8ab9-52b0c1a0179b&sId=1409151240976

Ishtiaq, N., Qasim, H. M., & Dar, A. A. (2016). Testing the Marshall-Lerner condition and the J-curve phenomenon for Pakistan: Some new insights. *International Journal of Economics and Empirical Research*, *4*(6), 307–319.

Jaffri, A. A., Asghar, N., Ali, M. M., & Asjed, R. (2012). Foreign direct investment and current account balance of Pakistan. *Pakistan Economic and Social Review*, *50*(2), 207–222.

Khan, S., Azam, M., & Emirullah, C. (2016). Import demand income elasticity and growth rate in Pakistan: The impact of trade liberalization. *Foreign Trade Review*, *51*(3), 201–212.

Malik, S., Hayat, M. K., & Hayat, M. U. (2010). External debt and economic growth: Empirical evidence from Pakistan. *International Research Journal of Finance and Economics*, *44*, 88–97.

Obstfeld, M., & Krugman, P. R. (2003). *International economics: Theory and policy*. Addison-Wesley.

Pakistan, Ministry of Finance. (2018). *Pakistan Economic Survey 2017/18*. Government of Pakistan.

Pooley, C. R. (2018, October 25). Turkish interest rates: Has the central bank done enough? *Financial Times*. https://www.ft.com/content/2c0686ee-d778-11e8-ab8e-6be0dcf18713.

Rahim, S. (2020). **.

Rashidin, M. S., Ullah, I., & Jehangir, M. (2017). The influence of balance of payments and balance of trade on exchange rate in developing countries of Asia: A case study of Bangladesh, Pakistan and India. *Sonargaon University Journal*, *1*(2).

Shahzad, A. (2017). *Capital account liberalization and development in Pakistan* [Unpublished Master's dissertation]. Lahore School of Economics.

Song, Z., Storesletten, K., & Zilibotti, F. (2014). Growing (with capital controls) like China. *IMF Economic Review*, *62*(3), 327–370.

State Bank of Pakistan. (2018). *Annual report 2017–18: The state of Pakistan's economy*. https://www.sbp.org.pk/reports/annual/arFY18/Anul-index-eng-18.htm

Umezaki, S. (2019). The Malaysian economy after the global financial crisis: International capital flows, exchange rates, and policy responses. *Public Policy Review*, *15*(1), 69–98.

Valdivia-Velarde, E., & Razin, T. (2014). *BMP6 compilation guide* (chaps. 3, 4, 5, 10, 14, appendices 1, 4). International Monetary Fund.

Warnock, F. (2018). *A user's guide to the BOP and IIP*. Darden School of Business.

Weaver, C., & Stothard, M. (2013, March 28). Cyprus imposes severe capital controls. *Financial Times*. https://www.ft.com/content/9901f6ce-96f2-11e2-a77c-00144feabdc0.

Zhang, N. (2015, April 16–17). *Measuring global flow of funds and integrating real and financial accounts: Concepts, data sources and approaches* [Conference paper]. W(h)ither the SNA? IARIW-OECD, Paris.

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Trade Agreements and Export Creation: An Empirical Analysis of Pakistan's Exports at Industry Level

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Abstract

This paper examines patterns of export creation and diversion by analyzing Pakistan's trade agreements at the two-digit industry level for all 88 export-oriented industries. We compare the net change in exports with nine free trade agreement (FTA) partners and the top 15 partners with most-favored nation (MFN) status. We find that 45 industries account for USD4.1 billion in export creation across all Pakistan's FTA partners. Here, net exports increase after FTAs with both FTA and MFN partners. Conversely, export diversion worth USD137 million occurs in 10 industries with all FTA partners as net exports to FTA partners rise while net exports to MFN partners fall. In the same manner, we find that net exports in 33 industries declined by USD500 million with FTA and MFN partners. The total net exports addition after FTAs was USD3.5 billion or, on average, USD350 million annually, accounting for about 1.4 percent of Pakistan's total annual goods exports. On average, Pakistan has successfully created exports in half its export-oriented industries, although highly subsidized industries exhibit either export diversion or a net decline with both MFN and FTA partners. A difference-in-difference analysis shows that exports to China and Mauritius rose significantly while the remaining seven FTA partners did not have a significant increase in exports after the FTAs were implemented. In view of these findings, we suggest revisiting the policy of export subsidies.

Keywords: Free trade agreements, export creation, export diversion, industries.

JEL Classification: F1, F14, F68.

1. Introduction

Pakistan's export performance has remained sluggish over the past decade, with a modest 27 percent rise in exports during 2005–16 in contrast

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to countries such as India, Bangladesh and Vietnam that increased their exports by 165, 276 and 445 percent, respectively.[1] In 2013, Pakistan's exports in goods were recorded at USD25 billion, but by 2017, they had fallen to USD22 billion. On the imports side, Pakistan has been unable to slow down their constant rise and, as a result, the trade deficit has soared to USD31 billion in 2017 or 10 percent of GDP.[2]

The swelling trade deficit has resulted in various export promotion policies over the years, including bilateral and multilateral trade agreements; subsidies for major export industries such as concessional utility tariffs, sales tax refunds, and concessional interest rates; and the imposition of higher import tariffs and federal excise duties on consumer items. However, on average, these incentives have failed to have a significant impact on the growth of exports (Ahmed, Hamid & Mahmud, 2013). This study attempts to evaluate the free trade agreements (FTAs) and preferential trade agreements (PTAs) implemented by Pakistan.

Numerous studies have focused on the issues of trade diversion and trade creation through FTAs, PTAs and customs unions, including work by Frankel and Wei (1995), Yeats (1998), Magee (2008), and Akhter and Ghani (2010). Caliendo and Parro (2015) and Felbermayr et al. (2015) have worked on the general equilibrium effects of trade creation and diversion by estimating the welfare changes to producers and consumers. A major weakness of computable general equilibrium models are their complexity, which makes them nontransparent. Simulating an economic system means making many choices that affect the outcome. It is sometimes difficult to justify them, and questions arise as to how such choices can be linked to policy changes (Magee, 2016; Sorgho, 2016).

There is a caveat to the trade creation narrative: An FTA deemed successful in increasing exports may actually lead to declining exports with nonmember countries. This decrease in exports may even surpass the increase in exports with FTA partners. However, government agencies reviewing the FTA may only be examining the trend in exports to FTA partners. Such reviews neglect export trends with nonmember countries. The key reason for signing an FTA is that the economy aims at earnings through exports. If the increased exports from an industry in the home country to a member country are being diverted from nonmember countries,

[1] Data from the World Development Indicators database for 2016.
[2] Data for 2018 from the State Bank of Pakistan.

then no new foreign exchange is flowing in (Soloaga & Winters, 2001). This is the intuition underlying our study—to examine whether Pakistan's FTAs have brought in new foreign income to the country.

There are two main research gaps. First, the bulk of research carried out has been on the welfare effects, focusing on whether FTAs favor or harm low-cost producers. There has been little research on whether FTAs are a way of enhancing export income through concessional trade. Second, earlier research has focused on the econometric significance of trade creation or trade diversion variables rather than the *net* export creation and diversion by determining the change in value of net exports after signing FTAs with member countries vis-à-vis the change in exports to nonmember countries during the same period.

Pakistan currently enjoys free or preferential trade access with 11 of its trading partners under the following seven agreements: (a) South Asian Free Trade Agreement (SAFTA) (2006), comprising India, Bangladesh, Sri Lanka, the Maldives, Nepal and Bhutan; (b) Pakistan-Malaysia FTA (2008); (c) Pakistan-China FTA (2007); (d) Pakistan-Iran PTA; (e) Pakistan-Indonesia PTA (2012); and (f) Pakistan-Mauritius PTA (2007). Data on Pakistan's bilateral trade with Nepal and Bhutan is, however, largely unavailable. We examine whether these trade agreements have been able to create new exports in value for Pakistan or if they have diverted exports from partners with most-favored nation (MFN) status. If the latter is true, we could argue that the FTAs and PTAs did not create new exports or bring in higher foreign exchange.

The study is divided into six sections. Section 2 discusses our theoretical framework. Section 3 discusses the empirical literature and gaps on the issue of trade creation and diversion. Section 4 presents the data and methodology applied. Section 5 details our findings and results. Section 6 concludes the paper and presents policy implications.

2. Theoretical Framework

In Bentick's (1963) three-country model, all three have similar levels of economic development. Countries A and B decide to sign an FTA in which both will maintain a protective tariff against the third country, C. It is assumed that the governments of A and B (a) are aware of the production costs involved, and (b) compare their own production costs with the production costs of C as a criterion for tariff adjustment.

Let us consider the example of textiles. Country A levies a 30 percent tariff while country B imposes a 20 percent tariff against textile imports from C. We can infer that A's cost of production (for textiles) is at least 30 percent more than that of C, while B's cost of production is at least 20 percent higher than that of C. Therefore, A's cost of production is 10 percent more than that of B. In the scenario of free trade between A and B, textiles will be exported by B to A. Thus, exports will be created in all those commodities for which the tariffs of A and B are different for C. B will export all those commodities to A for which its tariff is lower than that of A and vice versa.

This implies that, when a country imposes tariffs on the import of a commodity, it is assumed that the domestic cost of production for that commodity is higher in that country and that, to protect domestic producers, low-cost imports after tariffs are sold at the same price or higher as the domestically produced commodity. Therefore, exports between member countries will be greater for those commodities in which each member has a competitive advantage and this will reduce exports to nonmember countries, causing export diversion. However, if A does not impose any tariff on C for a given commodity, for example, footwear, but B imposes a 10 percent tariff on footwear for C, we can assume that the cost of producing footwear in A is lower than that of B as well as C. In this scenario, the exports of a low-cost producer of footwear, A, will not be affected by imports from C and will increase for B. If exports to nonmember countries are not affected and exports to member countries increase, then we call this export creation.

3. Review of the Literature

Tinbergen (1962) pioneered use of the gravity model and found a significant increase in trade between Commonwealth countries. Viner (1950) examined whether trade agreements were responsible for a shift in imports from low-cost nonmembers to high-cost members, and for a shift from reliance on high-cost domestic production to low-cost imports from member countries. The gravity model became more robust in the 1970s and 1980s when it was suggested that physical distance was not the only determinant but that many other unobserved and observed variables contributed to bilateral and multilateral trade flows.

The extended gravity model was applied by Aitken (1973) and Brada and Mendez (1983) to the Latin American Free Trade Association and European Free Trade Association (EFTA) by adding a dummy variable (FTA_{ijt}) for whether both countries fall under the same FTA during one period, and another dummy (FTA_{it}) if only one partner has joined the FTA in that period. If FTA_{ijt} has a positive sign, this implies trade creation between FTA members, while a negative coefficient for FTA_{it} implies trade diversion. This dummy variable methodology is still widely used to determine trade creation and diversion under various trade agreements.

Application of the gravity model has generated inconclusive results in certain cases: some studies have found FTAs such as the North American Free Trade Agreement (NAFTA), Mercosur, ASEAN, and the European Union Customs Union to be trade creating (see Bergstrand, 2002; Carrere, 2003), while others have found the same FTAs to be trade diverting (see Chor, 2010; Costinot, Donaldson & Komunjer, 2012; Donaldson, 2012; Wei & Frankel, 1995). The main criticism of the gravity model is that including dummy variables catches the range of other variables that may have helped initiate the FTA, but which are not included in the model. In addition, there remains a reverse casualty bias in gravity model estimates, as economies with higher levels of trade are more likely to engage in bilateral or regional agreements. Hence, the error term becomes correlated with the FTA dummy variable, inducing the problem of endogeneity (Baier & Bergstrand, 2007; Magee, 2008, 2016).

The literature on the impact of FTAs on exports is very limited. Freund and Ornelas (2010) discuss the importance of including exports in trade creation and diversion analysis and add an exports variable to the gravity model to assess whether inclusion in an FTA causes exports to be more than they would in the absence of such an agreement. Their sample includes data from 1948 to 2000, covering a large range of FTAs. The EC, NAFTA, Mercosur and AFTA results show that all FTAs caused countries to export more than they would have in the case of no agreement. These results imply that agreements between richer countries are more successful while agreements between low-income and lower middle-income countries are more or less a failure and may even have adverse results.

