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What Factors Determine the Rice Exports of Pakistan? Finding the Answer by Applying the Gravity Model

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Abstract: The objective of this study was to identify the factors which determine the flow of rice exports from Pakistan to its 54 major importing partners during 2000 to 2012. For this purpose the secondary data were collected from official websites of United Nations as well as other reliable sources and gravity model was applied. The findings revealed increase in Pakistan' GDP, Pakistan' GDP per capita, importer' GDP, importer GDP per capita, exchange rate volatility and having common border as the factors which increase the flow of Pakistan rice towards its 54 major rice importing markets. Increase in Pakistan GDP per capita was found having a positive impact on Pakistan rice exports because rice is not a staple food for Pakistani people so despite an increase in the GDP per capita, demand in rice does not impact on rice exports. Increase in importers' GDP and increase in importer' GDP per capita increase Pakistan rice exports because an increase in both stated variables increases the purchasing power and as the result, rice export from Pakistan increases. Having common border allows the delivery of Pakistan rice at minimum transportation cost which results in increase in the export flow of rice from Pakistan. The volatility of exchange rate was found to have significant positive coefficient that argue that a decline in the value of Pakistan's currency would boost its rice exports. On the other side, Distance was identified as a factor that causes shrinkage in export of rice from Pakistan to its 54 partners while the other variables like common language, Pakistan' openness and importer's openness were found to be insignificant factors for the rice exports from Pakistan. The results of this study can be useful for the policy makers i.e. Trade Development Authority Pakistan and Rice Export Association of Pakistan while developing strategies to promote rice exports.

Key words: Pakistan's rice exports · Gravity model · Determinants of rice exports · Gross domestic product

INTRODUCTION

Agriculture holds a key role in the economic and social development of Pakistan. Being a key sector in Pakistan's economy, it is source of provision of employment to almost 44% of the total labor force and contributes 21% in the gross domestic product of the country [1]. Agriculture sector of Pakistan is also a major source of provision of raw material to various other industries and hence plays a direct as well as indirect role in the production and exports from the country. Rice is one of the five major crops in Pakistan and an important exportable commodity. Since rice is not a staple food for Pakistani society and the domestic rice consumption per capita is only 10kg/year so every year almost 40% of the rice produced is exported and precious foreign exchange is earned which is helpful to overcome the overall trade deficit of Pakistan [2]. This exported quantity of rice is also helpful to keep the domestic rice prices at a level where the farmers as well as other stakeholders earn reasonable margins. After cotton and cotton products, rice is the second largest export item. It contributes almost

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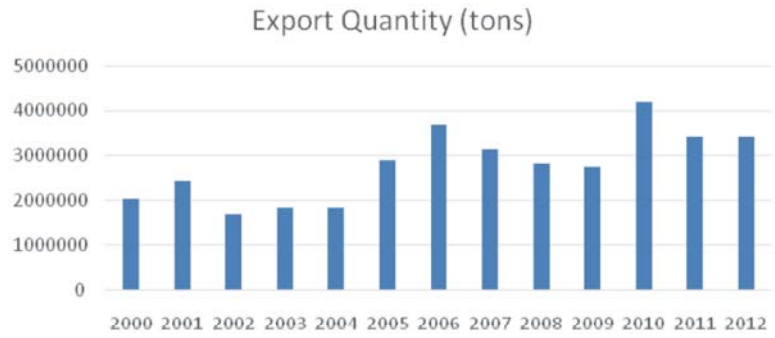

Fig. 1: Pakistan's Rice Exports in tons:
Source: Food and Agriculture Organization of United Nations

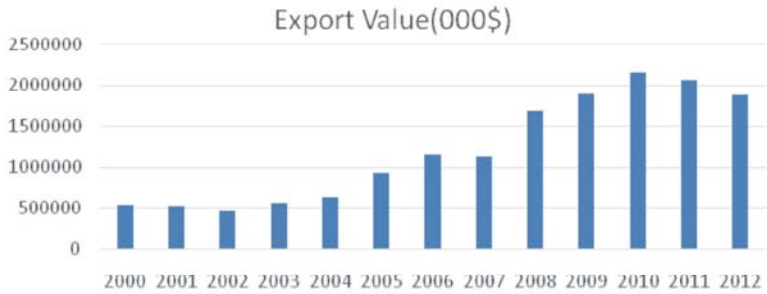

Fig. 2: Pakistan's Rice Exports in terms of value:
Source: Food and Agriculture Organization of United Nations

