UNIVERSITAT DE BARCELONA

Three Empirical Essays on Comparative Advantage & Productivity Growth in Asia

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To my lovely family

Contents

Chapter 5: Concluding Remarks: Main Findings and Future Research

103

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List of Abbreviations

ADF	Augmented Dickey–Fuller test
AI	Additive Index
AIC	Akaike Information Criteria
ARDL	Autoregressive Distributed Lag Model
BI	Balassa Index
CA	Comparative Advantage
CD	Cross-Section Dependence
ECM	Error Correction Model
ECT	Error Correction Term
ELG	Export-Led Growth
EU	European Union
EU-15	Refers to the 15 member states of the European Union as of December 31, 2003 (i.e., Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom)
FDI	Foreign Direct Investment
FRED	Federal Reserve Bank of St. Louis
GDP	Gross Domestic Production
GP	Gender Parity
GPI	Gender Parity Index
GCF	Gross Capital Formation
HCI	Human Capital Index
I (0)	Integrated of Order Zero
I (1)	Integrated of Order One

1 (2)	Integrated of Order Two
ISI	Import Substitution Industrialization
LI	Lafay Index
LDCs	Less Developed Countries
LF	Labor Force
LFPR	Labor Force Participation Rate
LP	Labor Productivity
NI	Normalized Index
OECD	Organization for Economic Cooperation and Development
PP	Phillips–Perron Test
R&D	Research and Development
SAARC	South Asian Association for Regional Cooperation
SBC	Schwarz Bayesian Criteria
SI	Symmetric Index
SITC	Standard International Trade Classification
TED	Total Economy Database
TOP	Trade Openness
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
US	United States
VAR	Vector Auto-Regression
VECM	Vector Error Correction Model
WB	World Bank
WI	Weighted Index

WTO	World Trade Organization
X	Exports

List of Figures

List of Tables

Chapter 1 – Introduction

In the modern global economy, prosperity is a nation's choice.
Michael Porter (1990) in "The Competitive Advantage of Nations"

1.1 Comparative Advantage and Productivity Growth in Developing Countries of Asia

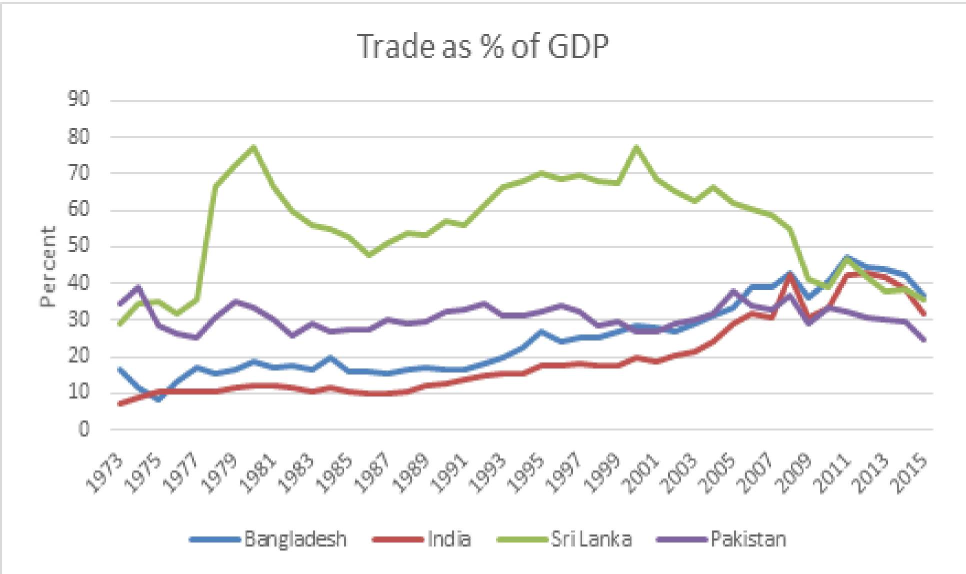
In the modern global economy, prosperity is a nation's choice. Yet, in this modern economic world, sustained prosperity and the achievement of higher level of productivity growth still remain an issue. Comparative advantage theory is old but still relevant in explaining patterns of trade especially among developing countries. The Ricardian model shows how technological differences can lead to gains from trade which makes it as relevant today as it has always been (Feenstra 2004). Many developing countries can simultaneously boost-up their economic growth and promote the efficient allocation of resources through the exploitation of their comparative advantage.

Establishing sustainable growth in an economy is one of the most important concepts in countries across the globe. Most countries structure their economies in order to meet their long-term development goals although what they choose as the main drivers of growth may differ. Long before the industrial revolution, agriculture was the main economic activity in almost all countries, but it was especially true in developing and third world countries. However, over the last 50 years, there has been a shift in focus from agriculture to manufacturing activities. In fact, many economies across the world have achieved a far more significant development. Even though the Industrial Revolution started in Europe, it quickly spread to other countries. What made the Industrial Revolution more attractive was the fact that it improved the standards of living. Immediately after the end of the Second World War, economic independence was gained by some of the developing countries. At last at the end of the 20^{th} century, a small group of developing world became successful in achieving higher economic growth trimming the gap between them and the advanced economies. Japan, Hong Kong, China Singapore and Taiwan are the major examples of countries which performed very well in achieving higher annual growth. Recently in some large developing economies, China, Brazil and India for instance growth rate is quite high and turned them into global growth poles (The World Bank 2011).

1.2 Trade Openness and Economic Growth

Trade openness and economic growth are certainly not independent from each other. The arguments in favour of trade openness are well documented in the literature as evaluated by Harrison (1996), Sachs et. al. (1995), Edwards (1998), Chang et. al. (2009), Awokuse (2008), Sakyi et. al. (2015) among others. Trade openness promotes resource allocation efficiently through exploiting comparative advantage and economy-wide increasing returns (new trade theory) and it also allows the distribution of knowledge and technological development. The latter further stimulates competition in domestic as well as international markets. Figure 1.1 shows that trade seems to have not grown much over most of the past forty years as percent of the GDP in South Asian countries.

Figure 1.1: Trade Volume as Percentage of GDP, 1973-2015 (World Development Indicators - WB database)



Most economies have shifted from the over reliance of the agrarian revolution and integrating the industrial sector along with agricultural sectors. As of a result, countries such as Brazil that implemented import substitution industrialization (ISI) policies in the post-war period, experienced tremendous growth. However, Brazil is one of the few countries that have relied on its dominant agricultural sector and the agricultural exports of products such as coffee have been a major source of revenue for the economy. In fact, Brazil, India, and China are ones of the few countries that have experienced steady growth in the last half century and this has enabled them to narrow the gap between them and the industrialized countries. With this in mind, the high rate of economic growth in these countries has allowed them to improve the standards of living by reducing the rate of unemployment in their respective economies. In fact, right after the Second World War, most developing countries had poverty rates above 50%, but they have managed to reduce this significantly in the last few decades.

The main challenge that has faced by some other developing countries in the past is the fact that they haven't been able to overcome slower economic growth (Huang and Quibria 2013). Furthermore, this has delayed the economic growth of some developing countries as only a few countries such as China, India, Sri Lanka and Turkey have been able to maintain steady growth while others have been unable to maintain steady growth due to the absence of strong economic policies (Figure 1.2 and 1.3). As a matter of fact, only a few countries have been able to move to middle-income country status from the low-income country status and at the same time sustained the same level of income growth. Sri Lanka has also been able to record exceptional growth up until 2010 (Figure 1.3).

Figure 1.2: GDP Growth Rate, 1961-2014 (World Development Indicators - WB database)