Soloaga and Winters (2001) apply the dummy variable gravity model to estimate the impact of FTAs on the exports and imports of 58 countries under various trade agreements. They find evidence of export diversion in the EU and EFTA, but do not explore export creation.

The impact of trade agreements is not just associated with imports from member and nonmember countries or the world's welfare gain and loss from FTAs. It is equally important to understand how bilateral and regional trade agreements contribute to the broader approach of openness and whether they provide a stimulus for local exporters to capture larger shares in the world export market. Interestingly, while there are studies on the success of FTAs that estimate the gain in exports before and after member countries implement the FTA, trade creation and diversion effects from an exports point of view remain relatively unexplored.

4. Data and Methodology

This paper estimates export creation and diversion patterns for all the FTAs/PTAs that Pakistan has signed to date, for 88 industries in which exports originated from Pakistan. We note that we have only included those industries for each FTA comparison that were granted concessions by FTA partners according to each agreement. This is because commodities for which concessions were not guaranteed are in the same league as commodities exported to MFN countries since they bear the same customs duties. We look at all those industries for which data was available for at least four years post-FTA as otherwise the results would be distorted in the presence of small outliers.

The data used to estimate the change in exports is taken from the United Nations Commodity Trade Statistics (UN Comtrade) database. We use data from 2003 to 2017 on the basis of the harmonized system two-digit commodity level. We start with 2003 because most of Pakistan's trade agreements were initiated after 2006. The MFN partners included are those with whom Pakistan's share of exports is at least 1 percent of its total exports. We therefore estimate the change in exports with respect to Pakistan's top 15 MFN trading partners relative to its FTA partners.

The methodology we use is adapted from UNESCAP and entails calculating the change in exports with each FTA partner pre- and post-trade agreement.[3] This methodology is used to estimate the absolute and percentage change in the value and quantity of exports and imports for one country or a group of countries. We use it to estimate the growth in value of exports for Pakistan. The change is calculated in absolute as well as percentage terms. The change in exports for each year is summed to obtain the net change in exports over time. In the same way, the average annual percentage change in exports is estimated pre- and post-FTA.

[3] https://artnet.unescap.org/APTIAD/Export%20growth.pdf

$$\sum_{i=1}^{99} \Delta exports_{i\ FTA} + \sum_{i=1}^{99} \Delta exports_{i\ MFN} = total\ net\ change \quad (1)$$

where

- $\Delta exports_{i\ FTA}$= sum of change in exports for all years for commodity i with FTA partners (a)
- $\Delta exports_{i\ MFN}$ = sum of change in exports for all years for commodity i with MFN partners (b)
- Total net change = difference between (a) and (b)

If the total net change in industry i is positive, then the result will be export creation. The rationale for this is that a positive net change indicates a higher increase in export proceeds with respect to at least one group of partners (FTA or MFN) even if there is a decrease in export proceeds with respect to another group of partners. Similarly, if the total net change in industry i is negative, then this indicates export diversion. Intuitively, the sign of the change in exports to the FTA partner should be positive because FTAs presumably boost exports. However, it is also possible that the exports of a given industry have decreased with respect to the FTA partner and thus the sign may become negative. In such a scenario, we may find that the export creation in that industry was not due to the FTA but due to an increase in exports to an MFN partner.

Additionally, we run a difference-in-difference model to find out whether exports to FTA partners increased or decreased after they were "treated" with the FTA, compared to the control group of MFN partners that were not treated with an FTA. The control group includes the same top 15 MFN partners that account for 75 percent of Pakistan's total exports. The treated group of FTA/PTA partners includes only those industries that were part of the concessional list in each respective FTA/PTA. Dummy variables for time and treatment and an interaction term for time and treatment are used to calculate the extent to which exports to each FTA/PTA partner increased after the trade agreement, compared to the MFN partners.

The data on trade volumes is taken from UN Comtrade for the period 2003 to 2016 for both FTA and MFN partners. The nontreated years for each FTA/PTA partner vary according to the timing of the trade agreement: for example, for SAFTA, the nontreated years are 2003–06 while for Malaysia, the nontreated years are 2003–07. Details are given in the Appendix.

5. Results and Discussion

Table A.1 in the Appendix lists the periods analyzed as pre- and post-trade agreement periods for each FTA/PTA partner. The net change in exports for the pre-FTA period is estimated to determine the trend in exports. This way, we control for the probability that an increase in exports was not due to the FTA but due to a linear increasing trend. Table A.2 in the Appendix lists the MFN partners included in this study. Since the first FTA was implemented with Sri Lanka in 2005, we analyze exports to MFN partners for 2005–17 for a comparison with the post-FTA exports to Pakistan's FTA partners. We do not analyze exports to MFN partners prior to 2006 because during the pre-FTA period, exports to FTA and MFN partners were independent of each other.

5.1. Cumulative Change in Exports with FTA Partners

We find that the cumulative net gain in export value with respect to all FTA partners over 10 years was USD3.5 billion, with annual average growth of 164 percent. This averages to a relatively small annual increase of USD350 million, approximately equal to 1.4 percent of Pakistan's total merchandise exports.

Table 1 shows the cumulative change in exports to FTA partners after the implementation of the FTA. The highest absolute gain in exports is in cotton to the tune of USD521 million. Pakistan's total goods exports were recorded at USD24.5 billion in 2017/18, out of which textile exports stood at USD13.3 billion,[4] contributing nearly 60 percent to total goods exports. The textiles sector contributes 8.5 percent to the national GDP and provides employment to 35 percent of the country's labor force. In the textiles category, exports of cotton were nearly USD3.5 billion in 2017, making it the second largest export commodity after textile made-up articles whose exports stood at USD3.9 billion. Pakistan is the fourth largest producer of cotton and has the third largest spinning capacity in Asia, with only China and India ahead (Mirza, 2018).

This shows why cotton has the highest net gain—its exports were already at a higher level compared to other industries. After the FTA was implemented, Pakistan was unable to efficiently increase its exports of cotton. Instead, exports remained virtually stagnant. Since the value of cotton exports was highest—at about 30 percent of total goods exports, while

[4] Data from the State Bank of Pakistan for 2018.

the remaining 98 industries accounted for 70 percent of goods exports—a small increase in cotton exports made it the top beneficiary of FTAs.

Table 1: Cumulative change in exports to FTA partners: Industry level

USD '000

Industry description	Absolute change and annual average growth rate	
	Pre-FTA	Post-FTA
Aircraft, spacecraft and parts thereof	-1	-4
Albuminoidal substances, modified starches, glues	-96	40
Aluminum and articles thereof	5,099	-5,711
Animal or vegetable fats and oils	54	1,250
Animal-originated products, NES	443	-10
Animals, live	Nil	-2
Apparel and clothing accessories, knitted or crocheted	2,959	20,319
Apparel and clothing accessories, not knitted or crocheted	1,523	19,119
Arms and ammunition, parts and accessories	Nil	132
Articles of leather	22,435	-10,011
Beverages, spirits and vinegar	Nil	13,465
Carpets and other textile floor coverings	Nil	25
Ceramic products	14	-109
Chemical products NES	46	1,426
Clocks and watches and parts	1,671	24,290
Cocoa and cocoa preparations	-139	-29
Coffee, tea, mate and spices	2,546	-312
Commodities not specified according to kind	186	36
Copper and articles thereof	6,466	3,038
Cotton	361,068	512,190
Dairy products	Nil	243
Electrical machinery and equipment and parts thereof	5,047	4,208
Essential oils	192	648
Explosives	37	-20
Fabrics, knitted or crocheted	11,675	-2,550
Fabrics, special woven fabrics	307	307
Fish	9,003	16,511
Food industries, residues and wastes thereof	-114	12,845
Footwear	-82	572
Fruits and nuts	12,581	96,547
Fur skins and artificial fur	Nil	28

Industry description	Absolute change and annual average growth rate	
	Pre-FTA	Post-FTA
Glass and glassware	2,322	3,854
Headgear and parts	0.4	2
Inorganic chemicals	743	8,364
Iron and steel	-310	3,486
Iron or steel articles	5,964	17,779
Lac, gums and resins	829	1,959
Lead and articles thereof	Nil	-3,302
Machinery, mechanical appliances and nuclear reactors	47	-17
Malt, starches, inulin, wheat gluten	12,855	-13,714
Manmade filaments	-10,866	-4,222
Manmade staple fibers	25,059	-15,599
Meat and fish preparations	Nil	-941
Meat and edible meat	-7	69
Medical or surgical instruments	Nil	-30,139
Metal, miscellaneous products of base metal	1,278	2,061
Mineral fuels, mineral oils and products of their distillation	155,320	-73,999
Miscellaneous edible preparations	-153	2,213
Miscellaneous manufactured articles	-402	6,359
Nickel and articles thereof	Nil	64
Oil seeds	2,468	-1,841
Ores, slag and ash	23,085	-4,901
Organic chemicals	18,897	7,494
Paper and paperboard	104	21,637
Pharmaceutical products	3,707	15,366
Photographic or cinematographic goods	-122	-43
Plastics and articles thereof	-3,537	16,585
Precious metals and stones	124	1,222
Preparations of cereals, flour, starch or milk	-631	890
Preparations of vegetables, fruit, nuts	683	1,370
Printed books and newspapers	136	598
Railway and parts thereof	5,099	-4,348
Raw hides, skins and leather	18,155	33,350
Rice and cereals	49,977	68,593
Rubber and articles thereof	607	3,066
Salt, sulfur and stones	-851	153,371
Ships, boats and floating structures	Nil	-26
Silk	Nil	-19
Soap, washing, polishing and lubricating	-114	1,244

Industry description	Absolute change and annual average growth rate	
	Pre-FTA	**Post-FTA**
Stone, plaster, cement and articles	1,475	347
Sugars and sugar confectionery	-6,097	-112
Tanning or dyeing extract	1,284	2,024
Textile fabric	705	300
Textiles, made-up articles	-2,627	27,164
Tobacco	1,346	348
Tools and cutlery	Nil	-522
Toys, games and sports requisites	-47	225
Trees and other plants	Nil	51
Vegetable products, NES	-730	28,243
Vegetable textile fibers, paper yarn	6,245	-3,833
Vegetables	28,149	-446
Vehicles and parts, accessories thereof	Nil	-11
Waddings, rope, cable	79	1,426
Wood and articles of wood	18	81
Wood pulp	Nil	-21
Wool	Nil	-115
Works of art; collectors' pieces and antiques	376	-631
Zinc and articles thereof	Nil	14

Note: Percentage change in parentheses.
Source: Authors' calculations.

After cotton, the second highest net gain in export value was for salt, sulfur and stones. The main commodities in this industry are cement, marble and granite. This industry had a negative net change pre-FTA, but grew at an average rate of 78 percent and gained an additional USD153 million after the FTAs. In this way, salt, sulfur and stone, an industry with a less than 2 percent share of Pakistan's total goods exports, was a major beneficiary of the FTAs and PTAs. The fruits and nuts industry comes third, with a net change in export value of USD96 million and 45 percent annual average growth. Pakistan has rich pomological resources and its fruits are in demand in various parts of the world, especially mango, citrus and apples. Pakistan's total exports of fruits and nuts in 2017 were USD353 million, making the industry's share close to 1.4 percent of total exports.

