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Total Factor Productivity and Trade: A Panel Data Analysis

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Abstract

This study tries to explore the impact of trade openness on the total factor productivity growth in a panel of 94 countries for the period of 1964 to 2003. First, we calculate the total factor productivity growth rates by the growth accounting technique. Second, we estimate the relation between trade openness and the total factor productivity with two different specifications, one without country size and the other with country size. To control for expected heterogeneity in the sample countries, the analysis is carried out separately for the comprehensive sample (all countries) and three subgroups based on the income. Our empirical findings, without country size, suggest that total factor productivity growth is positively affected by trade openness for the comprehensive sample and also its three sub-groups of countries. Further, we also find that the magnitude of the trade impact on productivity growth is the highest for middle-income group of countries than low- and high-income group of countries. Results with country size suggests that country size itself, is not an important variable in describing the productivity growth, but it helps in capturing the true marginal effect of trade openness of the productivity growth. The impact of openness is stronger with country size for the comprehensive, middle and high group of income.

Keywords: Total Factor Productivity, Trade Openness, Perpetual Inventory Method, Growth Accounting, Panel Analysis.

JEL classification: B23, C01, C12, C23, F15, J31

1. Introduction

There are two different strands about the link between trade and economic growth. One strand supports trade protection policies such as import substitution policies while other supports trade liberalization. Advocates of import substitution policies are of the view that these policies provide protection to the domestic industries[2]. When we look at the world trade from 1950 to 1970, we can see a

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[2] Import substitution policies include overvalued exchange rates, import control, a heavy dose of public ownership and pervasive price regulation.

regime of trade protection policies or import substitution Industrialization. For decades, most of developing countries have been following industrialization policies, with a very low degree of trade openness. In the late 1980s, outward-oriented trade policies gain momentum.

Debt crisis during the 1980s, which is the result of the oil price shock in 1973, played an important role to redirect the economic policy makers to bring a change in the previous policies. One of the major changes in development policies was to move away from inward-oriented import policies to outward-oriented export policies. According to the World Bank Report (1987), on trade orientation in developing countries during 1963 to 1985, Hong Kong, Korea, and Singapore are classified as strongly outward-oriented countries, and we have seen with the passage of time that these countries showed the highest growth rates and were known as Asian tigers. Now these countries are ranked in developed or rich countries according to World Bank ranking, based on income level. The transition of these countries from developing to the developed category is mostly attributed to their outward- oriented trade policies.

In numerous studies, irrespective of their methodology and time span, researchers try to test the hypothesis that the more open economies experience faster growth than the less open economies. Unluckily, there is no unanimous empirical evidence on the link between trade openness and productivity growth. Some of these empirical studies provide positive association see for example Edward (1998) while others provide no association (Young 1991) or even a negative association (Vamvakidis, 1998). This means that there is a room for research to explore empirically the clear conclusion to this hypothesis. This paper is a contribution to the panel studies which establish the relationship between total factor productivity growth and trade for the panel of 94 countries over the period from 1964 to 2003.

Specifically, this study tries to explore the impact of trade openness on the total factor productivity growth. As the data on the total factor productivity is not published, so first we have to compute it, using growth accounting technique. To capture the heterogeneity, we have divided the sample countries into three sub-groups on the basis of their income level, i.e. low, middle and high-income countries. Our empirical findings suggest that the total factor productivity growth is positively affected by trade openness for the comprehensive group and its three sub-groups of countries. Further, we also find that the magnitude of the trade impact on productivity growth is higher for middle-income group of countries than for the low and high-income groups. Results with country size suggests that

country size itself, is not an important variable in describing the productivity growth, but it helps in capturing the true marginal effect of trade openness of the productivity growth. The impact of openness is stronger with country size for the comprehensive, middle and high group of income. For the low group, the inclusion of country size makes trade openness coefficient insignificant.

To address the simultaneity or endogeneity issues, we also perform Granger Causality test before the main estimation. Granger causality test confirms that causality runs from trade openness to the total factor productivity growth and not in the opposite direction. So there is no caution of reverse causality.

The paper is organized as follow: section 2 gives an overview of the theoretical and empirical literature. Details of data and construction of required variables are discussed in section 3. Section 4 discusses the econometric methodologies and also presents graphical analysis. Empirical findings are reported in section 5. The study is concluded in section 6.

2. Literature Review

In this section, first, the theoretical relation between trade and economic growth is explained based on the traditional theories of growth is explained. Second, some empirical studies related to this study are briefly explained.

2.1 Theoretical Base

One of the predictions of neoclassical growth models is convergence in per capita incomes, i.e. poor countries grow faster than the rich countries if other things being equal. These models also assume closed economy and exogenous technological progress, so we cannot judge the impact of economic policies on the steady state growth. In the basic framework of neoclassical models, if we relax the assumption of the close economy then trade affects the long-run level of per capita income i.e. it will increase the overall technological efficiency of the economy. In a more elaborating way, trade liberalization policies such as trade openness in neoclassical framework increase the long-run level of per capita income and not the long-run growth rate of per capita income. The increase in the growth rate of per capita income is possible only in the transition to the new higher steady state level, and lasts only until sufficient savings and investment has taken place to achieve that higher level[3].

