

ABSTRACT

HAO, HU. Does Trade Liberalization Cause Growth? – An Empirical Analysis. (Under the direction of Dr. Ivan Kandilov.)

A number of theoretical studies have shown that trade has positive effect on growth.

However, empirical work has been inconclusive. This paper empirically tests for the effect of trade liberalization on the economy's growth rate. I employ two different measures of trade openness and panel data for 75 countries from 1970 to 2005. I find positive and significant effects for both measures. The results also vary by country's level of development - OECD vs. non-OECD sub-samples -, indicating that different groups benefit from different aspects of trade liberalization. I have also shown that that the results are quite robust in both full sample and sub-samples.

Does Trade Liberalization Cause Growth? – An Empirical Analysis

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1 Introduction

In the past fifty years, the volumes of trade for both developed countries and developing countries, have grown rapidly. According to Wacziarg and Horn Welch (2008), only 22% of all countries, representing 21% of the world population had open trade policies in 1960, while the ratio grew up to 73% of all countries, representing 46% of the world population by 2000.¹ These countries' economies have also grown greatly in these decades. Many factors have contributed to their growth technology and financial innovation, growth in capital investment and the labor force, as well as more open trade policies and global trade liberalization². It is widely accepted that international trade and open trade policies have played important roles in a country's economic growth. These ideas were inspired by the miracle growth in South East Asian countries, such as China, South Korea and Japan around 1980-1990.

The effect of trade on growth is a hot topic of research for both international trade theory and policy. The idea that trade increases growth can be traced back to Ricardo's theory of comparative advantage. Entering the global trading system will make each country specialize in their most efficient production activities and exchange with other countries. Therefore,

¹ Open trade policies are defined by Sachs and Warner (1995). A country is closed if it satisfied any of the following conditions; otherwise, it is open to trade.

- (1) Adjusted average tariff over 40 percent
- (2) Nontariff barriers covering 40 percent or more of trade
- (3) Black market exchange rate at least 20 percent lower than official exchange rate
- (4) A state monopoly on major exports
- (5) A socialist economic system (defined by Kornai 1992)

² I use Alessandro De Matteies's (2004) definition of global liberalization: "the process of progressive growth of economic activities which transcends any kind of geographical border."

there will be a positive correlation between trade and growth due to the gain of efficiency through international trade. In the theory, David Ricardo stated that trade liberalization allows the optimal use of resources to raise productivity, reduce costs and accelerate the growth rate of the economy. Also, recent research indicates that both trade openness and the volumes of trade (as a fraction of GDP) are highly positively correlated with the growth rate of GDP per capita, even after accounting for other factors that contribute to growth. However, there still exist several basic empirical difficulties in identifying the effects of trade on growth, such as measuring countries' trade policies. As a result, despite the fact that this topic has been discussed in many papers, there is still disagreement.

1.1 Research Objectives

The purpose of this paper is to provide a framework for testing the effects of trade on growth, especially focusing on the empirical test to see whether trade liberalization has positive effect on GDP per capita growth. I also investigate if the results differ across OECD and non-OECD countries respectively. I use the data on 75 countries during the period 1970-2010 and I apply panel data techniques to disentangle the relationship between trade and growth. Also, I employ two different measures of openness and test the robustness.

1.2 Structure of the Paper

The paper is organized into six sections. Section 2 discusses the literatures related to the topic, including theoretical support for positive impacts of trade on growth, and previous empirical

work. Section 3 discusses the model specification, including the measures of trade liberalization and other factors related to growth. Section 4 outlines the data used for the empirical test. Section 5 shows the regression results for the full sample, the subsamples and the robustness tests. Section 6 summarizes, concludes and discusses some issues left for future work.

2 Related Literature

There are many theoretical and empirical models supporting the idea that trade leads to higher growth. David Ricardo (1951) used a simple model of corn (produced by both land and labor) and velvet (produced only by labor). He claimed that when a country open to trade, the price of velvet would maintain its world autarky level and this would benefit capitalists at the expense of landowners. The model showed that growth may be associated with continual change in price. Bhagwati (1958) showed that “Immiserizing growth” only occurs under very extreme conditions³. Otherwise, trade will increase the growth rate of the economy.

According to Solow (1956) the growth rate depends on investment in the steady state, which is directly related to forced saving. Technology is considered exogenous. Take the model of productivity growth as an example.

$$\tilde{y}_i = \tilde{A}_i + \frac{\eta_i}{\eta_i - 1} \theta_{iL} (\tilde{L}_i - \tilde{K}_i) + \mu_i \tilde{K}_i \quad (1)$$

where \tilde{y}_i is the percentage growth rate of productions, \tilde{A}_i is the percentage growth rate of Hicks-neutral technology progress, \tilde{L}_i is the percentage growth rate of labor, \tilde{K}_i is the percentage growth rate of production, η_i is the elasticity of demand ($\eta_i > 0$), and θ_{iL} is the revenue share of labor. Production function is homogeneous of degree μ_i ($\mu_i > 1$).

Particularly, if rental capital is observable, then the share $\theta_{iK} = \frac{\eta_i - 1}{\eta_i} \frac{f_{iK} K_i}{f(L_i, K_i)}$ and $\theta_{iK} + \theta_{iL} =$

1, we will have the following equation.

³ These conditions are either one of the followings:

- (1) foreign demand of imports is highly inelastic
- (2) growth reduce the output of importable good at constant price level

$$\tilde{y}_i = \tilde{A}_i + \frac{\eta_i}{\eta_i - 1} (\theta_{iL} \tilde{L}_i + \theta_{iK} \tilde{K}_i) \quad (2)$$

It means the total factor productivity (TFP) is the growth of output minus a weighted average of the growth rate of labor and capital. With perfect competition and constant return to scale, these weights can be easily measured. These models consider technology to be exogenous, which means that it is unaffected regardless of the country's trade openness. However, opening to trade will introduce new technology, increase the productivity and affect a country's specialization.