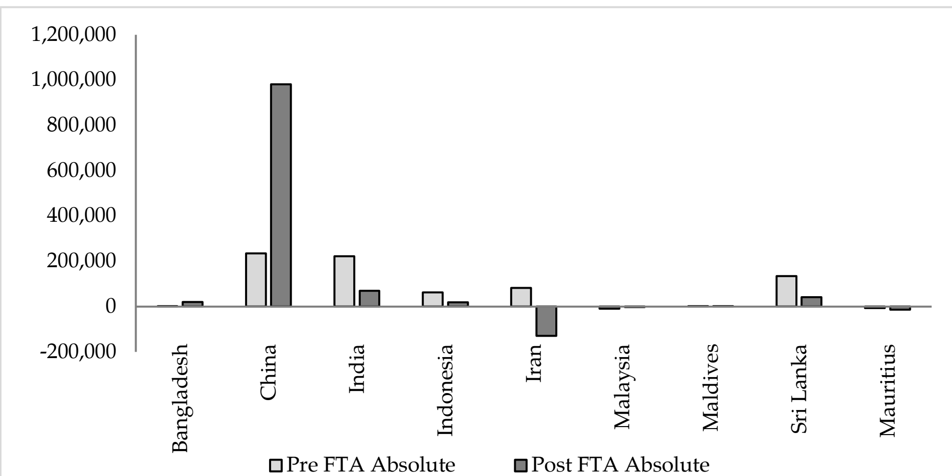
The highest average growth rate post-FTA was estimated to be in precious metals, and food, residues and wastes, both growing at more than 1,000 percent. Both industries had negative growth pre-FTA but high positive growth post-FTA, indicating the significant benefit these relatively small commodities gained. Edible meat and fur skin grew at an average of

883 and 748 percent, respectively, although the entire gain in edible meat came from exports to China since Pakistan did not export this commodity to any other FTA partner. The second largest export industry, cereals and rice, which brought in around USD1.75 billion in 2017, was also a beneficiary of FTAs, gaining a net USD68 million with respect to Pakistan's FTA partners and witnessing a 69 percent growth rate.

Industries that lost significantly in terms of export value include vegetable textile fiber, fur skins, ships and boats, manmade staple fibers, meats not elsewhere classified, and aircrafts. Almost all these industries have a very small share in total goods exports, ranging from 0.0001 percent to 0.1 percent. This implies that the main losers post-FTA were commodities in which Pakistan's exports are negligible. Other major export sectors, such as medical or surgical instruments and articles of leather, whose share of exports is close to 2 percent, show mixed results. The medical or surgical instruments industry gained and grew at 24 percent while articles of leather grew at 108 percent but lost in terms of export value. Another major export sector, sports goods, also witnessed positive growth in exports. Similarly, vegetables not elsewhere classified had an average growth rate of 363 percent and gained in terms of export value.

Figure 1: Net change in exports to FTA partners, 2007–16

USD '000

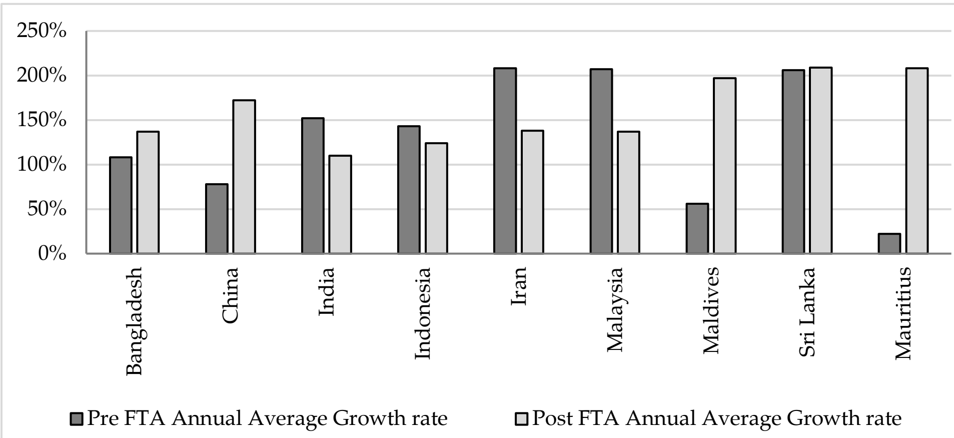


Source: Authors' calculations.

Figure 1 above and Figure 2 below illustrate the partner-level net change in exports pre- and post-FTA in absolute and percentage terms for the overall period. We can see that, after the implementation of FTAs and

PTAs, the net change in export value was negative for Iran, Malaysia and Mauritius but positive for other FTA partners. This implies that trade agreements have remained beneficial as net exports increased with respect to six out of nine FTA partners. The negative net change implies that the real benefit of these trade agreements was not attained after the FTAs and that exports witnessed a net decline over the years rather than increasing. The highest net absolute increase in exports was recorded with respect to China, followed by India and Sri Lanka. The highest net decline in exports was recorded with respect to Iran, followed by Mauritius and Malaysia.

Figure 2: Net percentage change in exports to FTA partners, 2007–16



Source: Authors' calculations.

5.2. Overall Results for Export-Creating and Diverting Industries

A comparison of the net change in Pakistan's exports to MFN and FTA partners helps identify export creation and diversion. Table 2 gives the overall results for export creation, diversion and decline. Among export-creating industries, we see a net increase of USD3 billion in exports to the top 15 MFN partners and, simultaneously, a net increase of USD1.1 billion with respect to the country's FTA partners in 45 industries. The total value of exports created during this period is USD4.1 billion.

The net increase in exports to nine FTA partners over the decade is nominal, indicating the very low levels of trade that Pakistan maintains with its neighbors, especially its South Asian trading partners. The net increase with respect to MFN partners was almost three times that of the country's FTA partners even though Pakistani exports are affected by the customs duties levied by its MFN partners. This implies either that Pakistan's exports are uncompetitive in the FTA countries or that it has been unable to tap the potential of these markets by failing to identify primary sources of demand.

Table 2: Overall results for exports creation and diversion, 2007–16

USD

	Net change in export-creating industries	Net change in export-diverting industries	Net change in export-declining industries
FTA partners	1,137,528	12,788	-152,060
MFN partners	3,028,727	-150,611	-355,958
Sum of FTA and MFN	4,161,330	-137,823	-508,018
Total no. of industries	45	10	33

Source: Authors' calculations.

In export-diverting industries, the net change in exports to MFN partners was –USD150 million, while the net change with respect to FTA partners was USD12 million, bringing the total net decrease in exports to USD137 million across 10 industries. The net change with respect to MFN partners is an estimated –USD355 million, while the net change with respect to FTA partners is an estimated –USD158 million, bringing the net decline to USD508 million. The total net export creation post-FTA, after subtracting the decline in exports and gross/net decline, is USD3.5 billion or, on average, USD350 million annually. This accounts for about 1.4 percent of Pakistan's total annual goods exports, implying that the benefits of the FTAs were very small and did not account for major export growth even though all the FTA partners, barring one, belong to the same region, and, according to the gravity model, should lead to higher levels of bilateral trade.

The results suggest that we can reject our null hypothesis because 45 out of a total of 88 industries (51 percent of the sample) experienced export creation while only 10 industries (11 percent) experienced export diversion. Further, in 33 industries (38 percent), the net change in exports to FTA partners was negative; this cannot be termed export creation or diversion, rather it denotes a decline in exports to FTA partners even after the implementation of the agreements. Since a small majority of these industries are found to have created exports, we accept the alternative hypothesis that Pakistan's bilateral and multilateral trade agreements have led primarily to export creation.

5.3. Detailed Results for Export-Creating and Diverting Industries

This section discusses in detail those industries that have performed well or poorly by merging them into broad sectors. Tables 3 and 4 give our findings for the textiles sector, which includes 16 industries. We find that knitted apparel, not-knitted apparel, made-up articles and cotton account for the highest export creation. Interestingly, these industries are also among Pakistan's top five export industry groups. However, these four are the only export-creating industries in the textiles sector, as all other textile groups are either export diverting or declining. Cotton and the other three textile sectors have achieved large-scale export creation, albeit at the cost of huge public subsidies and export incentives.

Table 3: Export-creating industries: Textiles

USD '000

Industry description	All MFN partners	All FTA partners	Total net change
Cotton	-321,191	512,190	190,999
Apparel and clothing accessories; knitted	778,109	20,319	798,428
Apparel and clothing accessories; not knitted	759,319	19,119	778,438
Headgear and parts	508	2	510
Raw hides, skins and leather	8,855	33,350	42,205
Tanning or dyeing extract	464	2,024	2,488
Textiles, made-up articles	621,683	27,641	649,325

Source: Authors' calculations.

Table 4: Export-diverting/declining industries: Textiles

USD '000

Industry description	All MFN partners	All FTA partners	Net change
Articles of leather	-26,240	-10,011	-36,251
Carpets	-157,081	-860	-157,941
Fabrics; knitted	-15,638	-2,550	-18,188
Fur skins	218	28	246
Manmade filaments	-127,032	-4,222	-131,254
Manmade staple fibers	45,313	-15,599	29,713
Silk	289	-19	270
Vegetable textile fibers	-396	-3,833	-4,228
Wool	542	-115	427

Source: Authors' calculations.

Pakistan's main subsidized export sectors include textiles, carpets, surgical instruments, sports goods, sugar, and leather. Combining these subsidies implies that the government is providing export subsidies equal to USD725 million annually (Qarni, 2018). Currently, the government gives about USD260 million annually in cash subsidies to textile exporters, while subsidized energy rates are another incentive. Until 2017, the government was providing cash subsidies equal to 4 percent of exports for yarn and fabric, 5 percent for processed fabric, 6 percent for made-up articles, and 7 percent for garments (knitted apparel). In addition, a discounted tariff of up to PKR3 was charged to export-oriented industries (Khan, 2018).

In the presence of such incentives, the positive performance of only four out of a total of ten textile groups implies that the at-par subsidy policy for the industry is not an optimal use of taxpayers' resources. The four export-creating textile groups—knitted apparel, not-knitted apparel, made-up articles, and cotton—should be the focus of government incentives. Diverting subsidies from unproductive groups to these productive groups would enhance their export potential; the resulting increase in exports would not only benefit the external account, but also create domestic employment.

The other subsidized industry that has experienced export creation is surgical instruments, which is concentrated in the Sialkot district. In 2017, its total exports were USD410 million, equivalent to about 2 percent of Pakistan's total goods exports. Surgical instruments performed better than cotton in the sense that exports to MFN partners did not fall and there was a significant increase in exports to both FTA and MFN partners; the total value of exports created was about USD152 million. In the category of basic metals, iron and steel, lead, and copper accounted for export creation, while furniture and mechanical appliances were two other major industries that experienced export creation.

A major subsidized industry, articles of leather, registered a net decline of USD36 million. The leather industry is given a 3 percent duty drawback subsidy on imports of raw material. An additional 2 percent duty drawback is given if the export is to a nontraditional market. Further, to encourage finished leather exports instead of raw hides, the government has allowed the duty-free import of tanning machinery and has taxed exports of raw skins. Having availed these incentives, the industry's performance should have experienced more positive gains.

Tables 5 and 6 show the performance of food and beverages (all edible items). Our findings reveal that 15 out of 23 industries experienced export creation, in particular rice, fish, meat, fruits and nuts, vegetable products, spices, animal and vegetable oils, beverages, and tobacco. The highest level of export creation occurred in rice, followed by beverages and fish. It can be argued that these industries produce a sufficient export surplus and were able to sustain the additional demand post-FTA, thereby benefitting the economy by bringing in foreign exchange proceeds from MFN and FTA partners despite little or no export subsidies and support from the government (Haque & Kemal, 2007).

The only subsidized industry in this sector, sugar and sugar confectionery, recorded an estimated gross decline of USD58 million, with rising exports to MFN partners but declining exports to FTA partners. The world price of sugar in 2017 was USD383 per tonne, while in Pakistan it was USD480. To fill this price gap, the government gave sugar mills a subsidy of about USD0.1 per kilogram to enhance exports. The total subsidy was USD200 million, which is 200 percent higher than the USD65 million subsidy given in 2015. The fall in exports to FTA partners suggests that sugar from Pakistan is not competitive in FTA markets, despite strong price supports from the government; this indicates serious issues dometically (Zaidi, 2018).