The rise in the savings rate and reduction in population growth rate also increase the long run level of per capita income, but these changes have no long

[3] For level effect of trade see David and Lowey (2003).

run impact on per capita income growth. These changes although cause an increase in the growth rate but only in the transition from low level to high level. Therefore, in neoclassical model of growth, trade openness policy does not have a growth effect i.e. permanent effect on growth rates of income. Increase in technological progress because of trade openness policy, is of the comparative static type which refers to one-time benefits to trade openness policy. These benefits arise due to the movements of national prices towards the global prices, and this causes a reallocation of the national resources

The endogenous growth theories emerged in 1980's in response to the failure of some of the main prediction of neoclassical growth theories, especially it was criticized on the grounds of convergence in per capita income and exogenously determined long run growth rate, since income in the poor economies does not grow faster than the rich economies, except the Asian tigers. By assuming non-decreasing returns to capital and endogenous technological change, positive and constant growth rates are possible to attain in an economy (Romer, 1986). The models are given by Uzawa (1965) and Lucas (1988), human capital is also required with physical capital in the process of production. Workers with more human capital are more productive as compared to the workers with less human capital (it means education).[4] No matter what is the type of model, we can have positive growth rates and the main reasons for these positive growth rates are the presence of positive externalities and spillover effect. Policy variables in these models can play an important role in the growth of the economies; so fiscal, trade, health and education policies can affect the rate of growth of the economy by affecting the productivity of the economy. We can say that new endogenous growth theories provide the researcher a device to test the relation between growth rates and policy variables such as trade openness, education, health, and savings[5].

2.2 Empirical Studies

There is a huge literature on time-series studies that links total factor productivity growth with the trade. However, there are relatively fewer cross-sectional studies to explore the relationship between trade and economic growth. Recently, the researchers are now using panel data to test the relationship between productivity and trade. In this subsection some of the important studies are reviewed.

[4] For non-decreasing returns and positive growth rate see Jones and Manuelli (1990) and Rebelo (1991).

[5] For detailed discussion see Ferrantino and Butcher (1997)

2.3. Time series country based studies

There is growing literature on linking trade and productivity using time series data. Different studies take different measures of openness such as import penetration, export shares, the ratio of export plus import to GDP, import coverage ratios, and different restrictions to trade etc. There are some studies that take inter- industrial data to analyze the effect of trade openness on the total factor productivity. Some of these studies are as follow: Korea, Okuda (1994) study on Taiwan, Chand and Ken (2002), a study on India etc. Nearly all of these studies establish a positive link between trade openness and the total factor productivity growth. There are some other studies that investigate the link on inter- firm base data such as Haddad (1993) among others and establish a positive and significant relation between trade openness and total factor productivity growth.

Most of the above mentioned studies confirm the positive link between the total factor productivity growth and openness to trade. For instance see Cororation (2004). This study investigates the link for the Philippines. The data consists of a time series covering the period of 1967-2000. He takes the total factor productivity growth as a function of several variables including trade openness. The study suggests that two measures of trade openness are positively correlated with the total factor productivity growth. Similarly, a study by Chandrachai (2004) also confirms the positive link using the annual aggregate data set for Thailand. However, we have a study on Israel by Hercowitz (2002) that does not confirm the positive link between trade and total factor productivity growth for the period 1960-96.

2.4. Cross Sectional and Panel data studies

Krueger (1978) tests two hypotheses about trade and growth relationship by using data for ten countries for the period 1954-72. One hypothesis, relates trade liberalization regimes with higher exports growth and the other hypothesis, relates more liberalized trade sector with more overall growth. Her results support the second hypothesis, which suggest a positive link between trade and growth. She rejects the first hypothesis and concludes that there is no direct effect of trade regimes on economic performance.

Grossman and Helpman (1991) finds that trade openness can influence the technological level of a country. New technology is embodied in new tradable goods so openness to trade causes an access to this new technology. This also causes an increase in the size of the market for new goods, which in turn increases returns to innovation that cause an improvement in domestic technology, the

production methods and thus cause an improvement in productivity.

Edward Sebastian (1998) pointed towards two main issues related with analysis of trade and productivity. One is concerned with the link between trade and productivity and the second is concerned with the issues of data problems. He uses nine alternative indices of trade openness to analyze its link with productivity. Edward conducts an analysis of the robustness of the regression used in his analysis and finds that they are robust to the use of openness indicators, estimation technique, time period and the functional form. He concludes that more open economies experience faster productivity growth.

Some studies put doubts on the positive correlation between growth and openness such as Rodrik (1998). Rodriguez and Rodrik (2000) points out on the measures of openness taken by Sachs and Warner (1995) and Dollar (1992). They argue that there are some methodological problems associated with the measurement of openness. These measures are not reliable and also highly correlated with other sources of poor economic performance.