15% in the Pakistan foreign exchange [3, 4]. Middle East countries are the major export markets for Pakistani rice. Along with the Middle East countries, the African markets are also important partner of Pakistani rice trade. The analysis of the determinants of Pakistan' rice export can be helpful to increase the exports and this information can be beneficial to reduce the trade deficit of the economy of Pakistan. For the prediction of the flow of international trade, the gravity model has been widely used and is much popular [5]. Figure 1 and 2 show the trend in the quantity and value of export of rice from Pakistan during 2000-2012. During the stated period a mix kind of trend can be seen i.e. in 2002, 2003 and 2004 the export quantity witnessed a decline and in the coming years, there was seen an increase in the exports of rice but this increase was not consistent and fluctuations were observed. On the other hand, we can see a trend showing increase in the export value with some fluctuations but this trend had relatively less fluctuations as compare to fluctuations in export quantity and it was due to the high demand which causes high prices in the international market. In this paper, the gravity model has been applied to identify the determinants of rice export from Pakistan to the major 54 Pakistan's rice importing countries of the world.

MATERIALS AND METHODS

For this study, we have used annual data from 2000 to 2012 to find out the factors that determine the flow of rice exports from Pakistan to 54 countries which have a major share in imports of rice from Pakistan. We have collected the data from official websites of Food and Agriculture Organization of the United Nations [6] as well as from United Nations' COMTRADE web portal [7] regarding the export quantity/export value of rice. Data regarding the GDP and population was collected from the official website of World Bank [8]. Website of IMF (international monitory fund) [9] was accessed to download the data regarding the exchange rate. The distance from Islamabad (capital city of Pakistan) and the relevant trading partner country' capital city was obtained using the Travel Distance Calculator.

The standard Gravity model states that there are two determinants of trade between two countries; the GDP of each country which has a positive impact on trade and the distance which has a negative impact on the bilateral trade. In this paper, a gravity model approach has been applied in order to find out the determinants of rice exports from Pakistan from the period of 2000 to 2012. In 1962, Jan Tinbergen developed and applied the gravity

model [10] which is widely considered as a useful model in order to formalize and describe the bilateral trade flow. This can be written as:

$$X_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} D_{ij}^{\beta_3} \quad (1)$$

where,

Where X*ij* represents the flow of exports from country i to country j

Y*i* and Y*j* represent the Gross Domestic Products (GDPs) of country i and j

D*ij* represents the distance between the capital cities of the countries.

In the linear form, this model can be expressed as:

$$\log(X_{ij}) = \alpha + \beta_1 \log(Y_i) + \beta_2 \log(Y_j) + \beta_3 \log(D_{ij}) \quad (2)$$

In general, the gravity model is based on the assumption that the volume of export between two countries, X*ij*, is the function of their gross domestic products i.e. income of the countries, population of both countries, distance between both countries (capital city to capital city) and different dummy variables. This can be represented as:

$$X_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} L_i^{\beta_3} L_j^{\beta_4} D_{ij}^{\beta_5} A_{ij}^{\beta_6} eu_{ij} \quad (3)$$

where

For the country *i (j)*

Yi (Yj) represents the gross domestic product,

Li (Lj) represents the population

Dij is the measurement of the distance between the two trading partner countries' capitals.

A*ij* represents dummy variables

eu*ij* is the error term

βs are the parameters of the model.

For the bilateral trade, income has long been considered as an enhancing variable. [11] argued that the country's potential trade should be measured by the GDP. Since the gross domestic product of rice importing countries measures the absorptive capacity and the gross domestic product of the exporting country (Pakistan in this case) measures productive capacity so therefore these above stated two variables are expected to have a positive impact on trade [12]. The variables of GDP per capita of Pakistan and GDP per capita of importing countries have also been added by assuming that the higher GDP per capita of the importing country would stimulate the demand of rice from Pakistan while the increase in the income of Pakistan population would stimulate the domestic demand of rice and hence would have a negative impact on rice exports from Pakistan. As the proxy of transaction cost, the distance has been used in this work by calculating the physical distance between the two capital cities of trading partners. Since the distance between trading partners' capital cities determines the transportation cost so more the distance, more the transportation cost which results in reduction in trade between trading partners. Openness is the impact of total import plus total export over the GDP. It is measured by adding the total exports & imports and then dividing by real GDP. Real bilateral exchange rate was added as an explanatory variable by [11] in the empirical model designed for the analysis of Mercosur-EU trade flows. In this paper we have defined the exchange rate as the number of importing market units of currency which can be purchased using one unit of Pakistani currency (Pakistani rupees). Some dummy variables have been included for this work i.e. common language (this variable is assigned the value 1 if Pakistan and importing partner j share the common language, otherwise zero), Common border (this variable is assigned the value of 1 if Pakistan and trading partner j share the common border, otherwise zero). Hence the agricultural exports' value (X*ij*) from Pakistan to its major 54 trading partners (j*s*) can be expressed as:

$$X_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} L_i^{\beta_3} L_j^{\beta_4} OP_i^{\beta_5} OP_j^{\beta_6} Exr_{ij}^{\beta_7} D_{ij}^{\beta_8} CommonB_{ij}^{\beta_9} CommonL_{ij}^{\beta_{10}} eu_{ij} \quad (4)$$

where

β0 is a constant

Y represents the GDP (gross domestic product)