Table 5: Export-creating industries: Foods and beverages

USD '000

Industry description	**All MFN partners**	**All FTA partners**	**Total net change**
Animal or vegetable fats and oils	878	1,250	2,128
Beverages, spirits and vinegar	201,237	13,465	214,702
Dairy products	8,235	243	8,478
Essential oils	785	648	1,433
Fish	109,248	16,511	125,759
Food industries, residues and wastes thereof	7,903	12,845	20,748
Fruits and nuts	982	96,549	97,531
Meat and edible meat	128,252	69	128,321
Miscellaneous edible preparations	3,858	2,213	6,071
Preparations of cereals, flour, starch or milk	13,871	1,126	14,997
Preparations of vegetables, fruit, nuts	21,213	1,370	22,583
Rice and cereals	213,680	68,593	282,273
Tobacco	4,583	348	4,932
Vegetable products, not else specified	2,550	28,243	30,793
Vegetables	6,188	847	7,035

Source: Authors' calculations.

Table 6: Export-diverting/declining industries: Foods and beverages

USD '000

Industry description	All MFN partners	All FTA partners	Net change
Animal-originated products, NES	1,625	-823	803
Animals; live	4,014	-2	4,012
Cocoa and cocoa preparations	-340	-29	-369
Coffee, tea, mate and spices	51,347	-312	51,035
Meat and fish preparations	-5,333	-607	-5,941
Oil seeds	24,065	-1,841	22,223
Malt, starches, wheat gluten	4,061	-13,714	-9,653
Sugars and sugar confectionery	58,180	-112	58,068

Source: Authors' calculations.

Tables 7 and 8 show the performance of industries in the machinery and equipment sector. The other subsidized industry that showed export creation is surgical instruments: its total annual exports account for only 2 percent, but its efforts increased on net. The highest level of export diversion in all sectors was in the sports goods industry, which is also concentrated in Sialkot and is among the five major subsidized industries of Pakistan.

Table 7: Export-creating industries: Machinery and equipment

USD '000

Industry description	All MFN partners	All FTA partners	Total net change
Machinery, mechanical appliances and nuclear reactors	51,144	4,208	55,352
Medical or surgical instruments	128,587	24,290	152,877
Miscellaneous manufactured articles	21,988	748	22,735
Musical instruments and parts	376	132	508
Tools and cutlery	36,049	2,061	38,110

Source: Authors' calculations.

Table 8: Export-diverting/declining industries: Machinery and equipment

USD '000

Industry description	All MFN partners	All FTA partners	Net change
Aircraft and parts thereof	4,855	-1,353	3,502
Ceramic products	-1,600	-109	-1,709
Electrical machinery and equipment	1,617	-17	1,600
Explosives	-835	-625	-1,460
Photographic or cinematographic goods	1,708	-43	1,665
Railway and parts thereof	-36,199	-4,348	-40,547
Ships, boats and floating structures	1100	-26	1,074
Vehicles and parts, accessories thereof	3,072	-11	3,061
Sports goods	-62,777	6,359	-56,418

Source: Authors' calculations.

Tables 9 and 10 show the performance of industries in the metals and minerals sector. Salt and sulfur, followed by copper, recorded the highest levels of export creation, while other basic metals such as iron and lead also experienced export creation. The highest decline in exports was in mineral fuels, with further export diversion in aluminum and nickel.

Table 9: Export-creating industries: Metals and minerals

USD '000

Industry description	All MFN partners	All FTA partners	Total net change
Chemical products NES	2,452	1,426	3,878
Copper and articles thereof	48,975	3,038	52,014
Precious metals and stones	2625	1,222	3,846
Stone, plaster, cement and articles	1,445	347	1,792
Salt, sulfur and stones	75,646	150,525	226,171
Inorganic chemicals	-2,542	8,364	5,822
Iron and steel	13,069	3486	16,555
Iron or steel articles	2,110	17779	19,889
Lac, gums and resins	2,600	1,959	4,559
Lead and articles thereof	1,837	14	1,851

Source: Authors' calculations.

Table 10: Export-diverting/declining industries: Metals and minerals

USD '000

Industry description	All MFN partners	All FTA partners	Total net change
Aluminum and articles thereof	7,264	-604	6,660
Metal; miscellaneous products of base metal	546	-522	24
Metals; NES, cermet and articles thereof	496	-3,302	-2,806
Mineral fuels, mineral oils and their products	-196,528	-73,999	-270,527
Nickel and articles thereof	1,629	-64	1,565
Ores, slag and ash	373	-4,901	-4,528
Organic chemicals	-1,228	-7494	-8,722
Wood pulp	177	-21	156

Source: Authors' estimates.

Table 11 shows the extent of export creation in miscellaneous industries. The highest level of export creation was in plastics, followed by furniture, paper, and pharmaceutical industries.

Table 11: Export-creating industries: Miscellaneous items

USD '000

Industry description	Top 15 MFN partners	All FTA partners	Total net change
Furniture; bedding, mattresses	32,388	225	32,613
Glass and glassware	640	3,854	4,494
Paper and paperboard	7614	21,637	29,252
Pharmaceutical products	9,560	15,366	24,926
Plastics and articles thereof	20,121	16,585	36,706
Soap, washing, polishing and lubricating	-220	1,244	1,024
Trees and other plants	1,037	51	1,088
Works of art; collectors' pieces and antiques	16	2	18

Source: Authors' estimates.

The FTAs and PTAs implemented by Pakistan were nominally successful in enhancing its export base. Our findings suggest that about half of industries sustained a sufficient export surplus since they were able to continue exporting to MFN partners while meeting the increased demand from FTA partners. For the remaining 33 industries, the factors responsible for export diversion or a gross/net decline in exports may be internal or external and require further attention from policymakers.

5.4. Pakistan's Exports to FTA Partners: Difference-in-Difference Results

Table 12 gives the results of a difference-in-difference estimation for exports to all nine FTA/PTA partners. Pakistan's exports to China in impacted sectors rose significantly relative to its MFN partners after the FTA was implemented, while overall exports to the latter increased over time after the Pakistan-China FTA. These results are similar to Chaudhry, Jamil and Chaudhry (2017) who also find that exports to China increased significantly post-FTA. Exports to Mauritius are significantly lower than to other MFN partners before the PTA, but rose significantly in impacted sectors after the Pakistan-Mauritius PTA was implemented.

In the case of SAFTA, exports to India, Bangladesh and the Maldives increased post-FTA compared to exports to Pakistan's MFN partners, although this increase is statistically insignificant. Exports to Sri Lanka fell to an insignificant degree after SAFTA was implemented. However, overall exports to all four SAFTA partners were significantly lower than those to MFN partners before SAFTA. Overall exports to Malaysia and Indonesia were significantly lower than to MFN partners before the respective FTAs were implemented, but exports to both countries decreased after the FTA, although this decrease remains insignificant. Further, overall exports to MFN partners also fell significantly over time. Exports to Iran were significantly lower than to MFN partners before the Pakistan-Iran PTA was implemented. Exports increased after the PTA but remain statistically insignificant. Exports to MFN partners fell significantly over time.

Table 12: Industry-level difference-in-difference analysis

	Log of exports to								
	China	**India**	**Sri Lanka**	**Bangla-desh**	**Maldives**	**Mauri-tius**	**Malaysia**	**Iran**	**Indone-sia**
Time*treatment	0.39*	0.03	-0.07	0.09	0.12	0.38*	-0.17	0.19	-0.06
	(0.23)	(0.25)	(0.23)	(0.25)	(0.25)	(0.22)	(0.22)	(0.28)	(0.28)
Treatment	0.08	-0.26	-0.30**	-0.77***	-2.0***	-1.5***	-0.4	-0.6***	-0.65***
	(0.19)	(0.21)	(0.14)	(0.21)	(0.21)	(0.15)	(0.15)	(0.13)	(0.25)
Time	0.21***	0.22***	-0.21**	0.22***	0.22***	-0.2***	-0.2***	-0.23**	-0.13**
	(0.05)	(0.26)	(0.05)	(0.06)	(0.06)	(0.05)	(-0.05)	(0.07)	(0.07)

Note: Standard errors in parentheses. Statistical significance: * at 10 percent, ** at 5 percent, and *** at 1 percent level.
Source: Authors' estimates, using UN Comtrade data.

The difference-in-difference results support our earlier finding that Pakistan's FTAs and PTAs have been largely unsuccessful in increasing exports. Our export creation and diversion results show that only half the industries were able to create new exports for Pakistan, while the difference-in-difference results show that the major contributors to this export creation were China and Mauritius. Further, the findings reveal that exports to FTA/PTA partners even before the trade agreements were lower than to other trading partners and that not much has improved even after the trade agreements.

6. Conclusion and Policy Implications

While Pakistan has signed several bilateral trade agreements and one regional trade agreement to boost export growth, policymakers may not necessarily be concerned as to whether exports are actually growing or merely being diverted away from nonmember countries. The purpose of this paper was to distinguish between the gross increase in exports due to FTAs and net exports under FTAs. The net increase in FTAs helps us assess whether these agreements were able to create new exports for the country or if they just diverted exports from non-FTA partners.

Overall, Pakistan's trade agreements are deemed partly successful because 45 industries show export creation while 10 show export diversion. However, it is a matter of concern that 33 industries witnessed a fall in net exports to FTA partners or to both MFN and FTA partners.

The results indicate that all five export-oriented sectors, barring surgical instruments, witnessed export diversion, including most components of the textiles sector, which remains the largest recipient of export subsidies. Barring cotton, textiles and leather were the worst performing, followed by other subsidized industries including sugar and sports goods, which was unable to benefit from concessional trade as exports kept falling or being diverted.

The industries most successful in creating new exports for Pakistan are associated primarily with the food and beverages sector, including vegetables, fish, dairy products, sugar, fruits and meat. This implies that the agriculture and livestock sector has immense potential for earning foreign exchange through exports. The results indicate that a shift in subsidies from export-diverting traditional export-oriented sectors toward export-creating sectors may be an important strategy.

The 33 industries identified as having declining net exports to both FTA and MFN partners are those that require serious attention from policymakers. Unless the factors associated with this decline in exports are addressed, adding these industries to FTAs will not bring about any gain. Similarly, negotiations for trade agreements should not be designed to target only the major industry groups. Rather, they should be more inclusive, given that many small industries are found to be export-creating while large industries may be export-diverting.

Before negotiating any new FTAs, it is important to revisit the existing ones and add export-creating industries to the concessions list. We also find that absolute fiscal incentives given to the major export-oriented industries have not yielded significant benefits. Instead, the government should prioritize those industries for export incentives and subsidies, which have been identified as export-creating but been neglected under previous export promotion policies.

Finally, the surgical instruments industry, concentrated in Sialkot as a cottage industry, is the only subsidized industry that is export-creating and has a positive net increase in exports to both MFN and FTA partners, even though its share of total exports is less than 2 percent. Policymakers should focus on the growth of this industry by providing special incentives, such as giving the existing Sialkot industrial cluster special economic zone status to enhance the vertical and horizontal linkages between firms.

References

Ahmed, H., Hamid, N., & Mahmud, M. (2013). Exports: Lessons from the past and the way forward. In R. Amjad & S. J. Burki (Eds.), *Pakistan: Moving the economy forward* (chap. 6). Lahore School of Economics.

Aitken, N. D. (1973). The effect of the EEC and EFTA on European trade: A temporal cross-section analysis. *American Economic Review*, *63*(5), 881–892.

Akhter, N., & Ghani, E. (2010). Regional integration in South Asia: An analysis of trade flows using the gravity model. *Pakistan Development Review*, *49*(2), 105–118.

Baier, S. L., & Bergstrand, J. H. (2007). Do free trade agreements actually increase members' international trade? *Journal of International Economics*, *71*, 72–95.

Bentick, B. L. (1963). Estimating trade creation and trade diversion. *The Economic Journal*, *73*(290), 219–225.

Brada, J. C., & Mendez, J. A. (1983). Economic integration among developed, developing and centrally planned economies: A comparative analysis. *Review of Economics and Statistics*, *67*(4), 549–556.

Caliendo, L., & Parro, F. (2015). Estimates of the trade and welfare effects of NAFTA. *Review of Economic Studies*, *82*(1), 1–44.