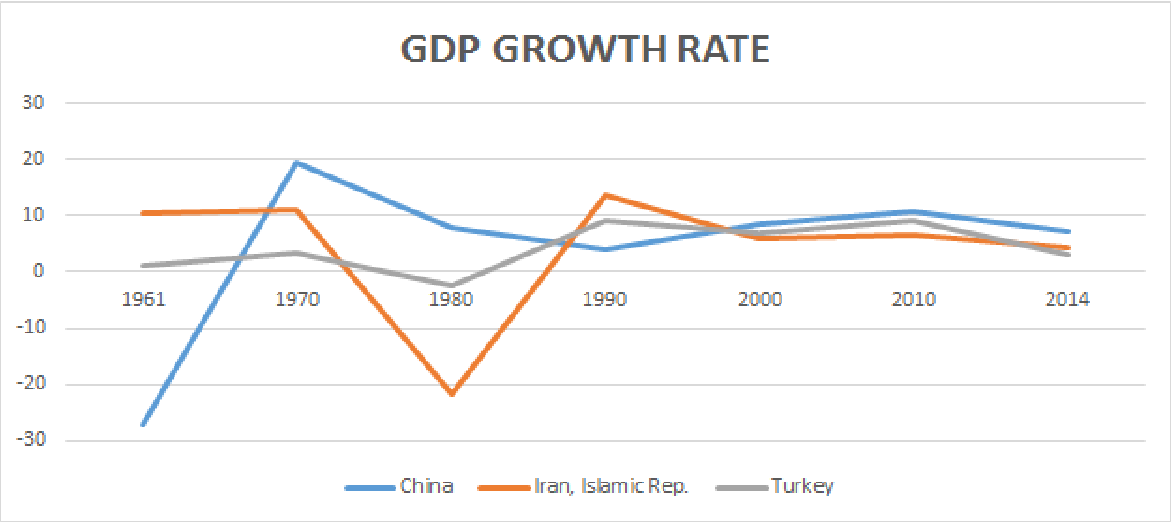
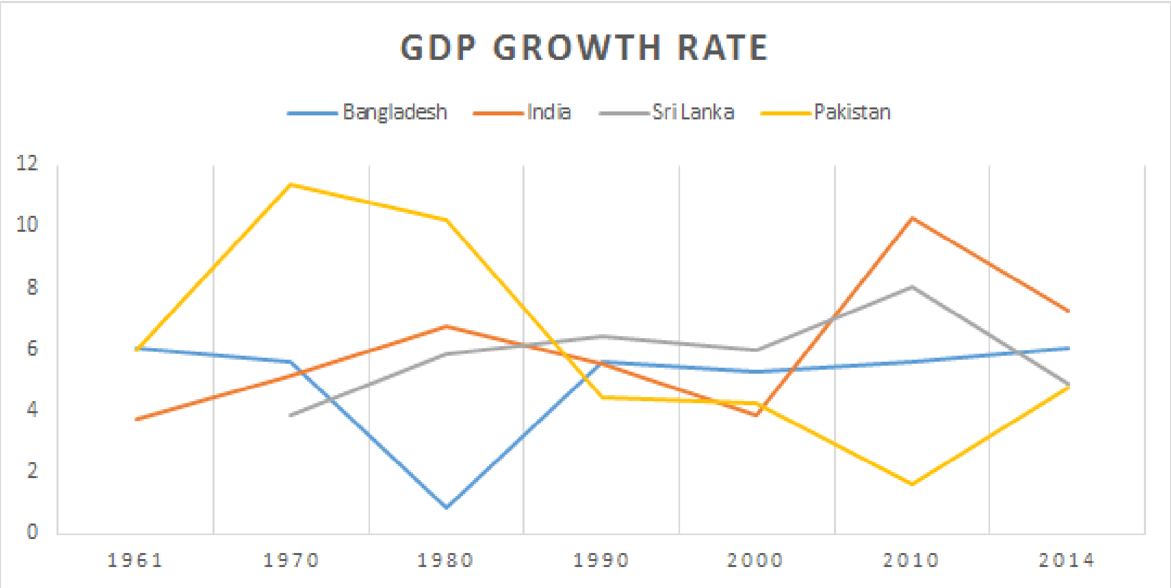


Figure 1.3: GDP Growth Rate, 1961-2014 (World Development Indicators - WB database)



1.3 Growth in the Process of Conforming or Defying Comparative Advantage: A Brief Overview

Countries that have been able to achieve sustained structural growth have been able to shift from the production of the traditional goods to manufacturing of contemporary goods. This has also led to a diversification of their economy. Relying only a few sources of income for a country is risky considering that other macroeconomic factors can have a considerable impact on a few sectors and this can undermine a country's economic growth (Lin 2012). Historically, most developing countries have focused on agriculture as a primary source of income. In Asia, the rise of China in a world dominant economic power has been based on the sound economic policies, growing industrial and the real estate sectors (Lin 2012). The success and the failures of the economies depend on the structural changes that a country goes through (Kuznet 1966). With this in mind, the main purpose of the first paper of this thesis is to see what changes affect the economic growth of the Asian developing economies. Moreover, should these countries conform to their comparative advantage or defy it?

Structural theorists have played a vital role in the economic development of different economies. However, our first paper is relevant to and inspired by the third wave of development thinking, advanced by some economists such as Dani Rodrik, Ricardo Hausmann, Andres Velasco, Phillippe Aghion, Justin Lin and many others. Their main argument is that the economic structure of an economy is dependent on its factor endowment structure and economic growth is driven by changes in factor endowments. Comparative advantage, and thus the optimal industrial structure, are determined by a country's factor endowments. Upgrading the economic and industrial structure of a country demands improvement of its factor endowment structure. For that reason, different waves of development economics has relied on the past failures to strengthen their arguments identifying the reasons as to why some economies succeed while others have failed even when similar resources are at their disposal. Economically, China was at the same level with other developing countries like Brazil but with their recent double-digit economic growth, the country is set to become an economic superpower shortly. Therefore, from the successes and failures of developing countries, it is possible to identify the reason for success.

New structural economists believe that for a country to succeed in the world, it needs to support the economic structure based on their comparative advantage at any given period. The theory of comparative advantage predicts that countries will have a higher relative exports in the sectors where they have higher relative productivity (Golub and Hsieh 2000; Costinot and Donaldson 2012; and Kerr 2017). In most cases, a country will be more competitive in international markets if it can produce products according to their existing comparative advantage.

Comparative advantage is still vital towards economic growth of a developing economy[1]. A country should ensure that it maximizes their comparative advantage while at the same time investing in other areas of their economy. Even though comparative advantage may shift as different countries engage in the same level of production, a country should focus on the production that in the long-run guarantees its dominance in global markets. For example, Brazil has a strong comparative advantage in coffee production relative to other countries across the globe. Therefore, the Brazilian government's focus should be on investing in the coffee industry to ensure that the country's coffee sector continues to dominate the market in the long-run by producing high-quality coffee and related products. Furthermore, more investments should be made on the infrastructure and in technology to make coffee production more efficient and easier. This enables the economy to be more competitive and at the same time ensures that there is surplus production in the market and this provides the government with the opportunity to invest more in the infrastructure and technology development.

1.4 Thesis Overview: Structure and Main Findings

This thesis is a combination of three independent papers that discuss various challenges posed on developing countries of Asia and provide suggestions as to how comparative advantage and labor productivity growth is relevant towards their economic growth. We seek to explore why these countries tend to lag behind in terms of productivity growth. Moreover, we

[1] Lin (2012) argues that countries that pursue a comparative advantage following development strategy perform better than other countries.

also seek to compare China, U.S., and the EU in terms of their trade competitiveness in various sectors to examine the convergence and divergence pattern of their comparative advantage in chapter 3.

The next chapter, titled *Should developing countries of Asia conform to comparative advantage or defy it?*, seeks to study the interaction between comparative advantage, exports, and economic growth for a set of developing countries in Asia. This paper is inspired by a debate between Justin Lin and Ha-Joon Chang (2009) in which the former World Bank chief economist Justin Lin asks "whether industrial upgrading and strategies for industrialization should follow to current comparative advantage or target to miss out steps on the ladder: textile first or mobile phones?" Chang argues that countries need to defy their comparative advantage in order to improve productivity in industrial sectors and that this can lead to higher economic growth (Lin and Chang 2009). According to Lin (2012), the purpose of industrialization is not to ignore those sectors in which a country has a natural comparative advantage. For example a country ignoring agriculture and focusing on sectors that do not match a country's factor endowment structure, such as high- tech, manufacturing and service sectors.

We empirically analyse a selected subset of developing countries in Asia which together account for more than half of the world's population. This paper analyses the causal relationship between comparative advantage, exports, and economic growth by using time series annual data for the period of 1980-2012 for the following 8 countries: Bangladesh, China, India, Iran, Korea, Pakistan, Sri Lanka, and Turkey. Panel cointegration and autoregressive distributed lag techniques are used to explore the causal relationship between the three variables. The purpose is to explore the differences or similarities between a variety of their sectors and show how comparative advantage influences exports which can affect a country's economic growth. We find that countries that follow their existing comparative advantage grow more rapidly, all else equal. The results suggest a mutual long-run relationship between comparative advantage, exports, and economic growth.

The third chapter, *Export Specialization and Convergence Patterns for the EU, U.S., and China*, sheds light on the trade competitiveness of the U.S., EU, and China and on changing trade patterns across sectors within countries and across countries within sectors. China's rapid growth and rise as the world's largest supplier of goods is one of the most notable changes to the global economy in the last three decades. The questions we try to address are the following: Has China's increased presence in global markets led to a convergence towards a more homogeneous international trade pattern? Are the U.S. and EU losing its existing comparative advantage in certain sectors? To analyse the changes in comparative advantage, we will compare and analyze two separate indices of revealed comparative advantage for sectors using different measures of aggregation. In order to check for convergence or divergence patterns, we use Galtonian regressions that compare cross-sections data as in Dalum et. al. (1998). Hinloopen and Marrewijk (2004) and Sanidas and Shin (2011) use similar methodology when conducting comparative advantage analysis.