Then after years, economists turned to models that allowed endogenous rate of technology innovation (such as human capital) and the long-term growth can depend on technology innovation. For example, Grossman and Helpman's (1991) model suggest that trade has large effect on growth for all trading partners if allowing free international flows of knowledge. This conclusion exists even without the assumption of perfect competition and constant return to scale. This paper brought about a new way to look at the reason why trade effect growth. The main engine to make this long-term growth possible, given their way, is the spillover of knowledge across borders. Rivera-Batiz and Romer (1991) reached a similar conclusion which stated that even without any trade in goods and services, the spillover of knowledge will increase productivity.

Since theoretical work does not always provide a clear answer, there has been many empirical works on this topic. Equation (2) allows us to estimate a regression model to see if

there exists a positive impact of trade liberalization. Harrison (1994) used a similar equation to estimate it. She tested for the correlation between openness and growth. The relationship was found to be generally positive, though it differed when examining different subsamples and cross-section of the data. By examining the change of β_t in equation (3) below, we can see the effect of trade liberalization on growth.

$$\Delta \ln y_{it} = \Delta \ln A_{it} + \beta_t \theta_{iL} (\Delta \ln L_{it} - \Delta \ln K_{it}) + \mu \Delta \ln K_{it} + \epsilon_{it} \quad (3)$$

The most celebrated work was done by Frankel and Romer (1999). They estimated the effect of trade on growth using gravity equation, equation (4), and a series of equations involving distances, squares and common borders between pairs of countries using OLS and instrument variables (IV) techniques.

$$\ln Y_i = a + b \ln T_i + c_1 \ln N_i + c_2 \ln A_i + \epsilon_i \quad (4)$$

where Y_i is the income per person of country i , T_i is the international trade share, N_i is the population and A_i is the area.

Frankel and Romer estimated trade share from these equations. Generally speaking, they found that when the ratio of trade over GDP increases by 1%, income per capita will increase by about 1.5%. Similar results could also be found in the literatures of Sachs and Warner (1995) Dollar and Kraay (2001) and Ben-David (1993, 1998, and 2001). Sachs and Warner (1995) divided the countries into two groups: those with open and closed trade policies.

Within the open group, poorer countries grew faster and tended to “converge” to the steady

state much faster than the closed group does. Dollar and Kraay (2001) demonstrated that developing countries that become more open benefited from openness and, the benefits were especially large for the poor countries. Ben David grouped the countries by membership in Regional Trade Agreement (RTA). He found similar results showing that GDP per capita “converge” within a group but not across groups. Coe and Helpman (1995) used the explanation of “knowledge spillover” to demonstrate the extra growth after open to trade. They found a positive relationship between TFP growth rate and import weighted R&D expenditures. Sprout and Weaver (1993) tested for the relation between exports and economic growth in a simultaneous equation model. They found that for most countries, growing exports lead to greater growth. They also found that the structure of exports really matters, which is, the higher proportion of primary products in export, the lower is the increase in the growth rate.

Despite plenty of empirical work on this topic, researchers often disagreed with one another. There are (at least) three reasons for the discrepancies. First, different measures of openness are employed. Some use trade volumes while the others use trade policies. Also, there are difficulties in defining trade policies. Second, there are arguments about the choice of sample countries. Third, the econometric methodology (time series vs. cross-section vs. panel) may influence the results as well.

3 Model Specification

3.1 Measurement of Trade Liberalization

This paper uses two different measures of trade liberalization. The first measures use realized trade volumes, where I separate exports and imports. It is not surprising as many papers argue that exports and imports have different impacts on growth. Also, these effects may vary across different groups of countries. OECD countries may rely more on imports while non-OECD countries may rely more on exports. As a result, I split the export and import terms instead of using only one overall trade term.

The second measure I use is using the change of trade policies. This measure treats openness categorically. As Ben David suggests, I choose two dummies. One indicates accession to the WTO and the other indicates accession to a Regional Trade Agreements (RTA) or Preferential Trade Agreements (PTA).⁴

There are other measures that might be appropriate, such as trade barriers, adjusted average tariff or the ratios of nontariff barriers over total barriers. These measures are also common but are difficult to construct. For example, in the World Bank Data base, it is very hard to find annual data on tariff, especially for earlier years. Similarly, the measurement of non-tariff barriers is especially difficult.

⁴ These dummies equal to 1 if the country in that year is involved in WTO/RTA. Otherwise it's zero. By defining these, the coefficient means the average benefits from opening to trade while controlling other factors constant. Note that WTO and RTA/PTA only capture multilateral trade liberalization episodes. Unilateral trade liberalization episodes will be captured in the import share variable discussed earlier – lower import tariffs lead to higher imports.

3.2 Other important factors that affect economic growth

As we are focusing on the growth rate of GDP per capita, I will assume the population has no direct effect on it, which is consistent with the conclusions of many economic growth models. For example, in Solow Model, the long-term growth rate of GDP per effective labor (if in the steady state) will be zero, the growth rate of GDP per capita will only rely on the growth rate of technology innovation while the growth rate of GDP will rely on both technology and population growth.

One important factor is investment. In Solow Model, it is reflected as the forced saving rate. Former studies include Mankiw, Romer and Weil (1992), as well as Levine and Renelt (1992) etc. All these studies indicate that the coefficient measures the positive effect of investment. This is not surprising because almost all growth models demonstrate that more capital leads to higher rate of growth. In this thesis, I use the quantity of investment (measured in 2000 US Dollars, including both fixed and non-fixed capital).

Another important factor is human capital. Including human capital investment in growth models leads to a permanent increase in the growth rate per capita. This implies that every country should pay great attention to education, training and other human capital accumulation. I use the number of people in the labor force who have bachelor or higher degrees to control for human capital. There are two reasons for not using the education

expenditure instead. First, these statistics are not collected and reported annually. Second, these data are incomplete or inconsistent for the earlier years (1960-1970).