Carrere, C. (2003). *Revisiting the effects of regional trade agreements on trade flows with proper specification of the gravity model* (Working Paper No. 200310). Centre d'Études et de Recherches sur le Développement International.

Chaudhry, T., Jamil, N., & Chaudhry, A. (2017). Pakistan's experience with the Pakistan-China FTA: Lessons for CPEC. *Lahore Journal of Economics*, *22*, 1–24.

Chor, D. (2010). Unpacking sources of comparative advantage: A quantitative approach. *Journal of International Economics*, *82*(2), 152–167.

Costinot, A., Donaldson, D., & Komunjer, I. (2012). What goods do countries trade? A quantitative exploration of Ricardo's ideas. *Review of Economic Studies*, *79*(2), 581–608.

Freund, C., & Ornelas, E. (2010). *Regional trade agreements* (Policy Research Paper No. 5314). World Bank Group.

Haque, N., & Kemal, A. (2007). *Impact of export subsidies on Pakistan's exports* (Working Paper No. 2007:26). Pakistan Institute of Development Economics.

Khan, Z. (2018). PM to announce export package worth Rs70bn today. *Dawn*. https://www.dawn.com/news/1307426

Magee, C. S. (2008). New measures of trade creation and trade diversion. *Journal of International Economics*, *75*(2), 349–362.

Qarni, O. (2018). Textile producers expect further hike in exports. *Express Tribune*. https://tribune.com.pk/story/1725423/2-textile-producers-expect-hike-exports/

Soloaga, I., & Winters, L. A. (2001). Regionalism in the nineties: What effect on trade? *North American Journal of Economics and Finance*, *12*, 1–29.

Tinbergen, J. (1962). *Shaping the world economy: Suggestions for an international economic policy*. Twentieth Century Fund.

Viner, J. (1950). *The customs union issue*. Carnegie Endowment for International Peace.

Yeats, A. J. (1998). Does Mercosur's trade performance raise concerns about the effects of regional trade arrangements? *World Bank Economic Review*, *12*(1), 1–28.

Zaidi, H. (2018). The political economy of export packages. *Dawn*. https://www.dawn.com/news/1413402

Appendix

Table A1: Description of pre- and post-FTA/PTA periods analyzed

FTA/PTA partner	Pre-FTA period (nontreated)	Post-FTA period (treated)
SAFTA	2003-2006	2007-2017
China	2003-2007	2008-2017
Iran	2003-2004	2005-2017
Indonesia	2009-2012	2013-2017
Malaysia	2003-2007	2008-2017
Mauritius	2003-2007	2008-2017
Sri Lanka	2003-2004	2006-2017

Table A2: Description of MFN partners and periods analyzed

MFN partner	Export period analyzed
Australia	2005-2017
Belgium	2005-2017
France	2005-2017
Germany	2005-2017
Italy	2005-2017
Kenya	2005-2017
Kingdom of Saudi Arabia	2005-2017
The Netherlands	2005-2017
South Korea	2005-2017
Spain	2005-2017
Turkey	2005-2017
United Arab Emirates	2005-2017
United Kingdom	2005-2017
United States of America	2005-2017
Vietnam	2005-2017

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Unskilled Migration, Child labor and Human Capital Accumulation of Children in the Presence of Parental Absenteeism*

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Abstract

Temporary unskilled migration and the remittances it generates have the potential to reduce child labor and improve educational outcomes in developing countries. However, recent literature points towards the adverse impact of the parental absenteeism on children left behind. We build a theoretical model to explore the joint impact of remittances and parental absenteeism on child labor and human capital formation of children left behind in the context of unskilled workers' migration. We find threshold conditions for the relative wage of source to destination countries beyond which unskilled migration helps in reducing child labor and increasing human capital. Moreover, the threshold is endogenous and depends on the sensitivity of human capital formation to parental absenteeism relative to the child's time spent on acquiring human capital. In a special case when the former is equal to the latter, the wages in the destination country should at least be twice as much as in the source country to have a detrimental (promoting) impact on child labor (human capital formation). Since the importance of parental absenteeism would depend on a variety of sociocultural factors such as marriage, presence of extended families, religious communities, and social networks, there will be heterogeneity in the impact of unskilled migration.

Keywords: Migration, child labor, parental absenteeism; human capital.

JEL Classification: F22, F24, J24, O15.

1. Introduction

The last few decades have witnessed a significant increase in the international migration of unskilled workers from developing countries.

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This rise in migration flows internationally have also been associated with an increase in remittances (Ratha et al., 2011). Temporary unskilled migration and the remittances that result from it may reduce child labor and increase educational attainment in developing countries. However, recent literature also points towards the adverse impact of parental absenteeism on children left behind. In this article, we build a theoretical model to explore the joint impact of remittances and parental absenteeism on child labor and human capital formation of the children left behind in the context of unskilled workers' migration. The article builds on three fundamental premises observed in the migration literature: first, migration has important implications for the education of children; second, migration and child education are joint decisions taken by parents; and third, human capital impacts economic growth.

There is overwhelming evidence showing the positive impact of migration and resulting remittances on the schooling outcomes of the children left behind. In particular, the literature identifies the dual role of remittances in enhancing school enrolment on one hand while reducing child labor on the other (see Acosta, 2006; Arif & Chaudhry, 2015; Calero et al., 2007; Mansuri, 2006; Yang, 2008). Hanson and Woodruff (2003) found that children belonging to households with an emigrant complete more years of schooling and this effect is particularly large for girls. Similarly, Cox Edwards and Ureta (2003) report that remittances significantly enhance school retention and reduce drop outs. This holds true irrespective of the amount of remittances received. Furthermore, Dorantes et al. (2010) found that not only does migration increase school enrollment and enhance the school retention, it also reduces child labor.

The theoretical literature on the other hand predominantly models the migration decision in the context of high skilled workers. Several theoretical papers show that the prospect of migrating to countries where education entails higher returns leads to higher education attainment in anticipation of potential future migration (Beine et al., 2001; Beine et al., 2008; Mayr & Peri, 2009 Mountford, 1997; Stark & Wang, 2002). This branch of theoretical work underscores the role of greater prospective returns for human capital existing in foreign countries that affects the decision to accumulate human capital at home. Another branch of theoretical work deals with how the prospect of their children emigrating in the future induces parents to invest in their children's education (Chen, 2006; Marchiori et al., 2010).

Understanding the determinants and implications of unskilled labor migration is crucial for two reasons. First, unskilled migration forms a large portion of the emigration from developing countries. According to Ahn (2004), the bulk of the people emigrating from the South Asian countries of Bangladesh, Nepal, Sri Lanka, India and Pakistan constitute unskilled manpower. For example, the proportion of unskilled workers in total workers emigrating from a developing country like Sri Lanka was greater than 70 percent in 2002. Second, unskilled migration is important for the growth of a developing country and is not associated with the negative consequences noted of migration such as brain drain (Bhagwati & Hamada 1974; Faini 2007; Rapoport 2002; Richard & Adams 2009; Nimi et al., 2010). These studies highlight how migration of skilled labor puts developing countries at a disadvantage by not only draining the source country of its skilled workforce but also because skilled labor sends back less remittances as compared to unskilled workers.

In this study, we construct a model of human capital formation in which the emigration of parents and the remittances that they send back influence economic growth in the source country through the human capital accumulation of their children. We propose that unskilled workers are forward-looking and therefore make joint decisions to emigrate and to send back remittances. Unskilled workers migrate to avail the wage premiums offered by the destination countries but leave their children behind. In such an environment, the migrating parents undertake three crucial decisions: the total duration of migration; the amount of remittances send back to dependent children, and the time their children should devote to education. Parental remittances finance the consumption of the child; however, the children might have to supplement these remittances by engaging in child labor.

We model migration and child education as a joint decision taken by the migrating parents. Empirical literature clearly acknowledges migration and child education as interdependent decisions and authors have taken steps to tackle this endogeneity issue (Acosta, 2006; Calero et al., 2009; Dorantes et al., 2010; Ebeke, 2012; Hanson & Woodruff, 2003; Mansuri, 2006; Yang, 2008). The theoretical literature on skilled migration has also treated migration as endogenous when people incorporate the probability to migrate while undertaking educational investment decisions (Beine et al., 2001; Beine et al., 2008; Chen, 2006; Mayr and Peri, 2009; Marchiori et al., 2010; Mountford, 1997; Stark and Wang, 2002). We introduce human capital accumulation technology that is a function of remittances and parental absenteeism. Thus, migration on one hand positively affects human capital accumulation of the child through remittances, and negatively due to parental absenteeism.

The adverse impact of parental absenteeism is also well documented in the empirical literature. The human capital of children is adversely affected by parental migration due to three main reasons. Firstly, households that experience migration are similar to disrupted families which may lead to negative psychological effects on children. This consequently has a bearing on the educational performance of children (Bennett et al., 2012; Kandel & Kao, 2001). Secondly, owing to migration, rearing along with housework responsibilities are placed on the children who are left behind which affects the time allocated to schooling. Moreover, the children who are left behind have to assume the role of their parents as the breadwinner and hence join the workforce at an earlier age, taking on the role of the parent for the younger siblings (Booth & Tamura, 2009; McKenzie & Rapoport, 2010). Thirdly, if children develop a perception that their parents can earn higher wages as a result of migrating to a foreign country then it greatly reduces the incentives of children to attain more education. For instance, migration might be seen as an alternate route of achieving economic success without attaining higher educational levels (Kandel & Kao, 2001).

By incorporating parental absenteeism, this study offers a unique framework that combines the impact of parental absenteeism and remittances on human capital formation in the source country through human capital accumulation of the children left behind. Moreover, adding the aspect of parental absenteeism is imperative for more fully understanding the implications of international migration because the absence of a migrant parent might negatively affect the human capital accumulation of the child. Thus, the net effect of international migration would be dependent upon whether the child's time spent on education or parental absenteeism has a larger effect.

We find threshold conditions for the relative wage in the source to destination countries beyond which unskilled migration helps reduce child labor and increase human capital. Moreover, the threshold is endogenous and depends on the sensitivity of human capital formation to parental absenteeism relative to the child's time spent on acquiring human capital. In the special case when the former is equal to the latter, the wages in the destination country should at least be twice as much as in the source country to have a detrimental (promoting) impact on child labor (human capital formation). Since the importance of parental absenteeism would depend on a variety of sociocultural factors such as marriage, presence of extended families, religious communities, and social networks, there will be heterogeneity in the impact of unskilled migration.

The organization of the rest of the paper is as follows: section 2 describes the model setup, section 3 solves the decision problems of parents, section 4 looks at the impact of unskilled migration on human capital formation of children while section 5 presents the concluding remarks and policy recommendations.

2. Model Setup

We utilize a two-period lived overlapping generations model of one parent and one child in a world that comprises two economies, the destination country (denoted as D) and the source country (denoted as S). There is no population growth and the size of population is fixed at N. We model the behavior of agents in the source country and examine the case of temporary migration. Total population of the adults of generation (t) in the source country is further sub-divided into skilled workers, $L_{S;t}$, and unskilled workers, $L_{u,t,}$ $N_t^S = L_{s,t} + L_{u,t}$.[1]

We are interested in modelling the migration decision of unskilled workers from a relatively poor source country. Hence, we assume no migration by the skilled workers.[2] There is a wage premium associated with migration. Specifically,

$$\alpha = \frac{w_{u,t}^D}{w_{u,t}^S} > 1 \tag{1}$$

where $w_{u,t}^D$ and $w_{u,t}^S$ are the wage that an unskilled worker earns in the destination and source country, respectively. Migrating parents leave their children behind in the source country and send back remittances to finance their expenditures. Parents jointly decide the time spent in the destination country as a migrant, the amount of remittances to be sent to the child left behind in the source country and the child's time investment in education. All parents are identical and endowed with one unit of time that they devote to working. They spend a fraction $\delta_{2,t} \epsilon (0,1)$ of their unit endowment in the destination country as a temporary migrant. Similarly, all children of the

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[1] Since we focus on modelling the behaviour of unskilled migrants, we simplify the model by excluding the skilled sector. The skilled sector would employ human capital, with each unit of human capital producing one unit of output, i.e. $Y_{\tau,h} = H_{\tau}$. We could use this setup to find the overall growth rate in the economy.