L represents the population

Op represents the real openness

Exr represents the real exchange rate between trading partners

D represents the distance between the capitals cities of trading partners

Common border and common language are represented by Common B and Common L and these are dummy variables.

By taking the logarithm of equation 4, we get following equation which is in the form of log linier form.

$$Ln(X_{ij}) = \beta_0 + \beta_1 Ln(Y_i) + \beta_2 Ln(Y_j) + \beta_3 Ln(L_i)\beta_4 Ln(L_j) + \beta_5 Ln(OP_i) + \beta_6 Ln(OP_j) + \beta_7 Ln(Exr_{ij}) + \beta_8 Ln(D_{ij}) + \beta_9 Ln(CommonB_{ij}) + \beta_{10} Ln(CommonL_{ij}) + eu_{ij} \quad (5)$$

There are three different methods available for estimating linear panel models. We will use all three methods available for estimation of linear panel model and then decide which one to prefer and on what basis. The three methods are following; Firstly, pooled ordinary least square (POLS), secondly, fixed effect method (FE) and thirdly, random effect method (RE). Every model is based on certain assumptions. As POLS assumes a homogeneous data set and takes a common constant for each group. POLS can be modeled as:

$$Y_{it} = \alpha + \beta X_{it} + \varepsilon_{it} \quad (6)$$

Due to not be able to estimate the country specific effects, it is considered a restricted model (13).

Since the fixed effect model assumes that each group differs in constant terms so the fixed effect model can also be written in the below form:

$$Y_{it} = \alpha_i + \beta X_{it} + \varepsilon_{it} \quad (7)$$

When the flow of trade is being estimated between the pre defined set of countries then the fixed effects model is considered to produce better results (14).

The third model; the random effect model, assumes that each group differs in its error term so random effect model can be modeled as:

$$Y_{it} = \alpha_i + \beta X_{it} + (\nu_i + \varepsilon_{it}) \quad (8)$$

The random effect model is useful in such situations when we want to estimate the trade flow between a country and its trading partners and those trading partners have been chosen from a lot of other countries (from quite a large population). Standard F-Statistics has been used to decide about which model should be used among Fixed Effect and POLS. The following formula is used to measure the F-statistic:

$$F = \frac{\left(R^2_{FE} - R^2_{CC}\right)/(N-1)}{\left(1 - R^2_{FE}\right)/(NT - N - K)} \approx F(N-1, NT - N - K) \quad (9)$$

where R_{FE}^2 and R_{CC}^2 are coefficient of determination of fixed effect model and common constant model respectively.
Here, we hypothesize that;
H0 = POLS is appropriate
H1 = Fixed Effect is appropriate

As found and given Table 1, our F-Statistic is bigger than F-critical in each case so, we will reject our null hypothesis. To differentiate between fixed effect and random effect models, we have used Hausmann test [15]. Hausmann test employ the following equation to estimate the Hausmann test statistic:

$$H = \left(\beta\hat{}FE - \beta\hat{}RE\right)' \left[Var\left(\beta\hat{}FE\right) - Var\left(\beta\hat{}RE\right)\right]^{-1} \left(\beta\hat{}FE - \beta\hat{}RE\right) \approx \chi^2(K) \quad (10)$$

We have hypothesized that;
H0 = Random Effect model is appropriate
H1 = Fixed Effect model is appropriate

Large value of H-statistic and significance of p-value indicate that random effect model is not appropriate in any case. So, our final model is Fixed Effect Model that is based on the assumption that each group differs in its constant term. We can model our final equations for estimation as:

$$X_{ij} = \alpha + \beta_1 Y_i + \beta_2 Y_j + \beta_3 L_i + \beta_4 L_j + \beta_5 OP_i + \beta_6 OP_j + \beta_7 Exr_{ij} + \beta_8 D_{ij} + + \beta_9 CommonB_{ij} + \beta_{10} CommonL_{ij} + eu_{ij} \quad (11)$$