There are some other country specific factors. Size is an important one. Size will bring “scale effect”, reduce fixed cost and gain more efficiency. In addition, the initial capital is also an important one because different country has different resources which will decide their comparative advantage at beginning. Also, the geographic condition (the condition for transportation, the number of border countries and the similarity of these countries) are also important ones. Thus, all these factors are country specified and hard to change through time. In the thesis, I include all these factors in the intercept of the regression equation.

Another important factor that affects growth each year is the time itself. In different years, the global economy situation may be different. Also, there could be a certain business cycle. All of the above factors might affect each country’s economic growth in a certain way. To test this, I include a time trend in the part of robustness test.

One can argue there are other factors that still need to be considered in the model for further studies. Fiscal policies and monetary policies are also very likely to be connecting to growth. Financial efficiency is another important factor. Many countries’ financial services including bank, security exchange and financial derivatives, grow rapidly through the recent 20 years,

which obviously has great effect for growth. All of them are difficult to measure and need further discussion.

3.3 Econometric Model

Using data from 75 countries during the period from 1970 to 2005, I estimate the following two panel data models:

Regression 1:

$$y_{it} = c_i + \beta_1 \left(\frac{\text{Inv}}{\text{GDP}} \right)_{it} + \beta_2 \left(\frac{\text{Edupop}}{\text{pop}} \right)_{it-5} + \beta_3 \left(\frac{\text{Exp}}{\text{GDP}} \right)_{it} + \beta_4 \left(\frac{\text{Imp}}{\text{GDP}} \right)_{it} + \varepsilon_{it}$$

$t=1975, 1980 \dots, 2005^5; \quad i=1, 2, \dots, 75$

Regression 2:

$$y_{it} = c_i + \beta_1 \left(\frac{\text{Inv}}{\text{GDP}} \right)_{it} + \beta_2 \left(\frac{\text{Edupop}}{\text{Pop}} \right)_{it-5} + \beta_3 (\text{wto})_{it} + \beta_4 (\text{rta})_{it} + \varepsilon_{it}$$

$t=1975, 1980 \dots, 2005; \quad i=1, 2, \dots, 75$

where $\left(\frac{\text{Inv}}{\text{GDP}} \right)_{it}$ is the percentage ratio of investment over GDP, $\left(\frac{\text{Edupop}}{\text{pop}} \right)_{it-1}$ is the percentage of labor force with bachelor or higher degrees in the total population, which is lagged one period, $\left(\frac{\text{Exp}}{\text{GDP}} \right)_{it}$ and $\left(\frac{\text{Imp}}{\text{GDP}} \right)_{it}$ are the percentage ratios of export and import over GDP. To be consistent, every variable (except $(\text{wto})_{it}$ and $(\text{rta})_{it}$) in the regression equation is measured

⁵ The first period in the regression equation is 1975 because education is lagged by one period

in percentage. The indicator variables $(wto)_{it}$ and $(rta)_{it}$ are dummies. All detail of how to obtain these variables can be found on Part 4 of this thesis.

In the model, each country has a unique constant intercept c_i . This intercept varies by countries but not over time. These intercepts capture time-invariant country-specific characteristics such as size, geographic position, initial capital and others. Also, I use the lag of education. A number of studies believe that it takes certain number of years before human capital can make a contribution to growth. As the result, I build in one time period lag in education.⁶

To test the robustness of these two models, I also estimate two alternative specifications. One includes a time trend in which case I add the term γ_t .⁷

⁶ I have also tried to add in different lag structure. The result is quite similar for zero, one or two lags. This may be because the percentage of people with bachelors or higher degrees does not change very fast over five years.

⁷ It is also meaningful to add year dummies to test for robustness. In that case, the regression will be:

Regression 1

$$y_{it} = c_i + \beta_1 \left(\frac{Inv}{GDP} \right)_{it} + \beta_2 \left(\frac{Edupop}{pop} \right)_{it-1} + \beta_3 \left(\frac{Exp}{GDP} \right)_{it} + \beta_4 \left(\frac{Imp}{GDP} \right)_{it} + \sum_{t=2}^7 \phi_t D_t$$

Regression 2

$$y_{it} = c_i + \beta_1 \left(\frac{Inv}{GDP} \right)_{it} + \beta_2 \left(\frac{Edupop}{Pop} \right)_{it-1} + \beta_3 (wto)_{it} + \beta_4 (rta)_{it} + \sum_{t=2}^7 \phi_t D_t$$

The second regression is hard to estimate because the year dummies are not surprisingly highly positively correlated with the WTO and RTA dummies. The correlation is nearly 0.85.

Regression1

$$y_{it} = c_i + \beta_1 \left(\frac{\text{Inv}}{\text{GDP}} \right)_{it} + \beta_2 \left(\frac{\text{Edupop}}{\text{pop}} \right)_{it-5} + \beta_3 \left(\frac{\text{Exp}}{\text{GDP}} \right)_{it} + \beta_4 \left(\frac{\text{Imp}}{\text{GDP}} \right)_{it} + \gamma t + \varepsilon_{it}$$

t=1975,1980...2005; i=1,2,...,75

Regression 2

$$y_{it} = c_i + \beta_1 \left(\frac{\text{Inv}}{\text{GDP}} \right)_{it} + \beta_2 \left(\frac{\text{Edupop}}{\text{Pop}} \right)_{it-5} + \beta_3 (\text{wto})_{it} + \beta_4 (\text{rta})_{it} + \gamma t + \varepsilon_{it}$$

t=1975,1980...2005; i=1,2,...,75

In the second alternative specification, I add the lagged growth rate of GDP per capita as an additional variable on the right-hand side. The reason for adding the lag dependent term is to account for serial correlation within a country.⁸