[2] This is to focus on the implications of unskilled migration. For the skilled migration, see Dessy and Rambeloma (2009), and Camacho and Shen (2010).

generation $(t + 1)$ are endowed with one unit of time which they divide between obtaining education and working. If e_{t+1} is the time devoted to education, then, $(1 — e_{t+1})$ is the time allocated to child labour.[3]

The individual preferences are represented by the following utility function

$$U_{2,t} = lnC_{2,t} + \gamma[lnC_{1,t+1} + \beta lnH_{2,t+1}] \qquad (2)$$

where $C_{2,t}$ is the consumption of the parent, $C_{1,t+1}$ is the consumption of the child, $\gamma > 0$ is the parental altruism parameter, $\beta \epsilon$ (0,1) is the discounting factor, and $H_{2,t+1}$, is the stock of human capital of a child.

The child devoting $e_t + 1$ time in obtaining education would end up accumulating human capital level, $H_{2,t+1}$, given by the following technology

$$H_{2,t+1} = \lambda H_t e_{t+1}^{\sigma 1}(1 - \delta_{2,t})^{\sigma 2}, \qquad 1 > \sigma_{1,}\sigma_2 > 0 \qquad (3)$$

where $\lambda > 1$ is the productivity parameter, $(1 - \delta_{2,t})$ is the time spent by the parent in the source country, and H_t is the mean human capital of teachers from generation t. When defined in this way, human capital accumulation technology takes into account the adverse effect of parental absenteeism. There are various reasons to believe that the left behind children of a migrant parent experience a negative effect. First, children are deprived of direct input of parental effort in their human capital. Second, the households with migrating parents may face disruption that exert negative psychological effects on children. Third, the absence of a parent may place housework responsibilities on children. Fourth, if children develop a perception that their parents can earn higher wages as a result of migrating to a foreign country with limited skills, then, it greatly reduces their incentives to attain greater educational. All these factors individually or jointly can have adverse effects on the child's human capital. The net impact of parental absenteeism would depend on the sensitivity of human capital to parental absenteeism represented by σ_2. The smaller the σ_2 is, the less important will be the parental absenteeism in determining child's human capital. The size of the parameter σ_2 depends on a variety of social factors such as marriage systems, presence of extended families, religious communities, and social networks in general that would differ across countries. For instance, joint family systems, presence of extended families, cousin marriages, good social

[3] Since all individuals are identical, we skip the individual subscript i for all variables.

networks in terms of good neighbors are all likely to reduce the value of σ_2. A small value of σ_2 implies that a child's human capital formation is less sensitive to parental absenteeism, thereby reducing the negative impact of migration. On the other hand, nuclear families, broken marriages, absence of extended families and poor social networks are all likely to increase the value of σ_2, thereby making parental absenteeism due to migration more damaging for a child's accumulation of human capital.

The total income of a migrating parents is the sum of income earned in the source and destination country, i.e. $I_t = (1-\delta)\omega_{u,t}^D + \delta\omega_{u,t}^D$. We assume that the income earned in the destination country is high enough for parents to not only finance their consumption but also send remittances to their left behind children.

$$\boldsymbol{I_t^D = \delta\omega_{u,t}^D = C_t^D + \theta_t}$$

where θ_t is the amount of remittances sent by the migrant parent.[4] Moreover, we assume that parents spend their entire income earned in the source country on their consumption[5],

$$I_t^S = (1-\delta_t)\omega_{u,t}^S + C_t^S$$

The consumption of left behind children is financed by the remittances sent by their migrant parents and their own child labor income

$$C_{t+1} = \theta_t + I_{t+1}$$

$$= \delta\omega_{u,t}^D - C_t^D + (1-e_{t+1})\omega_u^k$$

where ω_u^k is the child labor wage earned by children.

There is a unique final good produced by two different technologies in the unskilled sector. The total output of the unskilled sector in the source country, $Y_{\tau,u}$, at any time $\tau, \tau = 1,2$ is the sum of output produced by the unskilled adults and child labor

$$Y_{\tau,u} = Y_{\tau,u}^\alpha + \phi Y_{\tau,u}^k$$

The unskilled sector is sub-divided into two sectors. First one uses unskilled adults and physical capital, the second one which is relatively

[4] Since parents live only one adulthood period, we do not use time sub-script throughout the paper.
[5] This is assumed to highlight the financial constraint that unskilled workers face in the source country.

less productive employs unskilled children and physical capital, where $1 > \phi > 0$, and a and k represents the adult and children sectors, respectively.

Besides households, there also exists a fixed number K of childless capitalists.[6] Each capitalist has a one unit endowment of capital, hence, K is also the total stock of capital in the economy. The capitalist may begin a firm combining her unit of capital with either adult labor or a child labor to produce output. There is a perfect capital mobility between the two sectors. The representative firm's output in the adult sector is

$$Y^{\alpha}_{\tau,u} = L^{\mu}_{t}$$

While that in the child sector is

$$Y^{k}_{t} = \phi L^{\mu}_{t+1}$$

where $\mu \epsilon (0,1)$.

Total labor supply is given by $\bar{L}_t - M$ in the adult sector, and $\bar{L}_t + 1$ in the child labor sector, and M denotes the number of unskilled adults who migrate. $\bar{L}_t + 1$ is then also the total incidence of child labor in the economy. Given this, labor and inter-sectoral capital allocation constraints are

$$L_{t+1} \leq \bar{L}_{t+1}; \quad L_t \leq \bar{L}_t - M; \quad K^k + K^{\alpha} = K$$

Markets cleaning wages in each sector are, then, given by the marginal product of labor, i.e.

$$w^{S}_{u,t} = \mu \left(\frac{K^{\alpha}}{\bar{L}_t - M} \right)^{1-\mu}$$

$$w^{k}_{u} = \mu\phi \left(\frac{K^{k}}{\bar{L}_{t+1}} \right)^{1-\mu}$$

where $w^{S}_{u,t}$ denotes the wage for the unskilled adult labor, and w^{k}_{u} denotes the wage for child labor.

As the owner of the firm, a capitalist would claim a residual after production. This residual is $\pi^{\alpha}_{\tau,u} = Y^{\alpha}_{\tau,u} - w^{S}_{u,t}\bar{L}_t$ for the adult sector and

[6] We assume childless capitalists to abstain from focusing on the work/education decision of capitalists.

$\pi^k_{\tau,u} = Y^k_{\tau,u} - w^k_u \bar{L}_{t+1}$ for the child sector. The returns to capital for the adult and child labor sectors are as follows

$$\pi^\alpha_{\tau,u} = \left(\frac{\bar{L}_t - M}{K - K^k}\right)^\mu (1 - \mu)$$

$$\pi^k_{\tau,u} = \phi\left(\frac{\bar{L}_{t+1}}{K^k}\right)^\mu (1 - \mu)$$

Capital is perfectly mobile across sectors and the no arbitrage condition would imply that the returns to capital are equal in equilibrium, i.e. $\pi^\alpha_{\tau,u} = \pi^k_{\tau,u}$

$$K^k = \frac{\phi^{\frac{1}{\mu}}\bar{L}_t K}{(\bar{L}_{t+1} - M) + \phi^{\frac{1}{\mu}}\bar{L}_t}; \qquad K^\alpha = \frac{(\bar{L}_{t+1} - M)K}{(\bar{L}_{t+1} - M) + \phi^{\frac{1}{\mu}}\bar{L}_t};$$

Finally, by substituting in for capital, the wages in the unskilled adult and child sectors are give as follows

$$w^S_{u,t} = \mu\left(\frac{K}{\bar{L}_{t+1} - M + \phi^{\frac{1}{\mu}}\bar{L}_t}\right)^{1-\mu} \tag{4}$$

$$w^k_u = \mu\phi^{\frac{1}{\mu}}\left(\frac{K}{\bar{L}_{t+1} - M + \phi^{\frac{1}{\mu}}\bar{L}_t}\right)^{1-\mu} \tag{5}$$

1 The Decision Problems of Parents

Parents jointly decide about the proportion of their time to be spent in the destination country $\delta_{2,t}$, the remittance amount, θ_t, to be sent back to the child in the source country, as well as the proportion of time, e_{t+1}, their child devotes to education. Thus, the maximization problem of the household is as follows:

$$\max_{(\theta_t, e_t, \delta)} \; U_t = lnC_{2,t} + \gamma[lnC_{1,t+1} + \beta lnH_{2,t+1}]$$

subject to:

$$H_{2,t+1} = \lambda H_t e^{\sigma 1}_{t+1}(1 - \delta_{2,t})^{\sigma 2}, \qquad 1 > \sigma_1, \sigma_2 > 0$$

$C_{2,t}$ and $C_{1,t+1}$ follow by definition as described in Section $2, 0 \leq e_{t+1} \leq$

$1 \ and \ 0 \leq \delta_{2,t} \leq 1$. Given this, the household value function is as follows

$$\underset{\theta_t, e_t, \delta_t}{\mathrm{V}} = \ln(\delta_{2,t} w_{u,t}^D + (1-\delta_{2,t}) w_{u,t}^S - \theta_t) + \gamma[\ln(\theta_t + (1-e_{t+1}) w_u^k) + \beta \ln\{\lambda H_t e_{t+1}^{\sigma 1} (1-\delta_{2,t})^{\sigma 2}\}] \quad 6$$

The parents maximize this value function with respect to θ_t, e_{t+1} and $\delta_{2,t}$. The first order conditions are as follows

$$\frac{dV}{d\theta_t} = \frac{1}{\delta_{2,t} w_{u,t}^D + (1-\delta_{2,t}) w_{u,t}^S - \theta_t} + \frac{\gamma}{\theta_t + (1-e_{t+1}) w_u^k} = 0$$

$$\theta_t = \frac{\gamma \delta_{2,t} w_{u,t}^D + \gamma (1-\delta_{2,t}) w_{u,t}^S - (1-e_{t+1}) w_u^k}{(1+\gamma)}$$

$$\frac{dV}{de_{t+1}} = \gamma \left(\frac{-w_u^k}{\theta_t + (1-e_{t+1}) w_u^k} + \frac{\beta \sigma_1 \lambda H_t e_{t+1}^{\sigma 1 - 1} (1-\delta_{2,t})^{\sigma 2}}{\lambda H_t e_{t+1}^{\sigma 1} (1-\delta_{2,t})^{\sigma 2}} \right) = 0$$

$$e_{t+1} = \frac{\beta \sigma_1 (\theta_t + w_u^k)}{w_u^k (1+\beta \sigma_1)}$$

$$\frac{dV}{d\delta_{2,t}} = \frac{w_{u,t}^D - w_{u,t}^S}{\delta w_{u,t}^D + (1-\delta_{2,t}) w_{u,t}^S - \theta_t} - \frac{\gamma \beta \sigma_2 \lambda H_t e_{t+1}^{\sigma 1} (1-\delta_{2,t})^{\sigma 2 - 1}}{\lambda H_t e_{t+1}^{\sigma 1} (1-\delta_{2,t})^{\sigma 2}} = 0$$

$$\delta_{2,t} = \frac{\beta \sigma_2 (\theta + w_u^k) - (1-\delta)(w_{u,t}^D - w_{u,t}^S)}{\beta \sigma_2 w_u^k}$$

Solving the first order conditions simultaneously yields the optimal time spent as a migrant, $\delta_{2,t} = \delta^*$, the optimal amount of remittances, $\theta_t = \theta^*$, and the optimal time spent on children's schooling, $e_{t+1} = e^*$, as follows

$$\theta^* = \frac{\gamma (1+\beta \sigma_1) w_{u,t}^D - w_u^k (1+\gamma \beta \sigma_2)}{x}$$

$$e^* = \frac{\gamma \beta \sigma_1}{x} \left(\frac{w_{u,t}^D}{w_u^k} + 1 \right)$$

$$\delta^* = \frac{1+\gamma(1+\beta \sigma_1)}{x} - \left[\frac{\gamma \beta \sigma_2 (w_{u,t}^S + w_u^k}{x (w_{u,t}^D - w_{u,t}^S} \right]$$

Where $x = 1 + \gamma + \gamma\beta(\sigma_1 + \sigma_2)$. An increase in the unskilled worker's wage in the destination country increases the amount of remittances which in turn increases the children's time spent on education. On the other hand, an increase in the child's wage reduces the remittance flows, consequently reducing the children's time spent on education.