In matrix form the equations would be written as:

$$Y = D\alpha + X\beta' + \varepsilon \quad (12)$$

where,

$$Y = \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix}_{NT\times 1}, D = \begin{bmatrix} i_T & 0 & \cdots & 0 \\ 0 & i_T & \cdots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \cdots & i_T \end{bmatrix}_{NT\times N}, X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1K} \\ x_{21} & x_{22} & \cdots & x_{2K} \\ \vdots & \vdots & & \vdots \\ x_{N1} & x_{N2} & \cdots & x_{NK} \end{bmatrix}_{NT\times K} \quad (13)$$

&

$$\alpha = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \vdots \\ \alpha_N \end{bmatrix}_{N\times 1}, \beta' = \begin{bmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_K \end{bmatrix}_{K\times 1} \quad (14)$$

Dummy variable suggests that fixed effect model takes different constants for each groups.

RESULTS AND DISCUSSION

Table 1 presents the estimation results of equation 11. As to reach at the most suitable results we have applied three panel data techniques. The results of all three techniques applied have been presented in 2nd, 3rd and 4th column respectively in the Table 1. By definition, POLS does not allow any variation in constant terms as POLS uses only a constant term for all cross sections. On the other hand we have another panel estimation technique namely fixed effects model which can be used for estimation as it allows for different constants for different countries. To make a selection between POLS and fixed effect model we have used a standard F-test. The random effect model considers the heterogeneity effects present in the cross section data. This is same like the fixed effect model which also acknowledges heterogeneity but the random effect model is different from the fixed effect model as the effects generated by random effect model are in the form of specific distribution. Although this model assumes the presence of heterogeneity in the data but it does not presents each of the effect explicitly. In order to differentiate between random effect model and fixed effects model, Hausmann statistic is often used. This statistic tests whether there exists any correlation between the individual effects and regressors. The results in Table 1 show that the Hausmann specification test rejected the null hypothesis which indicates that country specific effects are correlated with regressors. This advocates the adoption of fixed effects model. As the fixed effects model has been found to be appropriate as compare to other models so in our work we will interpret our results based upon the fixed effects model.

Any increase in the Pakistan' Gross Domestic Product (GDP) and Pakistan's Gross Domestic Product (GDP) per capita causes an increase in its rice exports to the selected world rice markets i.e. if other variables remain constant then a one percent point increase in Pakistan GDP will result in a 1.0007 percent point increase in Pakistan's rice export flow to its 54 major trading partners and a one percent point increase in Pakistan GDP per capita would result in a 0.1372 percent point increase in Pakistan's rice export flow to its 54 major trading partners. For the variable of Pakistan's GDP per capita, the positive sign of coefficient may be due to the fact that rice is not a staple food in Pakistan and despite of the

Table 1: Estimation Results obtained by Applying Gravity Model

Variables	Pooled OLS	Fixed Effect Model	Random Effect Model
Constant	17.9965** (8.9414)	9.8671 (9.5090)	26.4180*** (9.4156)
Importer's GDP	1.0945*** (0.0984)	0.6871** (0.5714)	0.6172** (0.2782)
Pakistan's GDP	0.0529 (0.3591)	1.0007*** (0.3415)	0.7266*** (0.2799)
Importer's GDP Per Capita	-0.1963* (0.1057)	1.5467*** (0.5931)	0.1148 (0.3064)
Pakistan's GDP Per Capita	0.0968* (0.0561)	0.1372*** (0.3034)	0.2964* (0.1599)
Importer's Openness	0.2013* (0.1113)	-0.1383 (0.1217)	-0.0474 (0.1234)
Pakistan's Openness	-0.2323 (1.2341)	0.3342 (0.5191)	0.3108 (0.6207)
Exchange rate	-0.1788 (-0.6090)	0.8380*** (0.3029)	1.0151*** (0.3383)
Common Language	0.5637 (0.2696)	0.5638 (0.2696)	1.1553 (0.8691)
Common Border	4.0106*** (0.8529)	4.0107*** (0.8530)	4.2354* (2.5532)
Adjusted R-Square	0.4449	0.8606	0.2199
Hausman Test		19.6152***	
F-statistics value	32.5598***	64.2967***	12.0974***

*** shows significant at 1%, ** shows significant at 5% and * shows significant at 10% level. t- Statistics values are shown in parenthesis

economic development and population growth in the country, the domestic demand of rice is not increasing so it can be concluded that, in general, acceleration in economic growth and growing population could expand the domestic rice consumption but particularly for Pakistan, the domestic demand remained low because wheat is a staple food in Pakistan instead of rice.