It can be concluded that the empirical evidence is mixed on country and cross-country bases. Although we have more empirical favor for a positive link between openness to trade but we cannot ignore that in some circumstances openness to trade has no effect at all. Moving towards more trade leads to the adoption of more advanced and efficient techniques of production, leading to faster growth of the total factor productivity growth.

3. Data and Construction of Variables

The present study based on the sample of 94 countries. Which are divided into four groups? The first group contains all countries while second, third and fourth groups are consist of high-income countries, middle-income countries and low income countries. Furthermore, in order to make sub-groups we follow the division suggested by World Bank for world economies on the basis of their income. World Bank suggested five groups which are high-income OECD, high-income non-OECD, upper middle-income, lower middle-income and low income countries. For our analysis, high-income group consists of 23 high-income OECD countries. Middle-income group consists of 43 countries which are a sum of upper middle-income and lower middle-income countries. The third group remains as low income group consisting of 28 countries.

For the empirical analysis data on total factor productivity and trade openness is needed for sample countries. There are certain issues, related with the selection of trade openness measure which will be discussed in the end of this

section. Data on trade openness is taken from Penn World table version PWT6.2,[6] while Data on the total factor productivity is not published one, so we have to compute it. For the computation of total factor productivity growth rates, we must have data on variables such as physical capital stock and labor force. Again data on labor force is available in Penn World Tables but data on physical capital is not the published. We need to estimate physical capital stock first and then we will be able to calculate total factor productivity growth. We use data on GDP per capita, population, investment share, GDP per worker (economically active workers) from Penn world tables. Therefore, total factor productivity calculations can be done in two steps. The first step involves estimation of the physical capital while calculation of total factor productivity will be done in the second step. Data is annual and covers the period from 1963-2003.

We need to construct four different variables from the raw data available in pen world tables.

3.1 **Real GDP**: The real GDP is computed through real GDP per capita and population. Data on both of these variables are taken from PWT 6.2.

3.2 **Labor force**: Direct measure of the labor force is not available in Penn world tables, but we have a fine long time series of real GDP per worker for many countries. The labor force is computed through real GDP per worker and real GDP. By workers, we mean economically active population.

3.3 **Investment**: Investment variable is computed through investment share and real GDP. It is given in percentage form so we have to divide investment by 100.

3.4 **Capital stock**: There are several ways to construct physical capital stock. Detailed discussion will follow later in this section.

The literature on trade openness is suffering from a lack of right and reliable measure for trade openness. In the current study, we will use trade volume index, which can be define as the ratio of the sum of exports and imports as a percentage of GDP. It is a good measure for openness because it covers both imports and exports, while other measures cover one of them e.g. export growth and import intensity, considers only exports and imports respectively. The purpose of our study is to find the impact of trade openness on the total factor productivity in longitudinal data, so trade volume as openness measure is a good one; because it considers both imports and exports and it is also available for all our sample countries. In literature there are different variables that can be taken as

[6] http://pwt.econ.upenn.edu/php_site/pwt62/pwt62_form.php

a measure of country sizes, such as a log of population, land area or log of GDP. We choose a log of population as a measure of country size.

3.5 Construction of Capital Stock

There are several methods to compute capital stock. The detail discussion can be found in Neruh and Dhareshwar (1993) and King and Levine (1994). The first method is known as a direct method, which consists of an evaluation of the stock of physical capital through direct surveys. This method is more expensive, and it may not provide the accurate measure in the presence of disinformation on rental and second-hand prices. The second method is used the actual book values of capital items. This method is also not appropriate since it depend on the actual book values of capital items which are sensitive to the tax schedules of individual countries. The third method is indirect perpetual inventory method which is used in this study. The data on the physical capital stock is not available for all the regions and years, but the gross fixed capital formation is. Therefore, by using perpetual inventory method, we generate the capital stock variable.[7]

3.6 Measurement of TFP

The technology growth cannot be measured directly, but using the growth accounting method, we can measure it indirectly as the growth of unobservable factor i.e., the growth of residual of total factor productivity (TFP). There are basically two methodologies to compute the total factor productivity i.e. the growth accounting and the regression based method. The growth accounting is an empirical method, which decomposes the growth rate of output to its components such as growth in inputs and the technological progress (TFP growth). The regression method involves econometric estimation, but this method lacks time variations in factor shares and the total factor productivity. Therefore, we prefer to use growth accounting approach for this study[8].

4. Methodology

To determine the role of trade openness on the total factor productivity, we can use the endogenous growth framework. Empirical literature provides evidence to see this relationship base on country data or cross-country data analysis. Econometrically, we can use either time series or panel data models to investigate the impact of trade openness on the total factor productivity growth.

[7] For details see Neruh and Dhareshwar (1993) and King and Levine (1994)

[8] Solow (1957) used this method to calculate TFP for American manufacturing sector and find that more than 80 percent of the growth is due to technical progress.

For this study we have longitudinal or panel data so we can apply techniques or methods used for panel data to estimate the relation.