By substituting in for equation (1) and the wages in equations (4) and (5), the optimal values of θ^*, e^*, δ^* are give as follows

$$\delta^* = \frac{\mu K^{1-\mu}}{x(\bar{L}_t - M) + \phi^{\frac{1}{\mu}} \bar{L}_{t+1})^{1-\mu}} [\gamma(1 + \sigma_1\beta)\alpha - \phi^{\frac{1}{\mu}}(1 + \gamma\beta\sigma_2)] \qquad 7$$

$$e^* = \left(\frac{\gamma\beta\sigma_1}{x}\right)\left(\frac{\alpha + \phi^{\frac{1}{\mu}}}{\phi^{\frac{1}{\mu}}}\right) \qquad 8$$

$$(1 - \delta^*) = \frac{\gamma\beta\sigma_2\left(\alpha + \phi^{\frac{1}{\mu}}\right)}{x(\alpha - 1)} \qquad 9$$

Where $(1 - \delta^*)$ is the optimal time spent in the source country by an unskilled adult.

Proposition 1 *A higher relative wage of unskilled workers in the destination country reduces child labor. There exists a threshold* $\alpha = \phi^{\frac{1}{\mu}}\left(\frac{1+\gamma+\gamma\beta\sigma_2}{\gamma\beta\sigma^1}\right) = \bar{\alpha}$, *such that* $\forall\alpha \geq \bar{\alpha}$, *there is no child labor.*

Proof. As follows ■

The time spent in child labor is given by $1 - e_t^*$. From the above equation $\frac{\partial e^*}{\alpha} > 0$, thus, $1 - e_t^*$ decreases with the relative wage of unskilled workers in the destination country, α. When $\alpha = \bar{\alpha} = \phi^{\frac{1}{\mu}}\left(\frac{1+\gamma+\gamma\beta\sigma_2}{\gamma\beta\sigma^1}\right)$, $1 - e_t^* = 0$.

Intuitively, a higher relative wage in the destination country increases the time spent as a migrant as well as the amount of resources remitted back to the source countries. These remittances reduce the financial constraints of the migrant family and hence its reliance on the child labor as a source of family income. This is consistent with the empirical findings in the Cox Edwards and Ureta (2003) who reported that remittances significantly reduce the hazard of children drop out from school irrespective of the amount of remittances received. Moreover, the threshold *a* is a positive function of the productivity in the child labor sector implying that with a more productive child labor sector a higher relative wage would be required to eliminate the child labor. Thus, the policies in the destination countries that promote better wages for unskilled immigrants as well as the policies in the source countries that reduce child labor productivity would result in more schooling and lower incidence of child labor.

Second, the threshold $\bar{\alpha}$ is also a positive function of σ_2. σ_2 represents the sensitivity of human capital accumulation to parental absenteeism, and a higher value of σ_2 would imply a higher sensitivity. Intuitively, when human capital technology is more sensitive to parental absenteeism, the relative return from spending more time in schooling is lower. This, in turn, makes schooling less attractive and child labor more attractive. As a result, a greater relative wage in the destination country would be required to eliminate child labor.

2 Human Capital Formation

In this section, we derive the human capital equation of children. Human capital of the children from t + 1 generation is given by

$$H_{2,t+1} = \lambda H_t e_{t+1}^{\sigma_1}(1-\delta_{2,t})^{\sigma_2}$$

By substituting in for the optimal time allocation to schooling and the optimal time spent in the source country from the equations (8) and (9), respectively, the level of human capital of the unskilled workers' children is given by;

$$H_{t+1} = \frac{\lambda H_t(\gamma\beta\sigma_1)^{\sigma_1}(\gamma\beta\sigma_2)^{\sigma_2}(\alpha+\phi^{\frac{1}{\mu}})^{\sigma_1+\sigma_2}}{[1+\gamma+\gamma\beta(\sigma_1+\sigma_2)]^{\sigma_1+\sigma_2}\left(\phi^{\frac{1}{\mu}}\right)^{\sigma_1}(\alpha-1)^{\sigma_2}}$$

Proposition 2 *There is a non-monotonic relationship between the relative wages of the unskilled workers in the destination country and their children's human capital. There exists a threshold* $\alpha = 1+\frac{\sigma_2}{\sigma_1}\left(1+\phi^{\frac{1}{\mu}}\right) = \alpha_A$ *such that for* $\forall\alpha < \alpha_A$, *there is a negative impact of migration on the children's human capital, and* $\forall\alpha \geq \alpha_A$, *migration leads to higher levels of human capital.*

Proof. See Appendix A ■

Intuitively, the relative wage of the unskilled workers in the destination country affects their children's human capital in two ways. First, a higher relative wage would lead to more time spent in the destination country as well as a higher amount of the remittances sent back to children. Consequently, there would be an increase in the schooling (a higher e_t^*) of the children left behind, which would increase the level of their human capital. Second, more time spent in the destination country implies a less time $(1-\delta^*)$ spent with children which negatively affects their human capital. Which of the two effects dominate crucially depend on the magnitude of the relative wage, α. Moreover, the threshold α_A that demarcates the positive impact of relative wage on human capital from its negative impact crucially depends on the sensitivity of human capital technology to the parental absenteeism relative to the effort in schooling, $\frac{\sigma_2}{\sigma_1}$. σ_2 shows the importance of the parental time spent in the source country in shaping the level of human capital of their children. Thus, when human capital accumulation technology is more sensitive to parental absenteeism, there is a greater chance of a negative impact of migration on children's human capital. In an extreme case where $\sigma_2 = 0$, migration always leads to higher levels of human capital. In a special case, when the effort in schooling and parental absenteeism are equally important i.e. $\sigma_2 = \sigma_1 \Rightarrow \alpha_A = 2 + \phi^{\frac{1}{\mu}}$, the wage in the destination country has to be more than twice as much as that in the source country to have a positive impact on children's human capital. Overall, the threshold α_A would be higher with higher (lower) sensitivity of human capital formation to parental absenteeism (effort in schooling) and higher productivity of the child labor sector.

Since the importance of parental absenteeism would depend on a variety of sociocultural factors such as marriage, presence of extended families, religious communities, and social networks, there will be heterogeneity in the impact of unskilled migration. From a policy point of view, a policy that reduces the sensitivity of children's human capital on parental absenteeism would make unskilled migration conducive for human capital accumulation. Furthermore, policies in the destination country that raises wages of unskilled workers, and/or policies in the source country that reduces productivity of child labor sector would induce a positive impact of unskilled migration on human capital of the children left behind.

3 Conclusion

Despite having a wealth of empirical literature on the implications of unskilled migration on children's education in the source country, there is a dearth of a coherent theoretical framework linking unskilled migration and parental absenteeism to the human capital of the children left behind. We fill this gap by offering a framework that takes into account the joint decision of unskilled migration, the amount of remittances, and the effort exerted in children's schooling. Our results highlight the key role of relative wages of unskilled workers in the destination country in determining the impact of migration on child labor and human capital of left behind children. However, there are threshold effects in the size of this relative wage that determine the direction of the impact of unskilled migration. Moreover, these thresholds are endogenous and crucially depend on the sensitivity of human capital accumulation to parental absenteeism and the productivity of child labor sector. Since, the sensitivity of human capital would depend on sociocultural factors, our results suggest heterogeneity in the impact of migration on child labor and human capital of left behind children.

Our results propose important policy implications for developing countries. Developing countries can encourage the migration of unskilled migration to curb the child labor. The remittances sent back by the unskilled migrants play a major role in promoting school enrolment and reducing child labor by shifting the use of children's time towards education and away from working. Our results recommend three dimensional policies for the developing countries to harness the positive impact of unskilled migration. First, developing countries should devote efforts and resources to improve the matching between unskilled migrants and the host employers to improve their productivity and the relative wage. This could, for example, include designing well grounded labour market information systems. The systems which accurately assess labour market needs and the skill requirements, disseminate such information through innovative ways that are easily accessible to low-skilled workers, and provide training and match making opportunities. Second, within the source country, governments need to provide a conducive schooling environment such that the impact of parental absenteeism is minimized. This could include policies such as better access to schools and group or neighborhood based monitoring and evaluation of the schools. And third, policies are required to hamper the productivity of child labor sector, which will reduce the opportunity cost of schooling. This could include the policies that disincentivize child labor production sector such as mandatory registration with the government (documentation), penalty or higher taxes, as well as the policies that incentivise identification and punishment of child labor cases, and mandatory schooling.

References

Acosta, P. (2006). Labor Supply, School Attendance, and Remittances from International Migration: the case of El Salvador. Policy Research Working Paper Series 3903, The World Bank.

Ahn, P. (2004). Migrant Workers and Human Rights: Out-Migration from South Asia. International Labour Organization.

Arif, R., & Chaudhry, A. (2015). The effects of external migration on enrolments, accumulated schooling and dropouts in Punjab. *Applied Economics*, 47(16), 1607-1632.

Beine, M., Docquier, F. & Rapoport, H. (2001). Brain Drain and Economic Growth: Theory and Evidence. *Journal of Development Economics*, vol. 64 (1), pp. 275-289.

Beine, M., Docquier, F. & Rapoport, H. (2008). Brain Drain and Human Capital Formation in Developing countries: Winners and Losers. *The Economic Journal*, vol. 118, pp. 631-652.

Bennett, R., Clifford, D., & Falkingham, J. (2012). Household Members' Migration and the Education of Children 'Left Behind': Empirical Findings from Tajikistan and Reflections for Research Practice. Population, Space and Place, vol. 19 (1), pp. 1-14.

Bhagwati, J. & Hamada, K. (1974). The Brain Drain, International Integration of Markets for Professionals and Unemployment: A theoretical analysis. *Journal of Development Economics*, vol. 1(1), pp. 19-42.

Booth, A. & Tamura, Y. (2009). Impact of Paternal Temporary Absence on Children Left Behind. IZA Discussion Papers 4381, Institute for the Study of Labor (IZA).

Calero, C., Bedi, A.S. & Sparrow, R. (2009). Remittances, Liquidity Constraints and Human Capital Investments in Ecuador. *World Development*, vol. 37(6), pp. 1143-1154.

Camacho, C. & Shen, I-L. (2010). Public Education for the Children Left Behind. IZA Discussion Papers 4833, Institute for the Study of Labor (IZA).

Chen, H.J. (2006). International Migration and Economic Growth: A Source Country Perspective. *Journal of Population Economics,* vol. 19 (4), pp. 725-748.

Cox Edwards, A. & Ureta, M. (2003). International Migration, Remittances, and Schooling: Evidence from El Salvador. *Journal of Development Economics,* vol. 72 (2), pp. 429-461.

Dessy, S. & Rambeloma, T. (2009). Immigration Policy, Remittances and Growth in the MigrantSending Country. Cahier de recherche/ Working Paper 09-15, CIRPEE.

Docquier, F. (2006). Brain Drain and Inequality Across Nations. IZA Discussion Paper No. 2440.

Dorantes, C.A., Georges, A. & Pozo, S. (2010). Migration, Remittances, and Children's Schooling in Haiti. *Annals of the American Academy of Political and Social Science,* vol. 630, pp. 224-244.

Ebeke, C.H. (2012). The Power of Remittances on the International Prevalence of Child Labor. *Structural Change and Economic Dynamics*, vol. 23, pp. 452- 462.