Our results suggest that there is broad convergence across countries for almost all sectors and mixed findings of trade specialization within countries. These results are mostly in line with earlier work even though we employ different measures of comparative advantage and use different sectoral classifications. Our inclusion of China, relative to the rest of the literature, does lead us to find that there has been a shift towards trade specialization in the broadest classification of manufacturing (primarily due to their massive increase in export manufacturing over our time period) and therefore the manufacturing sector is characterized by a pattern of divergence unlike all other sectors. This new result shows how critical it is to include China, with their rise in global trade concentrated in manufactured goods, in any analysis of changes in global trade patterns.

The fourth chapter, *Determinants of labor productivity growth in SAARC countries: A Long-Run Panel Analysis,* examines the factors of labor productivity in countries belonging to the South Asian Association for Regional Cooperation. SAARC countries have enormous potential of increasing their productivity growth through some factors that can impact labor productivity such as investment in R&D, trade openness, foreign direct investment (FDI), human capital index (HCI) and gender parity. In this paper, the primary aim is to look at the determinants which foster labor productivity in the four largest countries in South Asia: Bangladesh, India, Pakistan and Sri Lanka and this will be a guide for the policy makers to make some better policies to enhance the productivity growth in SAARC. Recently, much of the research focus has been on policy analysis of East Asian countries. This has perhaps been due to their outward oriented policies and their perceived success while South Asian countries are viewed as being unsuccessful. Consequently, it is time to take a closer look at the policies employed in these countries and their potential impact on labor productivity growth.

To perform the empirical analysis, we construct panel data for Bangladesh, India, Pakistan and Sri Lanka from 1980-2013 using three data sources, the World Bank, FRED (Federal Reserve Bank of St. Louis), and the TED database.2 In order to investigate the long-run relationship among labor productivity and its determinants, we apply a new panel cointegration technique proposed by Baltagi and Pirotte (2014) which is detailed in the methodology section. After finding the cointegration relationships, we apply a vector error correction model (VECM) to check the short-run and long-run relationships among the variables. We find that gender parity plays a dominant role in the process of labor productivity growth in SAARC countries along with FDI, HCI, and R&D, whereas the effect of trade openness is positive but significant at 1% only. Tests using vector error correction find significant short-run as well as long-run relationships among all the variables.

The main findings of the three papers are analysed together in the final chapter with some separation as the issues are independent but are related to the developing economies of Asia. Annexes illustrating the data and explanations of different methodologies for the three principal papers are also included.

[2] For the other four countries, Bhutan, Maldives, Nepal and Afghanistan, data is not available for the whole period of study.

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Chapter 2 - Should developing countries of Asia conform to comparative advantage or defy it?[3]

2.1 Introduction

The concept that productivity differences across countries and sectors shape the patterns of trade dates back to Ricardo (1817). Though a simple concept, it is still relevant in explaining the pattern of international trade among developing countries. Some significant advances in the literature have revealed how comparative advantage can be formalised in the case where there are more than two industries (Dornbusch et. al. 1977) and in the case of many countries (Eaton and Kortum 2002). The theory of comparative advantage predicts that countries will have a higher relative exports in the sectors where they have higher relative productivity (Golub and Hsieh 2000; Costinot and Donaldson 2012; and Kerr 2017). Two major questions in the theory of international trade and comparative advantage are: why do counties trade and how important is it for countries to follow their comparative advantage. Recently, many economists have emphasized that the comparative advantage differences among developing countries account for an extensive part of their economic growth and have led to improved standards of living (Matsuyama 1992; Kuznet 1971; and Lucas 1988).

The relationship between comparative advantage and economic growth is routed in a basic question: what are the factors that determine economic growth? From an economic policy perspective, this is an important issue

[3] I am thankful to my supervisors, Elisenda Paluzie and Kristian Estevez, for their guidance. This paper was previously circulated as "Comparative advantage growth nexus" and has benefited from useful comments from presentations at the Universitat de Barcelona and the 2015 XREPP Doctoral Day.

because if comparative advantage leads to more exports and exports casually affect economic growth positively then exports should be promoted especially in developing countries. If this is the case, there might be a need for developing countries to focus on sectors in which they have a comparative advantage (by opening up to free trade and competing in the international market). In this paper, we examine which sectors are most relevant towards the economic growth of some Asian developing countries. The existing literature has put much focus on deviations from existing comparative advantage and has shown that it is important for a country's aggregate variables such as growth and labor productivity.[4]

The motivation for this paper is related to the debate by Justin Lin and Ha-Joon Chang in 2009 in which Lin notes that "whether industrial upgrading and strategies for industrialization should follow to current comparative advantage or target to miss out steps on the ladder: textile first or mobile phones?" Chang argues that countries need to defy their comparative advantage to improve productivity in industrial sectors to grow rapidly and catch up to industrial countries (Lin and Chang 2009). According to Lin (2012), the purpose of industrialization is not to ignore those sectors in which a country has natural comparative advantage, agriculture for example, and focus on sectors that do not match a country's factor endowment structure, such as high-tech and service sectors.

Why is it interesting to examine the nexus between comparative advantage, exports and economic growth? A lot of focus has been put on export-led growth (ELG) theory and it is discussed in many papers that econometrically test its predictions although the empirical evidence is still mixed and inconclusive.[5] This paper re-examines the long-run relationship between comparative advantage and economic growth by applying panel co-integration technique and a vector error correction model (VECM). We find that developing countries in Asia should not stray from their existing

[4] Kongsamut et. al. (2001) described several models that displayed generalized balanced growth paths which are consistent with the dynamics of structural change. Ngai and Pissarides (2007) model shows that structural change is a necessary part of aggregate growth. Herrendorf et. al. (2013) evaluated the empirical importance of changes in income and relative prices for structural transformation in the post war United States.

[5] For long-run significant relationship between exports and growth, See Xu (1996), Shan and Sun (1998), Giles and Williams (2000), Awokuse (2008) and Hye et. al. (2013).

comparative advantage; otherwise it will negatively impact their economic growth. We show this by examining the long-run, as well short-run, relationships between comparative advantage, exports, and economic growth for developing countries of Asia. The analyzed data set consists of panel data for the following 8 developing Asian countries for the period 1981-2012: Bangladesh, China, India, Iran, Korea, Pakistan, Sri Lanka, and Turkey.

Our research methodology is based on the recently developed technique proposed by Westerlund (2007) in which panel co-integration is used to investigate whether comparative advantage, exports, and economic growth are co-integrated or whether there exists a stationary linear combination among the variables considered. The panel unit root tests developed by Levin, Lin and Chu (2002), Fisher Chi-Square Test using ADF and PP Tests ((Maddala and Wu (1999), Choi (2001)), and Im Pesaren and Shin (2003) are applied to check for stationarity.

Comparative advantage in agriculture sector and its relation to economic growth is a complicated issue which has been examined by Matsuyama (1992) who finds that agricultural productivity might reduce economic growth in developing countries that are open to trade. We will investigate the relationship among comparative advantage in the agriculture sector and economic growth. The countries chosen are mostly agriculture-based economies and that is where their comparative advantage might reside. Therefore, it seems realistic that agriculture sector can positively affect economic growth. However, by applying co-integration technique we will see whether it works in these developing countries.

This study attempts to contribute to the body of available studies in several ways. First, our research tries to build a strong argument that existing comparative advantage is essential for economic growth in the selected countries of study. Second, the panel cointegration technique that we employ allows us to address the endogeneity problem that occurs from the simultaneous determination of comparative advantage (measured by the Balassa Index), a country's exports and GDP growth. This issue has not been empirically well established in the previous research on comparative advantage and growth. Third, while most of the previous research has focused on export-led growth theory, there has been little attention paid to comparative advantage and growth for Asian developing countries that are examined here.

The remainder of this paper is structured as follows: Section 2.2 briefly reviews the theory of comparative advantage and the relevant literature. Section 2.3 explains the data and descriptive statistics. The Balassa Index is explained in section 2.4. Section 2.5 describes the econometric analysis. Section 2.6 presents the estimation results and discusses their implications. Finally, Section 2.7 concludes with some final remarks.

2.2 Theory of Comparative Advantage

Countries trade to take advantage of their differences and the inherent advantages of specialisation (by large scale production). The concept of comparative advantage, in a Hecksher Ohlin framework, states that a country can benefit by producing those goods which utilize the abundant factors intensively. Therefore, labor-abundant countries will tend to have a comparative advantage in labor-intensive industries. Same holds true for capital-abundant countries. This phenomenon is very common, so that for developing countries which are rich in their labor-intensive goods and their economies, therefore, thrive on specializing in the production of labor intensive goods.