There are many advantages of using panel data for analysis. It is more useful, compared to either cross-sectional or time series data because it provides solutions to the problems, faced by cross- sectional or time series analysis, e.g. in time series analysis we may face the problem of unobserved heterogeneity bias while examining temporal pattern on behavior. Panel data analysis enables a researcher to see the dynamics over time. Through the panel data, we can control for factors such as cross-sectional variations, omitted variable bias, and unobserved variables. It also controls for measurement errors which cause an identification problem (Grilliches and Hausman, 1986). Further, a number of observations in panel data are larger than in time series and cross section data because of two dimensions.

4.1 Econometric Modeling

Our analysis consists of two parts. In one part we try to investigate the sign and significance of trade openness with respect to the total factor productivity and in another part we try to investigate the direction of the effect by applying the Granger causality test to see whether trade openness causes TFP growth or TFP growth causes trade openness.

4.2 Modeling Trade Openness as a Determinant of TFP:

To see the effect of trade openness on the total factor productivity we use the fixed effects methodology. Using the fixed effects method, we can extract the trade openness contribution in determining the total factor productivity by allowing unobserved country specific effects to correlate with the explanatory variable which is trade openness in the current study. General specification of our model is

$$TFP = f\,(\,TradeOpen\,, \alpha_i, \delta_t\,) \qquad (1)$$

Here total factor productivity is a function of trade openness, country-specific effects and time-specific effects. In terms of linear specification above function can be written as

$$TFP_{it} = \beta + \beta_1(TradeOpen) + \alpha_i + \delta_t + \mu_{it} \qquad (2)$$

Here α_i are the unobserved heterogeneity specific effects, it represents those unobserved variables that also influence the total factor productivity and δ_t are time specific effects and random error component μ_{it}. As we have a big sample of countries and there is off course unobserved country specific effects, it

is better to include those effects through a dummy variable instead of eliminating them from the regression. This reason convinces us to use the least square dummy variable technique, which allows us to capture the country specific effects by defining a dummy for each country. Under LSDV specification, equation (2) can be written as:

$$TFP_{jit} = \beta_j(TradeOpen) + \alpha_i \sum_1^n D_i + \delta_t + \mu_{it} \qquad (3)$$

This equation is the benchmark equation. In equation (3) subscript *'j'* describes the group of countries ($j = LIG, MIG, HIG, CG$) where LIG, MIG, HIG and CG represent low income group, middle-income group, high-income group and comprehensive group respectively. Subscript *'i'* represents a number of countries *'n'*, which varies within the group of countries. For example $i = 1, 2 \ldots, 28$ for LIG since it includes 28 countries. The number of countries for HIG is 23, MIG is 43 and for CG are 94. The subscript *'t'*, represents a number of time period. In our analysis we take five years averages values to avoid the cyclical changes. Whole time period consists of eight five years averages, i.e. $t = 1,2 \ldots 8$. For CG we may use group dummies with individual country specific effects in equation (3) by adding group dummies.

5. Results

Before going into the main estimation and results first we tested if trade openness drives the total factor productivity growth or the total factor productivity growth drives more trade openness? It is an interesting question to address. In the empirical literature, there is no clear answer to the question mention above. Earlier studies ignore to account for this issue and assume that it is trade openness that drives growth.[9] There are ambiguous results on the causality between trade openness and total factor productivity. Jung and Marshall (1985) perform the Granger causality test for 37 countries and found that only for four countries the causality runs from exports to GDP growth. The empirical literature on industry-based data shows a two-way relation. Karacaovoli (2006) attempts to find the positive causal link between productivity and trade policy and finds that impact of productivity on trade is stronger when they control for endogeneity bias.

Determining the direction of causality is very important with respect to estimation method because if there exist a reverse causality between the total factor productivity and trade openness then we have to control this simultaneity or endogeneity. We cannot apply single equation method for estimation because of

[9] See Miller and Upadhyay (2000).

the presence of simultaneity. We have to use the system of equation to control for simultaneity bias. So first we attempt to find the direction of causality between total factor productivity and trade openness for all the four groups of countries. We apply the Granger causality test to confirm the direction of causality.

Test results for the direction of causality between trade and TFP are reported in Table 1 for the comprehensive sample.[10] Let us take table 1 which shows results for granger causality between trade openness and total factor productivity for the comprehensive sample. The null hypothesis that trade openness does not granger cause the total factor productivity has rejected for this group, so we can say that trade granger causes total factor productivity. This result is consistent with empirical findings of Jung and Marshall (1985). We can see the second hypothesis stated in the third row of table 1 which suggests the direction of causality runs from the total factor productivity to trade openness. We accept this hypothesis and conclude, that trade openness is independent of the total factor productivity.

Table 1: Granger Causality Test for Comprehensive group

Null Hypothesis	Lag length	Test Stat.	No. of Obs.	p-value	Result
Trade openness does not granger cause TFP growth	3	8.763**	475	0.032	Reject null hypothesis
TFP Growth rate does not granger cause trade openness	3	2.844	475	0.416	Accept null hypothesis

Note: **, *** represent significance level at, 10%,5% and 1%.