Faini, R. (2007) Remittances and the Brain Drain: Do more skilled migrants remit more?. *World Bank Economic Review* 21(2): 177-91.

Hanson, G.H. & Woodruff, C. (2003). Emigration and Educational Attainment in Mexico. University of California at San Diego, Mimeographed.

Kandel, W., & Kao, G. (2001). The Impact of Temporary Labor Migration on Mexican Children's Educational Aspirations and Performance. *International Migration Review*, vol. 35 (4), pp.1205-1231.

Mansuri, G. (2006). Migration, School Attainment, and Child Labor: Evidence from Rural Pakistan. Policy Research Working Paper Series 3945, The World Bank.

Marchiori, L., Pieretti P. & Zou, B. (2010). Migration and human capital in an endogenous fertility model. *Annals of Economics and Statistics,* vol. 97-98, pp. 187-205.

Mayr, K. & Peri, G. (2009). Brain Drain and Brain Return: Theory and Application to Eastern- Western Europe. *The B.E. Journal of Economic Analysis & Policy,* vol. 9(1), pp.1-52.

McKenzie, D. & Rapoport, H. (2010). Can Migration Reduce Educational Attainment? Evidence from Mexico. *Journal of Population Economics,* vol. 24(4), pp.1331-1358.

Mountford, A. (1997). Can a brain drain be good for growth in the source economy? *Journal of Development Economics,* vol. 53(2), pp. 287-303.

Nimi, Y., Ozden, C. & Schiff, M. (2010). Remittances and the Brain Drain: Skilled Migrants Do Remit Less. *Annals of Economics and Statistics* No. 97/98, pp. 123-141.

Rapoport, H. (2002). Who is afraid of the brain drain? Human capital flight and growth in developing countries, SIEPR Policy Brief, Stanford University.

Ratha, D., Mohapatra, S. & Silwal, A. (2011). Migration and Remittances Factbook 2011. World Bank.

Richard, H & Adams, J. (2009). The Determinants of International Remittances in Developing Countries. *World Development,* vol. 37(1), pp. 93-103.

Stark, O. & Wang, Y. (2002). Inducing human capital formation: migration as a substitute for subsidies. *Journal of Public Economics,* vol. 86(l), pp.29-46.

Yang, D. (2008). International Migration, Remittances, and Household Investment: Evidence from Philippine Migrants' Exchange Rate Shocks. *Economic Journal,* vol. 118 (528), pp. 591-630.

Appendix A

In this appendix, we derive the level of human capital of the unskilled workers' children and then show a detailed comparative static analysis of H^*. The children's human capital is given by

$$H_{2,t+1} = \lambda H_t e_{t+1}^{\sigma_1} \left(1 - \delta_{2,t}\right)^{\sigma_2}$$

By substituting in for the optimal values of e^* and $(1 — \delta)$ from the equation (8) and (9), respectively

$$H^* = \lambda H_t \left[\frac{\gamma\beta\sigma_1 \left(\alpha + \phi^{\frac{1}{\mu}}\right)}{\left[1 + \gamma + \gamma\beta\left(\sigma_1 + \sigma_2\right)\right] \phi^{\frac{1}{\mu}}} \right]^{\sigma_1} \left[\frac{\gamma\beta\sigma_2 \left(\alpha + \phi^{\frac{1}{\mu}}\right)}{\left[1 + \gamma + \gamma\beta\left(\sigma_1 + \sigma_2\right)\right] (\alpha - 1)} \right]^{\sigma_2}$$

$$H^* = \frac{\lambda H_t \left(\gamma\beta\sigma_1\right)^{\sigma_1} \left(\alpha + \phi^{\frac{1}{\mu}}\right)^{\sigma_1 + \sigma_2} \left(\gamma\beta\sigma_2\right)^{\sigma_2}}{\left[1 + \gamma + \gamma\beta\left(\sigma_1 + \sigma_2\right)\right]^{\sigma_1 + \sigma_2} (\alpha - 1)^{\sigma_2} \left(\phi^{\frac{1}{\mu}}\right)^{\sigma_1}}$$

Thus, following is the level of human capital of the unskilled workers' child in time period $t + 1$:

$$H^* = \frac{\lambda H_t \left(\gamma\beta\sigma_1\right)^{\sigma_1} \left(\gamma\beta\sigma_2\right)^{\sigma_2} \left(\alpha + \phi^{\frac{1}{\mu}}\right)^{\sigma_1 + \sigma_2}}{\left[1 + \gamma + \gamma\beta\left(\sigma_1 + \sigma_2\right)\right]^{\sigma_1 + \sigma_2} \left(\phi^{\frac{1}{\mu}}\right)^{\sigma_1} (\alpha - 1)^{\sigma_2}}$$

Derivating H_{t+1} with respect to α shows a non-linear impact of α on H^*

$$\begin{aligned}
\frac{\partial H^*}{\partial \alpha} &= \frac{\lambda \left(\gamma\beta\sigma_1\right)^{\sigma_1} \left(\gamma\beta\sigma_2\right)^{\sigma_2}}{x^{\sigma_1 + \sigma_2} \left(\phi^{\frac{1}{\mu}}\right)^{\sigma_1}} \left[\frac{\begin{array}{c} (\alpha - 1)^{\sigma_2} \left(\sigma_1 + \sigma_2\right) \left(\alpha + \phi^{\frac{1}{\mu}}\right)^{\sigma_1 + \sigma_2 - 1} (1) \\ - \left(\alpha + \phi^{\frac{1}{\mu}}\right)^{\sigma_1 + \sigma_2} \sigma_2 (\alpha - 1)^{\sigma_2 - 1} \end{array}}{(\alpha - 1)^{2\sigma_2}} \right] \\
&= \frac{\lambda \left(\gamma\beta\sigma_1\right)^{\sigma_1} \left(\gamma\beta\sigma_2\right)^{\sigma_2}}{x^{\sigma_1 + \sigma_2} \left(\phi^{\frac{1}{\mu}}\right)^{\sigma_1} (\alpha - 1)^{2\sigma_2}} \left(\left[(\alpha - 1)^{\sigma_2} \left(\alpha + \phi^{\frac{1}{\mu}}\right)^{\sigma_1 + \sigma_2} \right] \left[\frac{\left(\sigma_1 + \sigma_2\right)}{\left(\alpha + \phi^{\frac{1}{\mu}}\right)} - \frac{\sigma_2}{(\alpha - 1)} \right] \right) \\
&= \frac{\lambda \left(\gamma\beta\sigma_1\right)^{\sigma_1} \left(\gamma\beta\sigma_2\right)^{\sigma_2} (\alpha - 1)^{\sigma_2} \left(\alpha + \phi^{\frac{1}{\mu}}\right)^{\sigma_1 + \sigma_2}}{x^{\sigma_1 + \sigma_2} \left(\phi^{\frac{1}{\mu}}\right)^{\sigma_1} (\alpha - 1)^{2\sigma_2}} \left[\frac{\left(\sigma_1 + \sigma_2\right)}{\left(\alpha + \phi^{\frac{1}{\mu}}\right)} - \frac{\sigma_2}{(\alpha - 1)} \right]
\end{aligned}$$

$$= \frac{\lambda \left(\gamma\beta\sigma_1\right)^{\sigma_1} \left(\gamma\beta\sigma_2\right)^{\sigma_2} \left(\alpha + \phi^{\frac{1}{\mu}}\right)^{\sigma_1+\sigma_2}}{x^{\sigma_1+\sigma_2} \left(\phi^{\frac{1}{\mu}}\right)^{\sigma_1} \left(\alpha - 1\right)^{\sigma_2}} \left[\frac{(\sigma_1+\sigma_2)}{\left(\alpha + \phi^{\frac{1}{\mu}}\right)} - \frac{\sigma_2}{(\alpha-1)}\right]$$

The first term $\frac{\lambda(\gamma\beta\sigma_1)^{\sigma_1}(\gamma\beta\sigma_2)^{\sigma_2}\left(\alpha+\phi^{\frac{1}{\mu}}\right)^{\sigma_1+\sigma_2}}{x^{\sigma_1+\sigma_2}\left(\phi^{\frac{1}{\mu}}\right)^{\sigma_1}(\alpha-1)^{\sigma_2}}$ is positive. Therefore, the sign of the derivative depends upon the sign of the term $\left[\frac{(\sigma_1+\sigma_2)}{\left(\alpha+\phi^{\frac{1}{\mu}}\right)} - \frac{\sigma_2}{(\alpha-1)}\right]$. Checking the sign of the second term.

$$\left[\frac{(\sigma_1+\sigma_2)}{\left(\alpha + \phi^{\frac{1}{\mu}}\right)} - \frac{\sigma_2}{(\alpha-1)}\right] \gtreqless 0$$

$$\frac{(\sigma_1+\sigma_2)(\alpha-1) - \sigma_2\left(\alpha + \phi^{\frac{1}{\mu}}\right)}{\left(\alpha + \phi^{\frac{1}{\mu}}\right)(\alpha-1)} \gtreqless 0$$

$$\frac{\alpha\sigma_2 + \alpha\sigma_1 - \sigma_2 - \sigma_1 - \alpha\sigma_2 - \sigma_2\phi^{\frac{1}{\mu}}}{\left(\alpha + \phi^{\frac{1}{\mu}}\right)(\alpha-1)} \gtreqless 0$$

$$\frac{\alpha\sigma_1 - \sigma_2 - \sigma_1 - \sigma_2\phi^{\frac{1}{\mu}}}{\left(\alpha + \phi^{\frac{1}{\mu}}\right)(\alpha-1)} \gtreqless 0$$

$$\alpha\sigma_1 - \sigma_2 - \sigma_1 - \sigma_2\phi^{\frac{1}{\mu}} \gtreqless 0$$

$$\frac{\partial H^*}{\partial \alpha} = 0 \text{ if } (\alpha\sigma_1 - \sigma_2 - \sigma_1 - \sigma_2\phi^{\frac{1}{\mu}}) = 0$$

$$\alpha\sigma_1 - \sigma_2 - \sigma_1 - \sigma_2\phi^{\frac{1}{\mu}} = 0$$

$$\alpha\sigma_1 = \sigma_2 + \sigma_1 + \sigma_2\phi^{\frac{1}{\mu}}$$

$$\alpha = \frac{\sigma_2 + \sigma_1 + \sigma_2\phi^{\frac{1}{\mu}}}{\sigma_1}$$

$$\alpha = \frac{\sigma_2 + \sigma_2\phi^{\frac{1}{\mu}}}{\sigma_1} + \frac{\sigma_1}{\sigma_1}$$

$$\alpha = \frac{\sigma_2\left(1 + \phi^{\frac{1}{\mu}}\right)}{\sigma_1} + 1$$

$$\alpha = 1 + \frac{\sigma_2}{\sigma_1}\left(1 + \phi^{\frac{1}{\mu}}\right) = \alpha_A$$

$$\frac{\partial H^*}{\partial \alpha} > 0 \text{ if } (\alpha\sigma_1 - \sigma_2 - \sigma_1 - \sigma_2\phi^{\frac{1}{\mu}}) > 0$$

$$\frac{\partial H^*}{\partial \alpha} > 0 \text{ if } \alpha > \left[1 + \frac{\sigma_2}{\sigma_1}\left(1 + \phi^{\frac{1}{\mu}}\right)\right]$$

$$\frac{dH_{t+1}}{d\alpha} > 0 \text{ if } \alpha > \alpha_A$$

$$\frac{\partial H^*}{\partial \alpha} < 0 \text{ if } (\alpha\sigma_1 - \sigma_2 - \sigma_1 - \sigma_2\phi^{\frac{1}{\mu}}) < 0$$

$$\frac{\partial H^*}{\partial \alpha} < 0 \text{ if } \alpha < \left[1 + \frac{\sigma_2}{\sigma_1}\left(1 + \phi^{\frac{1}{\mu}}\right) \equiv \alpha_A\right]$$

$$\text{Hence } \frac{\partial H^*}{\partial \alpha} < 0 \text{ if } \alpha < \alpha_A$$

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