Regression1

$$y_{it} = c_i + \beta_1 \left(\frac{\text{Inv}}{\text{GDP}} \right)_{it} + \beta_2 \left(\frac{\text{Edupop}}{\text{pop}} \right)_{it-5} + \beta_3 \left(\frac{\text{Exp}}{\text{GDP}} \right)_{it} + \beta_4 \left(\frac{\text{Imp}}{\text{GDP}} \right)_{it} + \varphi y_{it-1} + \varepsilon_{it}$$

t=1975,1980...2005; i=1,2,...,75

Regression 2

$$y_{it} = c_i + \beta_1 \left(\frac{\text{Inv}}{\text{GDP}} \right)_{it} + \beta_2 \left(\frac{\text{Edupop}}{\text{Pop}} \right)_{it-5} + \beta_3 (\text{wto})_{it} + \beta_4 (\text{rta})_{it} + \varphi y_{it-1} + \varepsilon_{it}$$

t=1975,1980...2005; i=1,2,...,75

⁸ A test for serial correlation indicates that most time series are I(1); only a few are I(2). Thus, a one-period lag is considered to be enough.

4. Data

Most of the data for my empirical analysis come from World Bank World Development Indicators (WDI). Some data, such as population and education, come from Penn World Tables. The data on each country's accession into the WTO and any RTA/PTA come from the database of agreements on the WTO's website.

The data are annual and include 75 countries (20 OECD countries and 55 non-OECD countries) from 1970 to 2005. Following Mankiw, Romer and Weil (1992), and Bond, Leblebiciođlu, and Schiantarelli (2009) countries that highly rely on oil production or mining, such as Iran and Iraq, are excluded. I also exclude East European countries because their data are inconsistent throughout the period before and after the split of the Soviet Union. Finally I exclude some countries whose data are incomplete or have negative growth rates during a particular period of time. The list of the selected countries can be found on the Appendix 1 in the last part of this paper.

The data I collect include each country's GDP (GDP_{it}), population (N_{it}), exports (Exp_{it}), imports (Imp_{it}), gross capital formation (K_{it}), the numbers of people with bachelor or higher degrees in the labor force ($Edupop_{it}$), the year of accession to the WTO ($(wto)_{it}$) and the year of joining any regional trade agreements ($(rta)_{it}$). All financial variables are calculated using purchasing power parity (PPP) and presented in 2000 US Dollars. I calculate

the growth rate of GDP per capita as $y_{it} = \frac{(\frac{GDP_{it}}{N_{it}} - \frac{GDP_{it-1}}{N_{it-1}})}{GDP_{it}/N_{it}}$. Also, I calculate investment using

the following formula $I_{it} = K_{it} - \delta K_{it-1}$. Here, as Baldwin et al. (2005) suggests, I select a depreciation rate $\delta = 0.15$. Summary statistics for the variables used in the analysis can be

found in Table 1. The matrix X for regression 1 is then:

$$\begin{pmatrix} 1 & 0 & \dots & 0 & \left(\frac{Inv}{GDP}\right)_{1,1} & \left(\frac{Edupop}{pop}\right)_{1,0} & \left(\frac{Exp}{GDP}\right)_{1,1} & \left(\frac{Imp}{GDP}\right)_{1,1} \\ 1 & 0 & \dots & 0 & \left(\frac{Inv}{GDP}\right)_{1,2} & \left(\frac{Edupop}{pop}\right)_{1,1} & \left(\frac{Exp}{GDP}\right)_{1,2} & \left(\frac{Imp}{GDP}\right)_{1,2} \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 1 & 0 & \dots & 0 & \left(\frac{Inv}{GDP}\right)_{1,7} & \left(\frac{Edupop}{pop}\right)_{1,6} & \left(\frac{Exp}{GDP}\right)_{1,7} & \left(\frac{Imp}{GDP}\right)_{1,7} \\ 0 & 1 & \dots & 0 & \left(\frac{Inv}{GDP}\right)_{2,1} & \left(\frac{Edupop}{pop}\right)_{2,0} & \left(\frac{Exp}{GDP}\right)_{2,1} & \left(\frac{Imp}{GDP}\right)_{2,1} \\ 0 & 1 & \dots & 0 & \left(\frac{Inv}{GDP}\right)_{2,2} & \left(\frac{Edupop}{pop}\right)_{2,1} & \left(\frac{Exp}{GDP}\right)_{2,2} & \left(\frac{Imp}{GDP}\right)_{2,2} \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 1 & \dots & 0 & \left(\frac{Inv}{GDP}\right)_{2,7} & \left(\frac{Edupop}{pop}\right)_{2,6} & \left(\frac{Exp}{GDP}\right)_{2,7} & \left(\frac{Imp}{GDP}\right)_{2,7} \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & \dots & 1 & \left(\frac{Inv}{GDP}\right)_{75,1} & \left(\frac{Edupop}{pop}\right)_{75,0} & \left(\frac{Exp}{GDP}\right)_{75,1} & \left(\frac{Imp}{GDP}\right)_{75,1} \\ 0 & 0 & \dots & 1 & \left(\frac{Inv}{GDP}\right)_{75,2} & \left(\frac{Edupop}{pop}\right)_{75,1} & \left(\frac{Exp}{GDP}\right)_{75,2} & \left(\frac{Imp}{GDP}\right)_{75,2} \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & \dots & 1 & \left(\frac{Inv}{GDP}\right)_{75,7} & \left(\frac{Edupop}{pop}\right)_{75,6} & \left(\frac{Exp}{GDP}\right)_{75,7} & \left(\frac{Imp}{GDP}\right)_{75,7} \end{pmatrix}$$

For regression 2, the last two columns are $(wto)_{it}$ and $(rta)_{it}$ instead. For the regression within sub-samples, certain lines will be deleted.