The theory of comparative advantage illustrates how even a country with no absolute advantage in any sector can still find trade to be beneficial by specializing in industries at which it is least bad (Lin and Chang 2009). Ricardo (1817) introduced the concept of comparative advantage in which a country exported goods in which it had a lower opportunity cost relative to other countries. Ricardo was not in favor of tariffs and other restrictions on trade and stated that comparative advantage explained how countries specializing in goods can gain from international trade. It is believed that specialization according to comparative advantage has lead to an increase in global production and lead to better living standards across the world. This is the reason why it is important, particularly in the developing world where trade restrictions remain high.

In order to estimate comparative advantage, we calculate indicators derived from ex-post trade data to "reveal" a country's comparative advantage.

A number of studies, such as Balassa (1977, 1979, and 1989), Yamazawa (1971), Balassa and Bauwens (1987), Roemer (1977), Hillman (1980) and others have employed revealed comparative advantage (RCA) indices for various sectors with respect to other countries.[6] This theory is difficult to bring to the data, however, to simplify we use the Balassa index.

There are important theoretical advances in the literature which have revealed how Ricardo's insight can be formalised in the case where there are more than two industries (Dornbusch et. al. 1977) and in the case of many countries (Eaton and Kortum 2002). Eaton and Kortum (2002) developed and quantified a Ricardian trade model based on differences in technology and the role of geography in 19 OECD countries. Their model explained that comparative advantage, created by differences in technology, can lead to potential gains from trade. Golub and Hsieh (2000) provided strong support for the Ricardian model. They extended classical tests of the Ricardian model by using a larger group of OECD countries to examine trade flows, productivity and unit labor costs for 40 manufacturing sectors. Costinot and Donaldson (2012) and Kerr (2017) showed that countries have higher relative exports in the sectors where they have higher relative productivity. The recent developments in the literature leads towards dynamic of export advantage, whether advantage ascends from home market effects (Krugman 1980), the accumulation of ideas (Eaton and Kortum 1999), or the quality of institutions (Levchenko 2007; Costinot 2009; Cuñat and Melitz 2012). Kowalski (2011) presented a quantitative assessment of relative significance of various sources of comparative advantage for 55 OECD and selected emerging market (SEM) economies covering 44 manufacturing sectors. The results explained the significance of comparative advantage which has also changed overtime because of changing policies and institutions. Costinot and Donaldson (2012) developed a structural Ricardian model and estimated the impact of productivity differences on the pattern of trade. Using trade and productivity data for 21 countries and 13 industries from 1997, they find a positive impact and concluded that an increase in observed productivity levels leads to increased exports. Our results supported the comparative advantage growth relationship in developing countries.

As for the relationship between trade and growth, Grossman and

[6] See for example Kojima 1970; Bowen, 1983; and Yeats 1985.

Helpman (1990) constructed a dynamic, two-country model of trade and growth. They derived a dynamic equilibrium model of the world economy and calculated two reduced form equations to investigate the structural determinants of long-run growth. According to their results, if a country has a comparative advantage in R&D, then their growth rate will be higher. Redding (1999) investigated the dynamic effects of trade and comparative advantage by considering the case of two economies where each country produces two goods using low and high-tech goods. He showed that in a model with endogenous technological change, specialization, according to existing comparative advantage of a country, cannot be welfare maximizing. Furthermore, when a country induces specialization (through subsidies or tariffs) in a sector where there is currently no comparative advantage, it may increase welfare. He emphasized the importance of dynamic comparative advantage for a country's betterment instead of static comparative advantage.

As for causal relationships, Deaton (1995) suggested that causation is important not only to understand the causal process or direction but also in designing policy. Bahmani-Oskooee and Alse (1993) pointed out some short-comings in previous studies done on causal relationship between exports and economic growth and re-examined the relationship and found fairly robust evidence for the ELG hypothesis in less-developed countries (LDCs). The results showed a long-run positive relationship among exports and output in LDCs. They also mentioned that any export promotion strategy could contribute to economic growth in LDCs. Kemal et. al. (2002) found evidence for long-run unidirectional causal relationship among a country's exports and their GDP for Pakistan and India and bidirectional causality for Bangladesh, Nepal, and Sri Lanka. Shirazi and Manap (2005) similarly looked at the causal relationships among exports, imports, and real output. They applied cointegration and multivariate Granger causality tests for five South Asian countries for different time periods and found a long-run relationship between exports, imports, and real output for Bangladesh (1973-2002), Nepal (1975-2003), Pakistan (1960-2003), and India (1960-2002).

Tsen (2010) investigated the causal relationship between exports, domestic demand, such as household consumption, government consumption and investment and economic growth in China. He applied Granger causality test using time-series data over the period 1978-2002. The results show bidirectional causality between exports, domestic demand and economic growth. Dodaro (1993) employed time-series analysis to test for the relationship between export growth and GDP growth. The causality tests provide very weak support for the argument that export growth promotes GDP growth and that GDP growth promotes export growth.

Ahmed et. al. (2000) examined the causality between export revenue and economic growth and introduced external debt servicing as a third economic variable by applying a tri-variate causality framework. Their results found no evidence or support for the ELG hypothesis for South Asian and South East Asian countries except for Bangladesh. Hye et. al. (2013) also examined the trade-growth relationship for six Asian developing countries using an autoregressive distributed lag (ARDL) approach. They found support for the export-led growth theory for all countries except Pakistan. Moreover, they found that growth-led export is relevant for all countries examined except Nepal and Bangladesh. While the causal relationship among exports and growth has been subject of many investigations, the issue of causation among comparative advantage, exports and growth has not been addressed. In this paper, we characterize how existing comparative advantage is essential for economic growth in developing countries in Asia. From the Westerlund panel cointegration and ARDL technique we built a strong argument how comparative advantage affect economic growth for 8 developing countries from 1980-2012.

2.3 Data and Descriptive Analysis

The empirical analysis performed is based on panel data. The variables that are analysed are a country's revealed comparative advantage, export value, and economic growth and the data comes from the WTO, FRED (Federal Reserve Bank of St. Louis), and World Bank databases. The human capital index (HCI), gross capital formation (GCF) and labor force participation rate (LFPR) are added as control variables in the GDP equation. HCI data is taken from FRED whereas; GCF and LFPR are obtained from the WTO database. The sample consists of 8 developing countries covering the period 1981-

2012.[7] The sample, although relatively small, consists of half of the world's population. The sectors are chosen on the availability of the WTO statistics and are: agriculture, manufacturing, service, fuel and mining, and clothing and textiles. The sectors make up a considerable share of exports of the countries in our sample. Henceforward, log values of real GDP and exports are denoted by LnGDP and LnX, respectively.

In this paper, all the time-series data are yearly observations of total exports of each country for a specific sector, total world exports and real GDP. GDP and exports are both measured in current US dollar. Table 2.1 provides the summary statistics for our panel data.

Table 2.1: Descriptive Statistics for Observed Variables

	Mean	**Minimum**	**Maximum**
GDP (millions)	4457.00	2482.00	6547.00
Exports (millions)	23.770	20.40	28.34
Balassa Index	0.960	0.03	1.67
GCF	28.26	14.12	47.86
HCI	2.060	1.26	3.63
LFPR	56.20	34.56	79.04

Note: Data from WTO, World Bank, and FRED Database. GDP and Exports are in million dollars. GCF is calculated as percent of GDP and LFPR is as percent of total population. HCI is the Index of human capital per person.

Before advancing further, we will first define our principle measure of revealed comparative advantage, the Balassa Index.

2.4 Balassa Index

In 1965, Bela Balassa developed the Balassa index to measure a country's comparative advantage in a sector as revealed by its export share. Since 1965, the Balassa index has been applied in several reports (e.g. World Bank 1994; OECD 2011) and other publications (e.g., Aquino 1981; Crafts and Thomas 1986; Van Hulst et. al. 1991; De Benedictis et. al. 2008; Amighini et. al. 2011), to gauge international trade specialization, to measure

[7] The countries in the sample are: Bangladesh, China, India, Iran, Korea, Pakistan, Sri Lanka, and Turkey.

technological specialization (e.g., D'Agostino et. al. 2013; Liegsalz and Wagner 2013), and to examine production specialization (e.g., Iapadre 2001; Laursen and Salter 2005). Moreover, there are some papers that have examined the properties of this measure in detail (e.g., Yeats 1985, Hinloopen and Marrewijk 2008). Although there exist many alternative measures of comparative advantage, we will use the Balassa revealed comparative advantage (BRCA) index. Country j's revealed comparative advantage in sector i is given by the following formula:

$$BRCA_{ij} = \frac{X_{ij}/X_j}{X_{iw}/X_w} \qquad (1)$$

where X_{ij} is the exports of sector i by country j, X_j is the total exports of country j, X_{iw} is the total world exports of sector i, and X_w is total world exports across all sectors.