On the other hand, sign of importer's GDP and importer's GDP per capita is also positive and significant. The positive and significant values indicate that increase in the importer's GDP and importer's GDP per capita causes an increase in the demand for Pakistani rice and resultantly the rice exports from Pakistan increase. Empirically we can say that for the variables of importer's GDP and importer's GDP per capita; if other variables remain constant then a one percent point increase in importer's GDP will result in a 0.6871 percent point increase in Pakistan's rice export flow to its 54 major trading partners and a one percent point increase in importer's GDP per capita would result in a 1.5467 percent point increase in Pakistan's rice export flow to its 54 major trading partners. The coefficient of the volatility of exchange rates is found to be significant positive which implies that the depression in Pakistani Rupees against the rice trading partner countries' currency would stimulate Pakistan's rice exports. Importer's openness and Pakistan's openness did not show any significant coefficients therefore have not been considered as explanatory variables in the Pakistan's rice exports to the selected major rice trading partners. Common language has not been found statistically significant which imply that this variable cannot be considered as the explanatory variables for the demand of Pakistan's rice exports. The dummy variable "Distance" as the proxy for transportation cost between Pakistan and its trading partners has been found highly significant and its sign is found to be negative which is as per the expectation. There exists a direct relationship between the distance and transportation cost so with the increase in distance, the trade falls between the countries. Pakistan can make efforts to reduce the transaction cost but it is only possible up to some extend so here it is strongly suggested that Pakistan should focus on exporting rice to its neighboring countries. Pakistani exporters can also try to do contacts of exporting rice in bulk quantity to different destinations and the bulk quantity export shipments to different destinations would be helpful to reduce the fixed transportation costs. Common border has significant positive coefficient which represents that if Pakistan's rice importing countries have common border with Pakistan then this has a positive impact on the volumes of rice exports from Pakistan. Hence having a common border stimulates the rice exports of Pakistan. Pakistan can export rice to Iran, Afghanistan and China. Having common border mean less distance between countries as trade via roads also becomes possible.

CONCLUSION

In order to pinpoint the factors determining the export flow of rice Pakistan to its 54 major rice importers, the gravity model was applied using the panel data from 2000-2012. The pooled, random and fixed effect estimations were made based upon the panel data obtained from official websites of the UNO. Since the null hypothesis (stating that the random effects were efficient) was rejected by the Hausmann test so the fixed effect model results were considered reliable and based upon the fixed model results, the findings revealed that the rice export flows from Pakistan to major 54 countries of the world are driven by GDP of the trading partner, Pakistan' GDP, importer country's GDP per capita, Pakistan GDP per

capita, exchange rate volatility, distance and common border. The economic growth of the 54 rice importing countries would have a strong impact on the export of rice from Pakistan to them and at the same time the economic growth of Pakistan would also stimulate the rice exports from Pakistan so the policy makers of Pakistan should take such steps which may be helpful to bring growth in the gross domestic product i.e. stable policies especially in the agriculture sector, better law and order situation, favorable business environment etc.

Exchange rate volatility has been found an impacting factor on the rice exports from Pakistan to 54 major countries so the central bank of Pakistan (also called State Bank of Pakistan) should effectively manage the exchange rate because a depression in Pakistan Rupee would stimulate the rice exports from Pakistan but it would also have other negative impacts on economy i.e. increase in inflation etc so appropriate actions should be taken by the State Bank of Pakistan. The distance between Pakistan and its 54 major rice export markets has a negative impact on trade flows so the transaction cost can be reduced by providing better transportation facilities and better infrastructure. Our results also indicate that sharing the border with trading partner country has a positive impact on the rice export from Pakistan. Hence it can be concluded that sharing common border promotes rice exports from Pakistan. Afghanistan, Iran and China share border with Pakistan and as well as import rice from Pakistan. Pakistan should focus on these markets. Since the transportation cost is also low because the roads can be used for transportation by adopting the shortest possible route so it provides a great potential for rice exports of Pakistan to these countries. In the past, the sanctions on Iran were imposed which now are being uplifted so Iran can be a vast market for Pakistan rice. Still if there are any hurdles due to sanctions regarding payments receiving from Iran, Pakistan can adopt the barter trade system to export rice to Iran. There are others many factors which impact on the flow of Pakistan rice towards its trading partners. Better relationship with other countries, adoption of quality standards, price etc so policy makers should focus on competitiveness of Pakistan rice in the international markets and it is only possible when the cost of Pakistani rice farmers is lower than its competitors like India, Thailand, Vietnam etc. Exporting rice by creating brands can be very helpful and it has become to necessary to compete in the international market. Reduction in production cost of rice is the 1st principle to remain in competition with major rice exporters.

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