5. Econometric Results

5.1 Econometric Methodology

I estimate a panel regression with the following matrix notation, where X is as previously defined:

$$Y = X\beta + \varepsilon \quad \varepsilon \sim N(0, \sigma^2 V) \quad E(X, \varepsilon) = 0$$

The assumptions are the same as in Aitken's Model. V is a matrix that depends on X . Here I assume that V is diagonal, which means that I only allow for heteroskedasticity.⁹

First, I use OLS to get an unbiased estimator and the estimated residuals using the following equations:

$$\widehat{\beta}_{ols} = (X'X)^{-1}X'Y$$

$$\varepsilon_i = y_i - x_i' \widehat{\beta}_{ols}$$

Second, I estimate the following regression $\varepsilon_i^2 = z_i' \widehat{\alpha}_{ols} + u_i$, where z_i includes a constant, intercept, terms at degree of one, square terms, and cross terms of all the explanatory variables. To be more specific, z_i is a vector of:

$$z_i = \left[1, \left(\frac{Inv}{GDP} \right)_{it}, \left(\frac{Edu\text{pop}}{pop} \right)_{it-5}, \left(\frac{Exp}{GDP} \right)_{it}, \left(\frac{Imp}{GDP} \right)_{it}, \left(\frac{Inv}{GDP} \right)_{it}^2, \left(\frac{Edu\text{pop}}{pop} \right)_{it-5}^2, \left(\frac{Exp}{GDP} \right)_{it}^2, \right. \\ \left. \left(\frac{Imp}{GDP} \right)_{it}^2, \left(\frac{Inv}{GDP} \right)_{it} \left(\frac{Edu\text{pop}}{pop} \right)_{it-5}, \left(\frac{Inv}{GDP} \right)_{it} \left(\frac{Exp}{GDP} \right)_{it}, \left(\frac{Inv}{GDP} \right)_{it} \left(\frac{Imp}{GDP} \right)_{it}, \right. \\ \left. \left(\frac{Edu\text{pop}}{pop} \right)_{it-5} \left(\frac{Exp}{GDP} \right)_{it}, \left(\frac{Edu\text{pop}}{pop} \right)_{it-5} \left(\frac{Imp}{GDP} \right)_{it}, \left(\frac{Exp}{GDP} \right)_{it} \left(\frac{Imp}{GDP} \right)_{it} \right]$$

⁹ It is also common to allow for serial correlation within a country (over time), but not across countries. As a result, V is a block diagonal in the more general case. I deal with the serial correlation case in the robustness tests.

Then I use the estimated error to form the matrix V . V is a diagonal matrix with an element $V_i(x) = z_i' \widehat{\alpha}_{ols}$ on the diagonal.

Third, I calculate the estimators and its variance-covariance matrix using:

$$\hat{\beta} = (X'V^{-1}X)^{-1}X'V^{-1}Y$$

$$\widehat{\text{Var}}(\beta) = \sigma^2(X'V^{-1}X)^{-1}$$

This method (Feasible Generalized Least Squares, FGLS) eliminates the effect of heteroskedasticity and is more general than a simple OLS regression. I estimate this model using Matlab 7.1.

5.2 Regression Results for the full sample

First, I present the results for the whole sample. The result of Regression 1 can be found in Table 2. The coefficients of investment, education and export are large, positive and significant. The coefficient of import is positive but it is close to zero and not significant. The results suggest that on average, if a country's export share rises by 1 percentage point, the economy will grow 0.06 percent all else constant. Imports seem to contribute little to economic growth (the coefficient is neither statistically significant nor economically significant). Not surprisingly, investment matters a lot.

In regression 2, the results seem even stronger. The coefficients on WTO and RTA variables are positive, large and significant. With entering the WTO, the growth rate increases by 0.93

percent on average. On the other hand, joining a regional trade agreement is associated with a 1.12 percent increase in the growth rate. This result strongly suggests that opening to trade will likely raise the growth rate of GDP per capita.

5.3 Subsample Results

For non-OECD countries, which are the majority in our sample, and in the world, the results are quite similar to those for the whole sample. The results can be found in Table 3. For regression 1, the coefficient of export is positive and significant while the coefficient of import is quite close to zero. The results suggest that on average, if a country's export share rises by 1 percentage point, the economy will grow 0.06 percent all else constant. The coefficient on imports is still neither statistically significant nor economically significant. Investment continues to have a large positive effect on growth.

For regression 2, the coefficient on WTO is positive, large and significant. As we can see, the growth rate of non-OECD countries increases by 1.1 percent on average after it joins the WTO. The coefficient on RTA is positive, not statistically significant but economically significant. It implies that the growth rate of non-OECD countries rises by 0.90 percent if the country joins a regional trade agreement – this effect is slightly smaller than the impact from joining the WTO. These findings should serve to encourage developing countries to enter the world market and adopt open trade policies.

For the 20 OECD countries, the results, which are presented in Table 4, are a little different from those with the full sample. The effects of investment and education are still positive but no longer significant. Furthermore, the estimated coefficients are much smaller than those in the sample of non-OECD countries. This may be due to the fact that developed countries are closer to the steady-state in the Solow model so that the effect of investment on the growth rate of GDP per capita will be much less than that in the case of developing countries. The coefficient on exports is positive, statistically insignificant but economically significant. Additionally, it is much smaller than that for non-OECD countries. This may be due to the fact that non-OECD countries rely more heavily on exports. Consider, for example, the case of many East and South Asian countries, such as Japan, Malaysia, and Indonesia. These countries grew rapidly through 1980s-1990s likely because of their high export volumes. The coefficient of imports is actually positive and significant for developing countries, implying that if the import share rises by 1 percentage point, the growth rate of OECD countries increases by 0.10 percent.