Equation (1) compares the market share of country j in the export of commodity i with the country's total market share in all exports. If $BRCA_{ij}$ is greater than 1 it implies country j has a comparative advantage in commodity i. If $BRCA_{ij}$ is less than 1 it indicates that country j has comparative disadvantage in export of commodity i. Finally, if $BRCA_{ij}$ is equal to 1, it means country j has neutral comparative advantage in commodity i. Porter (1990) more precisely defined the Balassa Index exceeding 2 to identify the sector in which a country has a strong comparative advantage.

To analyse comparative advantage in our empirical specification, the Balassa Index will be calculated for the five different sectors in our 8 countries. The time-series (stationarity) properties of the variables considered are checked before testing for the presence of a causal relationship among the relevant variables. We use a panel unit root test to check the stationarity of the different variables.

In co-integration and causality analyses, the objective is to determine the nature of long-run relationship between a set of various time series variables and to analyse the patterns of effect of one variable on another. The co-integration analysis also determines the stability of relationships and sources of that stability (Gujarati 2009). Before starting the co-integration and causality tests, it is essential to check each time series for stationary because if a time-series is non-stationary then the regression analysis done in a conventional way will produce spurious results (Shrestha and Chowdhury 2005). First, panel unit root tests are conducted to examine the property of the time series. A variable is stationary if it is time independent, i.e., a time series is said to be stationary if its mean and variance do not swing thoroughly with the passage of time. This means that the mean and variance are time invariant and the value of the covariance between two time periods depends only on the distance, gap, or lag between the two time periods and not the actual time at which the covariance is computed.

2.5 Econometric Analysis

2.5.1 Panel Unit Root Test Methods

To draw inference from the time series analysis, stationary tests are necessary. A stationary test that is widely used is the panel unit root test which determines the order of integration of the three variables of interest. The panel- based unit root test methods have been developed and applied by Levin, Lin and Chu (2002), Breitung (2000), Im, Pesaran and Shin (2003), Maddala and Wu (1999) and Choi (2001), and Hadri (1999). They have shown that panel unit root tests are more powerful compared to individual unit root tests because information in the time series data is improved by that contained in the cross-section data.[8] Moreover, panel unit root test methods lead to statistics with a normal distribution in the limit whereas individual unit root tests have complicated limiting distributions (Baltagi 2008).

All of the abovementioned tests assume that there is a common unit root across the cross-section except the test of Im, Pesaren and Shin (2003).[9] All the tests will be applied to all our variables to get results because the degree of integration of each variable is dependent on which unit root test one can use as different tests will give different results.[10] Moreover, we test for unit

[8] This means it is less likely to commit a Type II error.
[9] They assume individual unit root process.
[10] See Appendix A for details on the unit root tests.

root which is performed using the panel unit root test of Im, Pesaran and Shin (2003). This test is appropriate for balanced panels. In our model, a null hypothesis of non-stationarity is checked using a panel unit root test statistics for the following specification:

$$\Delta y_{it} = \alpha_i + \tau_i t + \rho_i y_{it-1} + \sum_{j=1}^{h_i} \beta_{ij} \Delta y_{it-j} + \varepsilon_{it} \qquad (2)$$

where i =1,2,...,N and t =1,2,...,T , for y = BI, X, GDP, HCI, GCF, and LFPR, i is the cross-sectional unit and t denotes time, ρ_i is the autoregressive root and h_i is the number of lags. The null hypothesis is that each series in the panel has non-stationary processes, so H_0: $\rho_i = 0, \forall_i$ which allows for a heterogeneous coefficient of y_{it} , and the alternative hypothesis is that some (however not all) of the individual series in the panel are stationary, i.e. H_1: $\rho_i < 0$ for at least one i . This test is built on the Augmented Dickey-Fuller (ADF) testing approach.

2.5.2 Panel Co-Integration and Error-Correction Approach

Over the last decade, considerable attention has been paid in econometrics to test the existence of relationships in levels between variables. There are several methods available for conducting these co-integration tests. Though an OLS estimator is consistent under panel co-integration, it has a second order asymptotic bias and its standard errors are not valid (Lee and Chang 2007). In order to investigate the co-integration relationships in panel data, various methods are available like the residual-based panel fully modified OLS (FMOLS) estimation technique developed by Phillips and Moon (1999) which gives asymptotically unbiased, normally distributed coefficient estimates. Kao, Chiang and Chen (1999) used this co-integration technique and estimate the co-integration relationship between total factor productivity, domestic and foreign R&D capital stock. This model was further developed by Pedroni (1999) who used four panel statistics and three group statistics to check the null hypothesis of no co-integration against a co-integration hypothesis. When we apply the Pedroni four panel statistics methods, we get mixed results and it seems that we fail to reject the null of no cointegration where cointegration is strongly suggested. Consequently, all the above-mentioned tests do not accommodate cross-section dependence. As a response to this problem, we apply the newly developed panel cointegration technique developed by Westerlund (2007). This method is based on four new panel cointegration tests "that are based on structural rather than residual dynamics" (Persyn and Westerlund 2008). According to their technique, these tests are normally distributed and try to accommodate unit-specific short-run dynamics, unit specific trend and slope parameters, and cross-sectional dependence.

$$\Delta GDP_{\mathrm{i,t}} = \alpha_i^G + \lambda_i^G\big(GDP_{i,t-1} - \beta_i^G BI_{i,t-1} - \gamma_i^G X_{i,t-1} - \delta_i^G GCF_{i,t-1} - \varrho_i^G LFPR_{i,t-1} - \emptyset_i^G HCI_{i,t-1}\big) + \sum_{j=1}^{m} \theta_{i,j}^G\, \Delta GDP_{i,t-j} + \sum_{j=1}^{n} \forall_{i,j}^G\, \Delta BI_{i,t-j} + \sum_{j=1}^{o} \varphi_{i,j}^G\, \Delta X_{i,t-j} + \sum_{j=1}^{p} \tau_{i,j}^G\, \Delta GCF_{i,t-j} + \sum_{j=1}^{q} \rho_{i,j}^G\, \Delta LFPR_{i,t-j} + \sum_{j=1}^{k} \vartheta_{i,j}^G\, \Delta HCI_{i,t-j} + \varepsilon_{i,t} \quad (3)$$

where the parameters λ_i^G are the error correction parameters which are also known as the speed of adjustment parameters, providing the long-run equilibrium information for country *i*, whereas, the $\varepsilon_{i,t}$ is the white noise error terms.

The Westerlund panel cointegration technique is classified into two different tests to investigate the null hypothesis of no cointegration: group mean test statistics and panel test statistics. Westerlund (2007) developed four panel cointegration techniques ($\mathrm{G_a}, \mathrm{G_t}, \mathrm{P_a}, \text{and } \mathrm{P_t}$) which are based on the Error Correction Model (ECM). The group-mean tests are based on weighted sums of the λ_i^k estimated for individual countries, whereas the panel tests are based on an estimate of λ^k for the panel as a whole. These four test statistics are normally distributed. The two tests (Gt , Pt are computed with the standard errors of λ_i^k estimated in a standard way, while the other statistics (Ga , Pa) are based on Newey and West (1994) standard errors, adjusted for heteroscedasticity and autocorrelations. By applying an error-correction model in which all variables are assumed to be I(1), the tests proposed by Westerlund (2007) examine whether cointegration is present or not by determining whether error-correction is present for individual panel members and for the panel as a whole.

After applying the four newly developed tests for panel cointegration, we will further apply an ARDL technique. Pesaran et. al. (1999) developed this technique to test for the existence of a long-run relationship between different variables irrespective of whether they are stationary or stochastic. This is known as an auto-regressive distributed lag (ARDL) approach to co-integration which gained popularity recently. This approach has various advantages. The main advantage lies in the fact that ARDL can be applied regardless of whether the variables are I(1), I(0) or fractionally integrated, i.e. whether the results are all unit root or all stationary or, indeed, even if mixed results are obtained (Shah et. al. 2012). It still allows for inferences on long-run estimates which are not possible under alternative co-integration procedures.

Similarly, this approach is good because it provides robust results with small sample size and estimates of the long-run coefficients are very consistent in small sample size (Pesaran et. al. 1999). Similarly, the endogeneity problem and inability to test hypothesis on the estimated long-run coefficients (as evidenced in some other approaches) are also resolved. Furthermore, a dynamic error correction term (ECT) can be derived from the ARDL through a simple linear transformation (Banerjee et. al. 1998) that integrates the short-run dynamics with the long-run equilibrium without losing long-run information. Thus, the long-run and short-run parameters of the model can be estimated simultaneously.

Finally, with the ARDL, it is also possible for variables to have differing optimal number of lags which is not possible in other co-integration approaches. Along with all these advantages, there is one important restriction for the application of ARDL. According to Pesaran et. al. (2001), the dependent variable must be integrated of order one but the regressors can be I(0) or I(1). Hence, implementation of the unit root test may still be necessary to confirm whether the variables are of mixed order i.e. I(0) or I(1), and none of the variables are of I(2). In this paper panel unit root tests show that the variables included in the study are a mix of I(0) and I(1) series. Therefore, the use of ARDL methodology is justified for the long-run estimation.