Therefore our results of the Granger test suggest that there is no reverse causality between the total factor productivity and trade openness. We also tested the same hypotheses for the sub-groups of the comprehensive group. For low, middle and high-income group we find that causality runs from trade openness to total factor productivity and not in the opposite direction.

As our results show that causality runs from trade openness to total factor productivity and not from productivity to trade openness so we can proceeds for our estimation with single equation method to find the impact of trade openness to total factor productivity.

5.1 Trade as a Determinant of TFP

To analyze the role of different policy variables such as trade in explaining

[10] Results for low income, middle-income and high-income groups are available on request.

total factor productivity, we have to use a framework through which we can proceed. As we have discussed earlier, there are two different theoretical frameworks available as a tool to calculate productivity. One of them is the neoclassical that accounts productivity for all those factors which are not explicitly included in production function and productivity has taken here an exogenous role. The other one gives the endogenous role to productivity. We cannot use the neoclassical setup to analyze the impact of policy variables on productivity because of its exogenous nature while the endogenous growth framework enables us to study the impact of different variables on productivity. This section tries to capture the impact of trade on the total factor productivity. In other words, we are testing the hypothesis if trade matters for the determination of the total factor productivity.

To test this hypothesis the current analysis uses a balance penal comprises of a five-year average data on trade openness and total factor productivity that covers a time span of forty years from 1964-2003 for all income groups. We have eight observations, on each country included in each group. Previous research suggests an ambiguous relation between trade and total factor productivity.

Empirical results of trade hypothesis through fixed effect method are reported in Table 2. Our empirical findings confirm the trade hypothesis for all the four groups of countries. We can say now that more open economies enjoy higher productivity growth. We will discuss the result in the following manner. First, we will discuss the results for the comprehensive sample and then our discussion will proceed towards three sub-samples of countries which have been made by splitting the comprehensive sample on the bases of income. Time dummies are included in all specification and designed criterion is satisfied i.e. there is no auto- correlation.

For the comprehensive sample that contains 95 developing and developed countries, we have a fair positive and significant coefficient for trade openness confirming our trade hypothesis. Trade openness which is here a measure of the ratio of export plus import to GDP has a positive and significant impact on the total factor productivity. So we can say that more open economies enjoy a higher level of productivity. Results suggest that a 1% increase in trade openness may raise the total factor productivity growth by nearly 0.038 %. Our results for the comprehensive sample are in line with the results by Edward (1998), Miller and Upadhyay (2000) and Akinlo (2005) who also finds a positive relationship between trade openness and the total factor productivity.

The discussion above explains the relation with reference to the whole

sample. Now consider the sub-groups of countries. Firstly, consider low and middle-income group. Our findings suggest a positive relation between trade openness and total factor productivity for these two groups. Here we have accepted the trade hypothesis for these two groups because we have a positive and significant coefficient for trade openness for both of these income groups.

Table 2: Trade and Total Factor Productivity (Fixed Effects Regression)

Group	No. of Countries	No. of Obs.	OLS Results Coefficients	R^2	GLS Results Coefficients	R^2
CG	94	752	0.0382 (3.00)***	0.31	0.0382 (7.87)***	0..31
LIG	28	224	0.0346 (2.39)***	0.28	0.0346 (5.00) ***	0.28
MIG	43	344	0.0535 (1.68) *	0.33	0.0535 (5.56) ***	0.33
HIG	23	184	0.0356 (2.95)***	0.58	0.0356 (3.49)***	0.58

Note:

a) CG, LIG, MIG and HIG stands for comprehensive, low income, middle income and high income group respectively.
b) T-statistics are given in the parentheses
c) *, **, *** represent significance level at, 10%, 5% and 1%.
d) The dependent variable is total factor productivity growth.

Our results are in line with some of the previous research, such as Edward (1998). These studies suggest a positive link between trade and productivity growth or trade and growth. Grossman and Helpman (1991), Barro and Sala-i-Martin (1995) also suggest a positive relationship between trade and productivity. Our empirical findings for the low and the middle-income groups suggest that more open economies enjoy a greater level of productivity, compared to less open economies because more open economies have greater ability to absorb new and advanced technology from the more developed courtiers and thus cause an increase in total factor productivity.

Let us first consider the coefficient of trade openness for the low income group. The estimated coefficient suggests a positive relation between trade openness and the total factor Productivity; it is equal to 0.034 and highly significant. This estimate of trade openness implies that a 1% increase in trade openness variable increases the productivity growth by 0.034 %. This result

suggests that productivity grows by opening more to the rest of the world through trade. Low income economies can grow by removing barriers to trade both institutional and policy related such as tariff, import control etc. By removing trade barriers, these economies can utilize the advanced technology of the more developed world and can be able to grow faster than before. Actually, there are many factors that directly affect growth, such as capital stock, labor, investment etc. but there are also other variables that indirectly effect growth such as education (investment in human capital), government policies included trade policy or even weather.

Middle-income group has also positive and significant estimated coefficient equal to 0.053 for trade openness. Here the estimated coefficient value is more than the low income group. The impact of trade openness on productivity level is stronger here because here increases of 1% in openness cause 0.053 % increase in productivity growth which is 0.019 higher than low income group.