For regression 2, the coefficients on investment and education are both positive and significant. The coefficient on WTO is about 0.43, which is positive but not significant. The coefficient of RTA is positive, large (more than 8 times the size of the coefficient on WTO) and highly significant (p -value < 0.01). This is interesting because it means the developed countries benefit more from particular regional trade agreements than joining the WTO. The reason may lie in the fact that other participants of these RTAs are also developed countries.

The majority of WTO members are developing countries. Joining the WTO seems to confer little benefit to OECD countries. Thus, the positive effect of joining the WTO is much smaller for OECD countries

5.4 Robustness Tests

First, I test for robustness by adding a time trend.¹⁰ Results are shown in Table 5, Table 6 and Table 7. These results are consistent with our previous estimates. The coefficients change somewhat because in most cases, some of the right-hand side variables are highly positively correlated with the time trend. For example, the trade is increasing throughout the sample years for most countries. As a result, the last column of the design matrix X (the time trend) is highly serially correlated with other variables (especially education), which may cause a bias in the estimates. That is why some coefficients are smaller than those in the previous specifications.¹¹ Here I only discuss the result for the full sample.

For regression 1, the coefficient of investment is still positive and significant but the coefficient of education approaches zero. The coefficient of export is still positive, statistically insignificant but economically significant. The coefficient of import is close to zero, just as what it is like in the previous regression's result. For regression 2, the coefficient of investment is positive and highly significant. The coefficient of education is also close to

¹⁰ I also tried to add individual year dummies. The results for regression 1 are quite similar. Regression 2 is hard to estimate because the matrix is almost singular for some sub-samples. This is because the year dummies are highly correlated with the dummies for WTO or RTA. Thus, X is almost not full-rank. This makes this test meaningless for regression 2

¹¹ The effects of some of those variables are "absorbed" in the time trend.

zero. The coefficients of WTO and RTA are positive, statistically insignificant but economically significant. In order to interpret these results, I test the correlation between each series in regression 1. The correlation between time trend and education is about 0.36. It does explain the biasness of the coefficient of education.

Similar results can be found in Table 6 and Table 7 for non-OECD countries and OECD countries. For non-OECD countries, the result is quite close to that of the full sample, which is consistent with the regression without the time trend. For OECD countries, both the coefficients on education and WTO are now negative, which is different from the previous estimates without the time trend. Similar to the full sample, the correlation between the time trend and education is 0.65, and the correlation between the time trend and WTO is 0.87. All of these high positive correlations may well cause biases in the estimated coefficients.

Finally, I test for robustness by adding a lag dependent term y_{it-1} on the right-hand side. The result for the full sample is shown in Table 8. For regression 1, the coefficients on investment and education are both positive and significant. The coefficient of exports is still positive and significant. The coefficient of import is close to zero, just as in the case with no lag dependent term. For regression 2, the coefficient on investment is positive and highly significant. The coefficient on education is nearly zero. The coefficient on WTO is positive and significant while the coefficient on RTA is positive but insignificant. The results are consistent with the conclusion from the baseline specification without a lag dependent term.

Results for non-OECD and OECD countries are shown in Table 9 and Table 10. The results for non-OECD countries are consistent with the baseline specification for the non-OECD sub-sample. The coefficients on exports and WTO are positive and economically significant. The coefficients on imports and RTA are close to zero and are insignificant. As for the OECD sub-sample, the results are also consistent for regression 2. The coefficient on RTA is positive and significant while the coefficient on WTO is close to zero. Only the results for regression 1 are inconsistent. The coefficient on exports seems to be positive and significant for OECD countries but the effect of imports is nearly zero. This still demonstrates the importance of trade. The only difference is that it emphasizes the importance of exports for OECD countries.

6. Conclusions and Discussion

This paper investigates the effect of trade openness on the growth rate of GDP per capita. In the paper, I measure the impact of trade in two ways: quantitatively (using the volume of trade) and categorically (using trade policies indicators). The paper uses panel data from 75 countries during the period from 1970 to 2005. Generally, I demonstrate that trade has positive effect on the growth rate of GDP per capita, even after controlling for investment and human capital. The results are robust and lead us to believe that greater openness is associated with higher growth rate of GDP per capita. I also split the sample into OECD and non-OECD countries, which further reveals some interesting results – OECD countries benefit more from imports and the joining a regional trade agreement, while non-OECD countries benefit more from exports and joining the WTO. The results for the whole sample are closer to those for the non-OECD sub-sample because the majority of countries in the world and in my sample are non-OECD countries. All these results demonstrate the importance of openness to trade and global liberalization.

Although our empirical models and conclusions were supported statistically, some concerns remain. The first is that trade policies may be endogenous as Elhanan Helpman (1988) suggests. This is because policy makers may come to a decision on openness while also considering economic growth. This may cause a bias in my empirical approach. Future can consider appropriate instrument variables to solve this problem. Second, this paper only tests for a correlation between trade and growth. To investigate if trade causes growth in this panel

data set up, future studies will needed to use Granger Causality Test and instrumental variable techniques.

Table 1: Statistic Description of the variables in regression

Whole Sample (N=525)

Variable	Mean	Unit	Standard deviation
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	19.2032	%	6.6462
2. $\left(\frac{\text{Exp}}{\text{GDP}}\right)_{it}$	33.3777	%	23.8908
3. $\left(\frac{\text{Imp}}{\text{GDP}}\right)_{it}$	37.1279	%	22.3331
4. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	16.3382	%	17.6849
5. y_{it}	1.7185	%	4.4219

Non-OECD Sub-sample (N=485)

Variable	Mean	Unit	Standard deviation
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	18.9930	%	7.3963
2. $\left(\frac{\text{Exp}}{\text{GDP}}\right)_{it}$	31.9464	%	23.1987
3. $\left(\frac{\text{Imp}}{\text{GDP}}\right)_{it}$	37.5262	%	22.6792
4. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	9.9671	%	11.5095
5. y_{it}	1.5706	%	4.9703