2.5.3 ARDL Representation:

The econometric specification of an ARDL for GDP is formulated on the log-linear model represented by the following equation:

$$\mathrm{lnGDP}_{\mathrm{it}} = \alpha_{\mathrm{i}} + \sum_{\mathrm{k=1}}^{\mathrm{p}} \delta_{\mathrm{1i,j}}\,\mathrm{lnGDP}_{\mathrm{i,t-j}} + \sum_{\mathrm{k=0}}^{\mathrm{q}} \delta_{\mathrm{2ij}}\,\mathrm{lnX}_{\mathrm{i,t-j}} + \sum_{\mathrm{k=0}}^{\mathrm{q}} \delta_{\mathrm{3i,j}}\,\mathrm{CA}_{\mathrm{it-j}} + \sum_{\mathrm{k=0}}^{\mathrm{q}} \delta_{\mathrm{4i,j}}\,\mathrm{GCF}_{\mathrm{i,t-j}} + \sum_{\mathrm{k=0}}^{\mathrm{q}} \delta_{\mathrm{5i,j}}\,\mathrm{HCI}_{\mathrm{i,t-j}} + \sum_{\mathrm{k=0}}^{\mathrm{q}} \delta_{\mathrm{6i,j}}\,\mathrm{lnLFPR}_{\mathrm{i,t-j}} + \mu_{\mathrm{it}} \qquad (4)$$

where X_{it} is exports in country i, CA_{it} is comparative advantage, GCF_{it} is the gross capital formation, HCI_{it} is the human capital index and $LFPR_{it}$ is the labor force participation rate. k is the maximum lag order and t represents the time period.

Once co-integration is established, lag length is selected for each variable. One of the more important issues in applying the ARDL is the choice of the order of the distributed lag function to analyze the long-run. We have two criteria, the Akaike Information Criteria (AIC) and Schwarz Bayesian Criterion (SBC), which are minimized to determine the appropriate lag length. Pesaran et. al. (1999) recommended the SBC. Similarly, SBC is also useful for the small sample data (Pahlavani et. al. 2005). Once co-integration is confirmed, we move to the next stage and estimate the long-run coefficients of our function and then obtain their asymptotic standard errors.

2.5.4 A General Error Correction Representation

Lastly, the associated ARDL error correction model is obtained:

$$\Delta lnGDP_{it} = \alpha_i + \sum_{k=1}^{p} \beta_{1ij}\,\Delta lnGDP_{i,t-j} + \sum_{k=0}^{q} \beta_{2ij}\,\Delta lnX_{i,t-j} + \sum_{k=0}^{q} \beta_{3ij}\,\Delta CA_{i,t-j} + \sum_{k=0}^{q} \beta_{4ij}\,\Delta GCF_{i,t-j} + \sum_{k=0}^{q} \beta_{5ij}\,\Delta HCI_{i,t-j} + \sum_{k=0}^{q} \beta_{6ij}\,\Delta LlnFPR_{i,t-j} + \varphi_{ij} ECT_{t-i} + \mu_{it} \qquad (5)$$

where ECT_{t-i} is the error correction term and φ is the parameter indicating the speed of adjustment to the equilibrium level after a shock. It shows how quickly variables return to equilibrium and it should have a statistically significant coefficient which must be less than one with negative sign. If it holds, then there is stability in the long-run equilibrium for each dependent variable. Similarly, it is said that a highly significant error correction term is further proof of the existence of a stable long-run relationship (Banerjee et. al. 1998).

2.6 Panel Identification Approach and Empirical Test Results

To consider whether the cross-section dependence assumption is met or not, a cross-section dependence (CD) test is applied. Table 2.2 illustrates the findings for the CD test proposed by Eberhardt (2012). Under the CD analysis with the null hypothesis of cross-section independence in all panels, we find cross-section dependence in all independent variables.

Table 2.2: Cross-Section Dependence Test Results

Variable	CD Test	P-value
Exports	62.58	0.000
CompAdv	54.71	0.000
GCF	51.34	0.000
HCI	64.31	0.000
LFPR	53.94	0.000

Note: Null hypothesis states that the series are cross-section independent. CD~ N (0, 1)

As discussed previously, comparative advantage may have strong effects on a country's export growth and its overall economic growth. In order to analyze these effects, panel cointegration and an ARDL test is conducted on equations 3 and 4. To analyze the comparative advantage in each country, the Balassa Index is calculated for various sectors. Table 2.3 lists the sectors in which countries had the strongest comparative advantage (where the BI has the highest value).

2.6.1 Comparative Advantage and Balassa Index

The Balassa index investigates the comparative advantage and trade specialization in different sectors of an economy revealed through a country's market share in a sector relative to their overall market share in world exports. It is necessary to mention here that most of the countries below have a comparative advantage in almost all 5 sectors (agriculture, manufacturing, service, fuel and mining, and clothing and textile) but only those sectors are mentioned where the value of Balassa Index is above 1 which identifies country's strong sector (Porter 1990) and where the BI is non-stationary at level and stationary at first difference.

Table 2.3: Results of Balassa Index

Countries	**Strongest Sector**	**BI Value**
Bangladesh	Clothing and Textile	7.87
China	Manufactures	9.73
India	Service	2.90
Iran	Fuel and mining	5.37
Korea	Manufactures	1.91
Pakistan	Clothing and Textile	7.76
Turkey	Service	1.84
Sri Lanka	Clothing and Textile	3.05

Note: See Appendix B, Table 2.9 for the results of comparative advantage for other four sectors of each developing country mentioned in this table. BI is the average value of whole time period.

2.6.2 Panel Unit Root Test Results

In the case of non-stationary data series, the direct application of OLS gives regression results that are spurious in nature. Such regressions give statistical results which are inflated in nature, such as very high values of R^2 and t-statistics and may lead to Type 1 errors (Granger and Newbold 1974). It is noteworthy that econometricians have declared the panel unit root tests more powerful than individual series. In this case, the chances of Type II errors are also less because the information in the time series is enhanced by that contained in the cross-section data. The degree of integration of each variable in this analysis is determined by using four panel unit root tests. In a series, the existence of unit root indicates that a series is non-stationary. In this case, a null hypothesis of non-stationarity for the Balassa Index variable, exports and economic growth is investigated against the alternate of stationarity. The results of the panel unit root (at level) test are reported in Table 2.4.

Table 2.4: Panel Unit Root Test Results (at level)

	Levin, Lin and Chu		**Im, Pesaran and Shin**		**ADF-Fisher Chi-Square**		**PP-Fisher Chi-Square**	
Variable	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
GDP	4.27	1.00	6.98	1.00	1.60	1.00	2.09	1.00
Exports	1.99	0.98	5.23	1.00	1.17	1.00	2.58	1.00
Balassa Index	-3.33	0.00	-2.53	0.01	36.77	0.00	45.60	0.00
GCF	1.68	0.95	0.99	0.84	14.40	0.56	16.11	0.44
LFPR	-1.57	0.05	-1.92	0.026	26.38	0.05	52.99	0.00
HCI	0.047	0.51	3.38	0.99	5.93	0.98	21.90	0.14

Note: Probabilities for Fisher tests are computed using an asymptotic Chi-Square distribution. All other tests assume asymptotic normality.

The values for the panel unit root test statistics are not significant for GDP and export variables, whereas for comparative advantage the values are highly significant for all tests. Therefore, in the level form, the null hypothesis of non-stationarity is not rejected except in the case of the comparative advantage variable which is stationary at level. Therefore, all other variables are random walk which are required to be first differenced.

Table 2.5: Panel Unit Root Test Results (at first difference)

	Levin, Lin and Chu		**Im, Pesaran and Shin**		**ADF-Fisher Chi-Square**		**PP-Fisher Chi-Square**	
Variable	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
GDP	-5.33	0.00	-6.86	0.00	77.28	0.00	120.56	0.00
Exports	-5.17	0.00	-9.38	0.00	109.31	0.00	171.03	0.00
Balassa Index	-9.16	0.00	-11.78	0.00	141.98	0.00	186.27	0.00
GCF	-6.54	0.00	-8.07	0.00	93.71	0.00	172.80	0.00
LFPR	-2.85	0.00	-7.00	0.00	79.86	0.00	134.98	0.00
HCI	-8.78	0.00	-7.01	0.00	78.43	0.00	161.16	0.00

Note: Probabilities for Fisher tests are computed using an asymptotic Chi-Square distribution All other tests assume asymptotic normality.