Our results suggest that effect of trade openness on productivity growth is more for middle-income group than in low income group. One of the justifications for such result may be macroeconomic and political instability in these countries. There are many countries in low income group who are suffering from political instability, poor infrastructure high degree of corruption and low degree of rule of law etc. The presence of these elements may render to reap the benefits from trade and thus cause a negative impact on productivity in case of low income group. In contrast, middle-income group comprises of those economies, which have better macroeconomic and political environment, compared to low income group.

We know that there are few empirical studies that try to establish a link between trade and the total factor productivity growth on the aggregate level. Further, as we have divided our sample into the income basis or stages of development, this is not common in this literature. Normally in trade productivity literature the sample countries are selected either on the geographical basis or as a bunch of big sample including all those countries for which data is available.[11] Because of these reasons, we cannot compare our results directly with other studies in this trade productivity manner. There are few studies that relate trade openness to growth for poor and middle-income, so we can use them for comparison.

Our results are in line with the Michaely (1977) who also reached the

[11] See for example, Edward (1998), Akinlo (2005)

same conclusion that coefficient of correlation between growth and openness is higher for middle-income than low income group. There are two differences between the current and the Michaely's study. Firstly, he studies the relation between trade and growth while we explore the relation between trade and productivity which is a part of total growth. Secondly, he uses simply the Spearman rank coefficient, but we have applied the fixed effects method which is more reliable, compared to just see the rank coefficient. Our results are further supported by the Rostom (1984) and Rati (1985) these studies also finds that coefficient of export growth (trade openness) in growth equation is higher for middle-income group. Our results are actually an attempt to answer one of the queries presented by Edward (1993).[12] He presents five different questions related with export growth and growth. One of the questions he raised is about the amount of effect of openness on the poor and middle-income group. Our empirical results with higher trade openness coefficient for middle-income provide indirectly, empirical evidence that a minimum level of development is required to enjoy more benefits from trade openness.

The estimated coefficient for high-income group is positive and highly significant, even at 1%. Estimated trade openness coefficient suggests that a 1% increase in trade openness cause nearly 0.035% increase in the total factor productivity growth. So for high-income group we also accept the trade hypothesis, which suggest a positive impact of trade on total factor productivity growth. But if we compare estimated coefficient for high-income with low and middle-income group we have interesting facts. We can see that estimated value for trade openness for high-income group is less than middle-income group and approximately same with low income group. Here a question raises that why the impact of trade in high-income is smaller than middle-income groups, although it comprises of more strong and rich countries? The answer lies in explaining the relation between convergence of the total factor productivity and trade argument.

Convergence in productivity suggests that growth rates are lower for those countries, which are more advanced in technology or near to technological frontier. Trade openness may cause a larger effect on the total factor productivity for a country which is far from the technology frontier because trade provides ease to catching-up process by transferring technological knowledge. Effect of

[12] Edward (1993): "in order to organize the discussion I have classified work on the relationship between exports growth and GDP growth under five general questions: 1) Are poor and middle-income countries affected in a similar way by outward orientation? or, is there a required minimum threshold level of development in order to enjoy the benefits of rapid exports growth?"

trade openness reduces as the country moves towards the technological frontier. Our findings are consistent with this story. For a high group of income, Bernard and Jones (1996) also have a lower impact of trade on productivity although their sample size and methodology is different from the current study. These results confirm the convergence theory for his productivity also.

5.2 Country Size, Trade Openness and TFP

Does the size of a country matters for growth or not? The empirical literature on the macro and the micro level does not provide much evidence about the relation between size and growth. There is a common view that size of the country does not matter for the growth of a country[13].

Backus, Kehoe, and Kehoe (1992) investigate separately the impact of the size of the country and imports of specialized inputs on growth. Authors find that growth and country size are unrelated. They also suggest that importing specialized inputs can lead to faster growth, but they do not emphasize the variations in the degree of openness and how it might impact the effect of size on growth. Alesina, Spolaore and Wacziarg (2005) suggest studying the openness and country size jointly as a determinant of the size of the market and its impact on growth.

There is a common view that there exist an interaction between size and openness to trade of a country. It has been argued that effect of the size of a country becomes less and less important as an economy becomes more and more open. This suggests a negative association between the size and the degree of openness. More elaborately, there is a negative interaction between openness to trade and size of a country. Let us have a look on table 3 to examine this argument of negative interaction between size and trade openness of country. This table provides figures on size (population in thousands) and trade openness as a ratio of import plus export to GDP for the first six largest countries of the world and three small countries with respect to their population size. World six largest countries include China, India, United States, Indonesia, Brazil, and Pakistan while small countries include Luxembourg, Denmark and Ireland. The argument of negative interaction between size and trade openness seems to be true when we compare size and OPEN for Luxembourg (the smallest country) and China (the largest country) for both of the years. Same is true for other large and small countries. With this precision, the size of a country seems to be an important factor when we

[13] see for example Backus, Kehoe, and Kehoe (1992).

try to capture the impact of trade openness on growth or productivity growth in a panel of countries.