OECD Sub-sample (N=140)

Variable	Mean	Unit	Standard deviation
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	19.7812	%	3.8640
2. $\left(\frac{\text{Exp}}{\text{GDP}}\right)_{it}$	37.3138	%	25.3698
3. $\left(\frac{\text{Imp}}{\text{GDP}}\right)_{it}$	36.0327	%	21.3933
4. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	33.8589	%	19.7851
5. y_{it}	2.1253	%	2.2885

Table 2: Regression Results for the whole sample

Regression 1

Variable	Coefficient	Std error	t-value	Significance level
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	0.1065	0.0393	2.7075	***
2. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	0.0310	0.0214	1.4476	
3. $\left(\frac{\text{Exp}}{\text{GDP}}\right)_{it}$	0.0614	0.0330	1.8581	*
4. $\left(\frac{\text{Imp}}{\text{GDP}}\right)_{it}$	0.0019	0.0346	0.0549	

Note: *** p<0.01, ** p<0.05, * p<0.10

Regression 2

Variable	Coefficient	Std error	t-value	Significance level
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	0.1022	0.0368	2.7798	***
2. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	0.0179	0.0248	0.7231	
3. $(\text{wto})_{it}$	0.9296	0.5233	1.7763	*
4. $(\text{rta})_{it}$	1.1219	0.6454	1.7382	*

Note: *** p<0.01, ** p<0.05, * p<0.10

Table 3: Regression Results for the Non-OECD sub-sample

Regression 1

Variable	Coefficient	Std error	t- value	Significance level
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	0.1129	0.0467	2.4148	**
2. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	0.0507	0.0433	1.1701	
3. $\left(\frac{\text{Exp}}{\text{GDP}}\right)_{it}$	0.0587	0.0398	1.4770	
4. $\left(\frac{\text{Imp}}{\text{GDP}}\right)_{it}$	-0.0063	0.0406	-0.1550	

Note: *** p<0.01, ** p<0.05, * p<0.10

Regression 2

Variable	Coefficient	Std error	t-value	Significance level
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	0.1023	0.0438	2.3378	**
2. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	0.0102	0.0491	0.2083	
3. $(\text{wto})_{it}$	1.1038	0.6875	1.6054	*
4. $(\text{rta})_{it}$	0.8992	0.7972	1.1279	

Note: *** p<0.01, ** p<0.05, * p<0.10

Table 4: Regression Results for the OECD sub-sample

Regression 1

Variable	Coefficient	Std error	t- value	Significance level
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	0.0303	0.0644	0.4702	
2. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	0.0053	0.0152	0.3516	
3. $\left(\frac{\text{Exp}}{\text{GDP}}\right)_{it}$	0.0279	0.0520	0.5366	
4. $\left(\frac{\text{Imp}}{\text{GDP}}\right)_{it}$	0.1089	0.0670	1.6253	*

Note: *** p<0.01, ** p<0.05, * p<0.10

Regression 2

Variable	Coefficient	Std error	t- value	Significance level
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	0.1154	0.0600	1.9249	*
2. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	0.0327	0.0185	1.7710	*
3. $(\text{wto})_{it}$	0.4331	0.5597	0.7739	
4. $(\text{rta})_{it}$	3.3379	1.1483	2.9068	***

Note: *** p<0.01, ** p<0.05, * p<0.10

Table 5: Regression Results for the whole sample with time trend

Regression 1

Variable	Coefficient	Std error	t- value	Significance level
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	0.1089	0.0392	2.7818	***
2. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	-0.0068	0.0270	-0.2528	
3. $\left(\frac{\text{Exp}}{\text{GDP}}\right)_{it}$	0.0482	0.0334	1.4439	
4. $\left(\frac{\text{Imp}}{\text{GDP}}\right)_{it}$	-0.0039	0.0345	-0.1136	
5. t	0.3030	0.1329	2.2806	**

Note: *** p<0.01, ** p<0.05, * p<0.10

Regression 2

Variable	Coefficient	Std error	t- value	Significance level
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	0.1045	0.0369	2.8354	***
2. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	0.0053	0.0281	0.1884	
3. $(\text{wto})_{it}$	0.4664	0.7150	0.6522	
4. $(\text{rta})_{it}$	0.8532	0.7046	1.2107	
5. t	0.1991	0.2094	0.9510	

Note: *** p<0.01, ** p<0.05, * p<0.10

Table 6: Regression Results for the non-OECD sub-sample with time trend

Regression 1

Variable	Coefficient	Std error	t- value	Significance level
1. $\left(\frac{Inv}{GDP}\right)_{it}$	0.1113	0.0466	2.3877	**
2. $\left(\frac{Edupop}{Pop}\right)_{it-1}$	-0.0050	0.0545	-0.0921	
3. $\left(\frac{Exp}{GDP}\right)_{it}$	0.0445	0.0406	1.0964	
4. $\left(\frac{Imp}{GDP}\right)_{it}$	-0.0082	0.0405	-0.2017	
5. t	0.2859	0.1707	1.6749	*

Note: *** p<0.01, ** p<0.05, * p<0.10

Regression 2

Variable	Coefficient	Std error	t- value	Significance level
1. $\left(\frac{Inv}{GDP}\right)_{it}$	0.1027	0.0439	2.3399	**
2. $\left(\frac{Edupop}{Pop}\right)_{it-1}$	0.0060	0.0551	0.1084	
3. $(wto)_{it}$	0.9952	0.9382	1.0607	
4. $(rta)_{it}$	0.8424	0.8652	0.9735	
5. t	0.0465	0.2729	0.1704	