It is obvious from the panel unit root test results that some of the data sets are integrated of I(0) and I(1). The panel unit root test results indicate that GDP, Exports, GCF, LFPR, and HCI series are I(1) and the Balassa index series are I(0) in Table 2.5. Obviously, the cointegration relationship for the mixture of I(0) and I(1) variables would not be possible under the Johansen cointegration procedure. This provides a good rationale for using the ARDL model proposed by Pesaran et. al. (2001). Now that the order of integration has been checked, we can move on to the panel cointegration results.

2.6.3 Panel Co-integration Test Results

To investigate the long-run relationship among the variables, the error correction based panel co-integration tests are applied. The null hypothesis of no co-integration is tested against the alternative of co-integration. The results of the tests are reported in Table 2.6 (a, b, c) for a country's strong sector, agricultural sector, and the manufacturing sector, respectively. The tables show the results of the four panel cointegration tests.

Table 2.6(a): Westerlund ECM panel cointegration tests (Strongest Sector)

Statistics	**Value**	**Z-value**	**P-value**
Gt	-3.38	-4.13	0.00
Ga	-13.62	-2.03	0.02
Pt	-6.77	-1.87	0.03
Pa	-12.70	-3.46	0.00

Note: Results for H0: no cointegration, with 8 series and 2 covariates

The group mean statistics; Gt and Ga, test the null hypothesis of no cointegration among some of our selected countries. However, the panel statistics Pt and Pa test the null hypothesis of no cointegration among all of our selected countries. The results in Table 2.6(a) suggest that there is long-run cointegration between comparative advantage in a country's strongest sector, exports, and GDP for all eight Asian countries in our sample. Our results suggest cointegration in both cases for all individual countries and the panel as a whole.

The null hypothesis of no co-integration between comparative advantage in agriculture, exports, and economic growth is not rejected as shown in Table 2.6(b) and we find that there is no cointegration for comparative advantage in agriculture and growth. In Table 2.6(c) we redo the analysis for the manufacturing sector. The results show that there is long-run co-integration between comparative advantage in the manufacturing sector, exports, and growth in the case of pooled test statistics but not for group mean statistics. It further implies that there is evidence of cointegration for the panel as a whole only. This result also supports Kaldor's engine of growth hypothesis which claims that there exists a strong relation between the manufacturing sector and growth (Kaldor: 1966, 1967). The validity of this hypothesis has been strengthened by many empirical studies (e.g. Sejkora and Sankot 2017; Dong et. al. 2013; Ibbih & Gaiya 2013; Wells & Thirlwall 2003).

Table 2.6(b): Westerlund ECM panel cointegration tests (Agriculture)

Statistics	Value	Z-value	P-value
Gt	-2.39	-1.09	0.14
Ga	-4.11	2.26	0.99
Pt	-4.13	0.69	0.76
Pa	-4.03	0.93	0.82

Note: Results for H0: no cointegration, with 8 series and 2 covariates

Table 2.6(c): Westerlund ECM panel cointegration tests (Manufacturing)

Statistics	Value	Z-value	P-value
Gt	-2.11	-0.22	0.41
Ga	-12.13	-1.36	0.09
Pt	-5.64	-0.77	0.02
Pa	-9.77	-1.97	0.02

Note: Results for H0: no cointegration, with 8 series and 2 covariates

After adding control variables, i.e. human capital index, gross capital formation (which is a good proxy for investments) and labor force participation rate, in the panel cointegration analysis, we strongly reject the hypothesis that the series are not cointegrated. The results are shown in the Table 2.6(d).

Table 2.6(d): Westerlund ECM panel cointegration tests (Strongest Sector)
(Including control variables)

Statistics	Value	Z-value	P-value
Gt	-2.75	-2.87	0.00
Ga	-13.25	-2.46	0.00
Pt	-8.65	-3.75	0.00
Pa	-14.34	-4.51	0.00

Note: Results for H0: no cointegration, with 8 series and 5 covariates

Our results suggest that developing countries should follow their comparative advantage to enhance their economic growth. These results are consistent with the studies of Justin Lin (2012) and Gallardo (2005). Countries following their comparative advantage benefit by production specialization which allows a country to lessen its average capital-output ratio to further enhance the possibility of higher output growth (Gallardo 2005).

2.6.4 ARDL Model Results

In light of the above discussion, in order to analyse the effects of comparative advantage and exports on economic growth, an ARDL test is conducted on the following equation:

$$lnGDP_{it} = \alpha_i + \sum_{k=1}^{p} \delta_{1i,j}\, lnGDP_{i,t-j} + \sum_{k=0}^{q} \delta_{2ij}\, lnX_{i,t-j} + \sum_{k=0}^{q} \delta_{3i,j}\, CA_{it-j} + \sum_{k=0}^{q} \delta_{4i,j}\, GCF_{i,t-j} + \sum_{k=0}^{q} \delta_{5i,j}\, HCI_{i,t-j} + \sum_{k=0}^{q} \delta_{6i,j}\, lnLFPR_{i,t-j} + \mu_{it} \qquad (6)$$

The optimum lag length of the variables included in the ARDL was chosen based on the minimum information results obtained by the Schwartz Bayesian Criterion (SBC). The SBC gives a more parsimonious number of criteria than the Akaike Information criteria (AIC) (Khan and Qayyum 2007). It is also suitable for small data sample (Pahlavani et. al. 2005) as it is the case in the current study with 264 observations. The ARDL results are reported in Table 2.7 and Table 2.8.

Table 2.7(a): ARDL Model for Comparative Advantage (Strong Sector only)

Dependent Variable: Δ*Ln GDP*			
Regressors	**Coefficient**	**Standard Error**	**T-statistics (P-value)**
Ln Exports	0.757	0.026	29.393 (0.000) ***
Balassa Index	0.012	0.005	2.329 (0.021) ***

Note: ** and *** indicate significant at 5% and 1% level of significance. Probability values of t-stats are given in parenthesis. Lag is chosen using minimum SBC which is 1 in the above model.

Table 2.7(b): ARDL Model for Comparative Advantage (with control variables)

Dependent Variable: Δ*Ln GDP*			
Regressors	**Coefficient**	**Standard Error**	**T-statistics (P-value)**
Ln Exports	0.049	0.026	29.39 (0.000) ***
Balassa Index	0.066	0.005	2.329 (0.021) ***
Ln GCF	0.042	0.001	29.36 (0.000) ***
HCI	0.118	0.051	2.283 (0.026) ***
Ln LFPR	-1.656	0.052	-31.32 (0.000) ***

Note: ** and *** indicate significant at 5% and 1% level of significance. Probability values of t-stats are given in parenthesis. Lag is chosen using minimum SBC which is 1 in the above model.

We discuss only the results of our main variables, which is our preferred specification. The expected effects of comparative advantage and exports on economic growth are positive as already shown in the panel cointegration results. Table 2.7(a) shows statistically significant long-run relationships which means that a country´s strong sector, in terms of their comparative advantage, leads to long term sustainable economic growth. If the export of selected developing countries increases by 1 percent, the GDP growth increases by 0.75 percent. As expected, the coefficients of exports and of the Balassa index are positive and statistically significant. Our results are similar when we include control variables in our main ARDL model. However, the effect of comparative advantage is stronger as compared to exports on GDP growth in the Table 2.7(b). Therefore, we can conclude that growth in comparative advantage can strongly effect economic growth in Asian developing countries.

Another interesting exercise is to assess whether this relationship exist in the short-run or not. Table 2.8(a) and 2.8(b) reports the results for the short-run error-correction representation of our ARDL model.

Table 2.8(a): Short-run Error Correction Representation of ARDL Model

Dependent Variable: Δ*Ln GDP*			
Regressors	**Coefficient**	**Standard Error**	**T-statistics (P-value)**
ΔLn Exports	0.259	0.091	2.848 (0.004) ***
ΔBI	0.218	0.200	1.088 (0.277)
ECT(t-1)	-0.255	0.138	-1.855 (0.065) **

Note: ** and *** indicate significant at 5% and 1% level of significance. Probability values of t-stats are given in parenthesis. Lag is chosen using minimum SBC which is 1 in the above model.

Table 2.8(b): Short-run Error Correction Representation of ARDL Model
(with control variables)

Dependent Variable: Δ*Ln GDP*			
Regressors	**Coefficient**	**Standard Error**	**T-statistics (P-value)**
ΔLn Exports	0.381	0.204	1.859 (0.067) **
ΔBI	0.209	0.111	1.876 (0.065) **
ΔGCF	-0.006	0.015	-0.408 (0.684)
ΔHCI	21.425	14.685	1.459 (0.149)
ΔLn LFPR	-0.150	0.664	-0.226 (0.821)
ECT(t-1)	-0.463	0.317	-1.461 (0.149)

Note: ** and *** indicate significant at 5% and 1% level of significance. Probability values of t-stats are given in parenthesis. Lag is chosen using minimum SBC which is 3 in the above model.