Table 3: Comparison of Size and Trade Openness

Country	Size(1964)	OPEN(1964)	Size(2003)	OPEN(2003)
China	696064.9	11.16886	1286975	56.82928
India	484755.8	23.35957	1049700	28.18554
United States	197335.6	8.204462	292616.6	25.31865
Indonesia	108590.6	55.59988	234893.5	70.56941
Brazil	80666.94	8.818714	182032.6	33.39674
Pakistan	55988.39	35.53169	150694.7	34.84483
Luxembourg	328.602	151.0451	453.109	273.6218
Ireland	2863.419	38.72928	4006.669	171.9223
Denmark	4721.594	34.98459	5397.11	92.0993

Source: World Population Data Sheet (2003)

Note: Size is equal to the population in Thousands

The expected impact of openness on productivity would be stronger when we control for the size of a country. In present analysis, this proposition can be tested in three ways, firstly by including country size alone with trade openness variable, secondly, add only an interaction term of trade openness and country size, and thirdly, add an interaction term between trade and country size and country size, in our basic equation of estimation. The predicted sign of the interaction term is negative. Through this interaction term, we can see how trade openness and country size interact in total factor productivity growth regression. Ades and Glaser (1999), Alesina, Spolaore and Wacziarg (2000) also use an interaction term in their growth regression. Discussion on the results of the three specifications is given below.

Results of the first specification or productivity regression with country

size are reported in Table 4. We can see that when we control for country size, there is a slight improvement in trade openness coefficients for all groups except a low group of income. For a low group of income, there is a decrease of .0002 in trade openness coefficients. The prediction that country size is an important factor in capturing the impact of openness on productivity growth is true, at least for comprehensive, middle and high-income group of countries but not for low income group. When we look for the impact of country size on productivity, we find that productivity and country size are unrelated for comprehensive low income and high-income groups because coefficients for country size for theses groups are insignificant.

Table 4: Total Factor Productivity, Trade and Country Size (Fixed Effects Regression)

Group	Countries	No. of Obs.	OLS Results			GLS Results		
			OPEN	LOGPOP	R^2	OPEN	LOG POP	R^2
CG	94	752	0.0384 (2.84)***	0.2498 (0.198)	0.31	0.0384 (7.78)**	0.249 (0.264)	0.31
LIG	28	224	0.0344 (2.32)	-5.0174 (-1.17)	0.28	0.0344 (4.97)***	-5.017 (-1.39)	0.28
MIG	43	344	0.0541 (1.69) *	-4.04328 (-1.7)	0.34	0.0541 (5.66)***	-4.043 (-2.08)**	0.34
HIG	23	184	0.0363 (3.18)**	2.12827 (0.80)	0.57	0.0363 (3.54)***	2.12827 (0.902)	0.57

Note:

a) CG, LIG, MIG and HIG stands for comprehensive, low income, middle income and high income group respectively.
b) T-statistics are given in the parentheses
c) *, **, *** represent significance level at, 10%, 5% and 1%.
d) The dependent variable is total factor productivity growth.

So we can conclude, at least for three groups excluding middle-income group that country size does not matter for productivity growth. Our findings are consistent with Backus, Kehoe, and Kehoe (1992), who also reached the same conclusion.

Results of the second specification are given in Table 5. Here we just take interaction term and trade openness in productivity regression as explanatory

variables. We again find that trade impact on productivity is stronger in this specification than the previous one with country size alone for all groups except low income group[14]. Again the signs of the parameters of trade openness are consistent with theory and also significant for all groups except low income group. Signs of interaction term are also the expected one. Interaction term is negative as the association between trade openness and size of the country is negative. So our results are consistent with the theory for three out of four groups. Estimated parameter of trade openness for low income group is negative, but it is insignificant. For low group, we conclude that trade openness has no effect on productivity growth that suggest a positive impact on productivity growth for this group.

Table 5: Trade openness and total factor productivity relationship for Comprehensive Group

Groups	No. of Countries	No. of Obs.	OLS Results		GLS Results	
			Coefficients	R^2	Coefficients	R^2
Group dummies	94	752	0.01449 (2.24)**	0.140	0.0174 (5.78)***	0.14
Group and individual dummies	94	752	0.03824 (2.99)**	0.31	0.0382 (7.87)***	0.31

Note: *, **, *** represent significance level at, 10%, 5% and 1%.

Results of the third specification or productivity growth regression with both country size and an interaction term between trade openness and country size are reported in Table A.1, in the appendix. Again there is a little increase in estimated parameters of trade openness for all groups except low income group. All the estimated parameters are significant and signs are consistent with expectation.

Table 6 gives a comparison of trade openness estimates obtained with different specification of productivity growth regression. One important point must be kept in mind while interpreting the results with an interaction term, the marginal effect of trade openness cannot be explained only by explaining the coefficient on trade openness, but it also have to explain the coefficient on interaction term which is negative in sign. Here the total marginal effect of the

[14] List countries with respect to income is available on request

trade openness can be obtained by subtracting the effect of interaction term from estimated trade openness coefficient for all groups. Finding marginal effect of trade openness with interaction term is more valuable when we are dealing with individual countries instead of a group as a whole.