Note: *** p<0.01, ** p<0.05, * p<0.10

Table 7: Regression Results for the OECD sub-sample with time trend

Regression 1

Variable	Coefficient	Std error	t- value	Significance level
1. $\left(\frac{Inv}{GDP}\right)_{it}$	0.0727	0.0639	1.1373	
2. $\left(\frac{Edupop}{Pop}\right)_{it-1}$	-0.0457	0.0226	-2.0264	**
3. $\left(\frac{Exp}{GDP}\right)_{it}$	0.0184	0.0504	0.3644	
4. $\left(\frac{Imp}{GDP}\right)_{it}$	0.1010	0.0649	1.5551	
5. t	0.5071	0.1700	2.9826	***

Note: *** p<0.01, ** p<0.05, * p<0.10

Regression 2

Variable	Coefficient	Std error	t- value	Significance level
1. $\left(\frac{Inv}{GDP}\right)_{it}$	0.1466	0.0585	2.5044	**
2. $\left(\frac{Edupop}{Pop}\right)_{it-1}$	-0.0137	0.0229	-0.5953	
3. $(wto)_{it}$	-0.9660	0.6943	-1.3913	
4. $(rta)_{it}$	2.2105	1.1602	1.9052	*
5. t	0.7358	0.2303	3.1947	***

Note: *** p<0.01, ** p<0.05, * p<0.10

Table 8 Regression Results for the full sample with lag terms of growth rate

Regression 1

Variable	Coefficient	Std error	t- value	Significance level
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	0.1175	0.0386	3.0420	***
2. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	0.0346	0.0210	1.6487	*
3. $\left(\frac{\text{Exp}}{\text{GDP}}\right)_{it}$	0.0615	0.0324	1.8992	*
4. $\left(\frac{\text{Imp}}{\text{GDP}}\right)_{it}$	0.0006	0.0339	0.0166	
5. y_{it-1}	-0.1882	0.0426	-4.4161	***

Note: *** p<0.01, ** p<0.05, * p<0.10

Regression 2

Variable	Coefficient	Std error	t- value	Significance level
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	0.1131	0.0361	3.1353	***
2. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	0.0172	0.0242	0.7096	
3. $(\text{wto})_{it}$	1.0928	0.5134	2.1284	**
4. $(\text{rta})_{it}$	0.9803	0.6324	1.5501	
5. y_{it-1}	-0.1937	0.0426	-4.5486	***

Note: *** p<0.01, ** p<0.05, * p<0.10

Table 9 Regression Results for the OECD sub-sample with lag terms of growth rate

Regression 1

Variable	Coefficient	Std error	t- value	Significance level
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	0.1205	0.0460	2.6176	**
2. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	0.0432	0.0427	1.0133	
3. $\left(\frac{\text{Exp}}{\text{GDP}}\right)_{it}$	0.0560	0.0391	1.4312	
4. $\left(\frac{\text{Imp}}{\text{GDP}}\right)_{it}$	-0.0046	0.0399	-0.1142	
5. y_{it-1}	-0.1735	0.0508	-3.4158	***

Note: *** p<0.01, ** p<0.05, * p<0.10

Regression 2

Variable	Coefficient	Std error	t- value	Significance level
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	0.1108	0.0430	2.5757	***
2. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	-0.0073	0.0484	-0.1513	
3. $(\text{wto})_{it}$	1.3396	0.6777	1.9768	**
4. $(\text{rta})_{it}$	0.7973	0.7827	1.0186	
5. y_{it-1}	-0.1866	0.0506	-3.6851	***

Note: *** p<0.01, ** p<0.05, * p<0.10

Table 10 Regression Results for the OECD sub-sample with lag terms of growth rate

Regression 1

Variable	Coefficient	Std error	t- value	Significance level
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	0.0838	0.0593	1.4128	
2. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	0.0138	0.0139	0.9945	
3. $\left(\frac{\text{Exp}}{\text{GDP}}\right)_{it}$	0.0840	0.0483	1.7368	*
4. $\left(\frac{\text{Imp}}{\text{GDP}}\right)_{it}$	0.0506	0.0618	0.8187	
5. y_{it-1}	-0.3461	0.0676	-5.1226	***

Note: *** p<0.01, ** p<0.05, * p<0.10

Regression 2

Variable	Coefficient	Std error	t- value	Significance level
1. $\left(\frac{\text{Inv}}{\text{GDP}}\right)_{it}$	0.1385	0.0564	2.4578	**
2. $\left(\frac{\text{Edupop}}{\text{Pop}}\right)_{it-1}$	0.0410	0.0174	2.3570	**
3. $(\text{wto})_{it}$	0.5701	0.5244	1.0870	
4. $(\text{rta})_{it}$	2.9554	1.0777	2.7423	***
5. y_{it-1}	-0.2975	0.0708	-4.1992	***

Note: *** p<0.01, ** p<0.05, * p<0.10

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APPENDIX

Appendix A: Selected Countries

Argentina	Finland **	Mexico
Australia **	France **	Morocco
Austria **	Germany **	Netherlands **
Bangladesh	Ghana	New Zealand
Belgium **	Greece	Niger
Benin	Guatemala	Norway **
Bolivia	Guyana	Papua New Guinea
Burkina Faso	Honduras	Paraguay
Burundi	Hong Kong SAR, China	Peru
Cameroon	Iceland **	Philippines
Canada **	India	Portugal **
Central African Republic	Indonesia	Rwanda
Chad	Ireland **	Senegal
Chile	Israel	South Africa
China	Italy **	Spain **
Colombia	Jamaica	Sri Lanka
Congo, Rep.	Japan **	Swaziland
Costa Rica	Kenya	Sweden **
Cote d'Ivoire	Korea, Rep.	Thailand
Denmark **	Luxembourg **	Togo
Dominican Republic	Madagascar	Trinidad and Tobago
Ecuador	Malawi	Turkey
Egypt, Arab Rep.	Malaysia	United Kingdom **
El Salvador	Mali	United States **
Fiji	Mauritania	Uruguay

Note:

Countries marked with stars (**) are included in the OECD sub-sample.