Table 6: Comparison of Impact of Openness on Productivity Growth

Groups	No. Of Count.	No. of Obs.	OPEN (without country size)	OPEN (with country size)	OPEN (with Interaction Term)	OPEN (with country size and interaction term)
CG	94	752	0.038 (7.87) ***	0.038 (7.78) ***	0.162 (5.88)**	0.165 (5.93)***
LIG	28	224	0.035 (5.00) ***	0.034 (4.97)***	-0.074 (-1.23)	-0.102 (-1.64)
MIG	43	344	0.054 (5.56) ***	0.054 (5.66)***	0.281 (7.44)***	0.279 (2.26)**
HIG	23	184	0.036 (3.49)***	0.036 (3.54)***	0.097 (2.52)**	0.0987 (2.57)**

Note:

a) CG, LIG, MIG and HIG stands for comprehensive, low income, middle income and high income group respectively.
b) T-statistics are given in the parentheses
c) *, **, *** represent significance level at, 10%, 5% and 1%.
d) The dependent variable is total factor productivity growth.

6. Conclusion

The purpose of this study is to find the exact nature of the relationship between trade openness and the total factor productivity. We first estimate the total factor productivity growth through famous growth accounting technique, suggested by Solow (1956). We use labor force without including human capital to calculate the total factor productivity growth. Then we consider the issue of the endogeneity between the total factor productivity growth and trade openness, by applying the Granger Causality Test. Finally, we estimate the relationship between trade and total factor productivity growth with four different specifications of the productivity growth regression with and without the size of country.

Our calculation of the total factor productivity growth suggests that it has a U-shape trend for three sub-income groups and also for the comprehensive group that contains all the groups together. The growth rate of total factor productivity for a high group of income decreases for the first decade started from 1964 and then has a rising trend for the rest of the period covering three decades from 1983 to 2003. For the low and middle-income, TFP growth decreases for the first three decades and for the last decade it has a rising trend. The time period of 1973 -1993 has major economic shocks, such as oil price shock in 1973, which is followed by a supply shock. This causes a negative impact on the economic performance of all the countries including the high group of income. Next, during the 1980s, the debt crisis of developing countries also hurts their economic performance. This is also one of the major reasons, why middle-income and low income group (developing countries) shows bad economic performance or low level of the total factor productivity.

Previous empirical research does not provide a clear view on the openness trade relationship because of the endogeneity and measurement issues related with trade openness. There are some studies, which yield a positive association and other yields no significant impact of trade openness on the total factor productivity. This paper is an attempt to resolve this issue in the context of the panel of countries, by taking into account of the causality issue.

To take into account for endogeneity issue, we apply the Granger Causality Test and find that there is no reverse causality between the growth rate of the total factor productivity and trade openness. Causality runs from trade to the growth rate of total factor productivity and not in the opposite direction. It is true for all the four groups of countries.

We then proceed to our main issue and find that there exists a positive association between the total factor productivity and trade openness for all the four groups of countries. Our empirical findings confirm the trade hypothesis, which suggests a positive association between trade openness and total factor productivity. Our empirical results are in line with the theory of endogenous growth which also suggests a positive role for policy variables such as trade openness to economic performance. Our results are further supported by some of the empirical studies such as Edward (1998), Miller and Upadhyay (2000) etc. Based on our empirical findings, we can conclude that the most open economies can experience a higher factor productivity growth. Although, the relation is positive, but the intensity of the impact of the trade openness to the total factor productivity growth for three sub income groups differs in magnitude. It is high

for middle-income group than low group of income, supporting the idea of development economics that a minimum level of development is required to reap the benefits of any policy variable. So, with respect to the policy implication moving more toward the trade liberalization, the developing countries, including low and middle-income countries can improve their economic performance. We also have an example of the Asian Tigers who jump from the developing world to the developed world, by applying a high degree of trade openness during the mid-1980s.

Our findings suggest that country size is not an important variable in explaining the productivity growth, but by controlling it, we have improvement in impact of trade openness for productivity growth.

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Appendix

Table A. 1: Total Factor Productivity, Trade and Country Size with interaction term (Fixed Effects Regression)

Group	No. of Countries	No. of Obs.	OPEN	LOGPOP	LOGPOP*OPEN	R^2
CG	94	752	0.164839 (5.93)***	0.685271 (0.732)	-0.0150 (-4.61)***	0.33
LIG	28	224	-0.1018 (-1.64)*	0.0159 (2.21)**	-6.9335 (-1.88)*	0.30
MIG	43	344	0.279013 (7.42)***	-3.65922 (-2.00)	-0.0270 (-6.16)***	0.42
HIG	23	184	0.098658 (2.57)***	2.25734 (0.962)	-0.0080 (-1.68)*	0.58

Note: a) CG, LIG, MIG and HIG stands for comprehensive, low, middle and high income group.

b) Log of population is taken as a measure of country size. c)*, **, *** represent significance level at, 10%,5% and 1%