Along with the regressors, the trend shows positive but statistically insignificant effects of comparative advantage on GDP growth in Table 2.8(a) which may occur due to any temporary shock in the economy. The short-run results for exports are positive and statistically significant. The estimated residuals of the long-run relationship between comparative advantage, exports, and growth are used to obtain the error correction term (ECT) and this term is used as a lagged value. The error correction term indicates the speed of adjustment which restores equilibrium in the dynamic model within one year and it is calculated from the long-run co-integrating vector. The error correction term is -0.255 and significant which shows that 0.2 percent of the deviations (from the long-run equilibrium) in the short-run are corrected annually. Furthermore, the results in the Table 2.8(b) show positive and statistically significant effect of comparative advantage and exports on economic growth in the short-run as well. Hence, the overall results support the argument that comparative advantage and exports play an important role for economic growth in the countries in our sample.

2.7 Conclusions

This essay has examined how a country's existing comparative advantage can affect their economic growth. We have shown this through the use of the Balassa Index to measure comparative advantage for a variety of sectors, employing a panel cointegration technique, and the use of an ARDL model. The principle result was that greater comparative advantage in a country's strong sector can lead to greater economic growth in the selected Asian countries. To test the argument, which is taken from the debate of Lin and Chang (2009), we took data for 8 Asian developing economies from 1980-2012. The results support the arguments made by Justin Lin that industrial upgrading and strategies for industrialization should follow a country's current comparative advantage (Lin and Chang 2009).

It has been shown that comparative advantage has a great impact on economic growth of any country. As a country develops, it expands the size of its market and its comparative advantage improves (see Lin and Chang 2009). Growth can lead to effective utilization of a country's existing comparative advantages since developing countries rely on labor and resource-intensive type of production activities and services which make these economies more competitive in international markets.

In order to identify the long-run interactions among the three variables, a panel co-integration test was applied. The panel co-integration results are interesting because they support the export-led growth hypothesis. According to our results, these Asian countries should follow their existing comparative advantage in order to enhance their long-term economic growth. These results are also aligned with those found in Gallardo (2005) where he argued that developing countries can benefit by specializing in production and trade according to their comparative advantage.

The results highlight the significance of labor-intensive exports as an engine of growth for our sample countries. Since the role of agricultural exports to economic growth do not remain important yet, however, export promotion policies should be made for the sectors in which they have a strong comparative advantage. The results support the recommendation that these countries should focus on their existing comparative advantage and pay more attention to enhance their exports and become more competitive in international markets in those sectors.

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Appendix A - Methods of Panel Unit Root Tests

Levin, Lin and Chu (2002)
Null: Panel data has unit root (assume common unit root process)
Alt: Panel data has not unit root (Stationary)

Breitung (2000)
Null: Panel data has unit root (assume common unit root process)
Alt: Panel data has not unit root (Stationary)

Im, Pesaran and Shin (2001)
Null: Panel data has unit root (assume individual unit root process) (Non-Stationary)
Alt: Panel data has not unit root (Stationary)

Fisher Type Test using ADF and PP Tests ((Maddala and Wu (1999) and Choi (2001))
Null: Panel data has unit root (assume individual unit root process) (Non-Stationary)
Alt: Panel data has not unit root (Stationary)

Hadri (1999)
Null: Panel data has not unit root (assume common unit root process) (stationary)
Alt: Panel data has unit root (Non-Stationary)

Appendix B - Balassa Index Results

In the below table, the results for Balassa index are reported for the five sectors considered in this research.

Table 2.9: Comparative Advantage Results

Countries	Agri.	Manuf.	Clothing & Textiles	Fuel & Mining	Services
Bangladesh	X	X	X		
China	X	X	X		
India	X	X	X		X
Iran				X	X
Korea	X	X	X		
Pakistan	X	X	X		
Turkey	X	X	X		X
Sri Lanka	X		X		X

Note: X denotes if a country has comparative advantage in that sector (Balassa Index greater than unity)

The results reveal the fact that comparative advantage for most of the above mentioned developing countries is observed to be predominantly in the labor and resource intensive manufactures. Sectors like agriculture, manufacturing, clothing and textiles dominate for most of the developing countries.

Chapter 3 - Export Specialization and Convergence Patterns for the EU, U.S., and China[11]

3.1 Introduction

One of the most striking aspects of the growth of international trade over the last 30 years has been China's rapid export growth in a variety of sectors. China's export value has increased by over 500% over the last two decades, consequently leading China to become the world's leading export country in 2013. Table 3.1 below shows the increase in China's share of world trade and the decline in the U.S. and the EU, respectively. This paper seeks to show if and how the rapid change in globalization has led to a change in the structure of comparative advantage and the degree of specialization for these countries/region over the last 20 years. Firstly, using two different indices of revealed comparative advantage, the symmetric index and normalized index, we examine the degree of stability in export specialization patterns at the country level for the selected group of countries. Secondly, we examine the degree to which export specialization has converged or diverged within sectors across our selected group of countries.

Table 3.1: Share of World Trade in Goods and Services (2005-2013)

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013
China	8.1	8.7	9.3	9.4	10.2	11.1	11.4	11.9	12.6
US	16.9	16.4	15.5	14.4	14.6	14.1	13.5	13.6	13.5
EU	19.0	18.7	19.0	18.7	18.7	17.3	17.1	16.3	16.4

Note: Sourced from Eurostat and the World Trade Organization

[11] This paper was previously circulated as "Convergence or divergence from comparative advantage: a comparison of China and the European Union" and has benefited greatly from helpful comments from presentations at the Universitat de Barcelona and the 17th European Trade Study Group Conference in Helsinki. All errors are our own.

Our analysis of specialization and convergence patterns across sectors and countries are analyzed in a similar vain to Amendola et. al. (1992), Archibugi and Pianta (1992 and 1994), and Dalum et. al. (1998). The contribution of our paper is the use of both the symmetric index (which is used in all of the papers above) as well as the newer normalized index (Yu et. al. 2009) to measure the degree of comparative advantage revealed by a country's exports. Another contribution is that we include China in our sample with other OECD countries which the other studies have largely ignored. As previously mentioned, China's ever increasing, and dominating, role in world trade makes it crucial to analyzing global changes to trade specialization and convergence patterns.

The methodology employed in the paper, namely Galtonian regressions, follows similar use by Cantwell (1989 and 1992) in order to examine technological specialization by comparing pairs of cross-sectional data. Dalum et. al. (1998) uses this methodology in order to examine specialization in export patterns. Following their definitions, we define specialization (or de-specialization) as the process of export specialization patterns becoming more dispersed within a country. Similarly, convergence (or divergence) is defined as the process of export specialization patterns become more similar across countries within a particular sector. The Galtonian regressions also allow us to see whether de-specialization within a country, or convergence within a sector, is due to a "regression effect" or "mobility effect". The former effect is determined by the resulting β coefficient of the regression while the latter effect examines the change in variance of the cross-sections.

Neoclassical trade theory predicts that as trade costs are lowered, countries should become more specialized in their exports and there should be divergence of comparative advantage within a sector across countries. Meanwhile, new trade theory, with their assumptions of imperfect competition which can lead to intra-industry trade, predicts that as countries trade pattern should converge over time within a sector as cross-country income differences are reduced. These contrasting predictions for how trade patterns might evolve over time is one of the aims of this paper.

The remainder of this paper is structured as follows: Section 2 provides a brief background on revealed comparative advantage and explains how the various indices of revealed comparative advantage are calculated. Section 3 discusses the data sources and the methodology employed to analyze specialization and convergence patterns. Section 4 provides the main results of the paper while Section 5 concludes with some final remarks.

3.2 Revealed Comparative Advantage

The concept of comparative advantage is one of the oldest and most astute economic theory that illustrates how a country with no absolute advantage in producing in any sector can still benefit from trade by specializing in industries at which it is 'least bad' (Lin and Chang 2009). As simple as Ricardian models tend to be, they still enjoy greater empirical validation relative to the factors proportion models that followed it and are still widely used with models that blend it with newer trade theories of increasing returns to scale and firm heterogeneity.

Empirically, economists that followed Ricardo struggled to find ways to capture productivity differences across countries that form the basis of the theory of comparative advantage. Balassa (1965) addressed this problem by creating a measure of comparative advantage using ex-post export trade data in order to 'reveal' a country's comparative advantage in a given sector relative to a reference group of countries or global exports. The Balassa Index (BI) of revealed comparative advantage, as it became known, takes the following form:

$$BI_{ijt} = \frac{\frac{x_{ijt}}{\sum X_{it}}}{\frac{X_{wjt}}{\sum X_{wt}}} \, , \qquad (1)$$

where BI_{ijt} represents country i's revealed comparative advantage in sector j at time t. X_{ijt} and X_{wjt} represent country i's and global export of goods in sector j, respectively, while $\sum X_{it}$ and $\sum X_{wt}$ represent country i's aggregate exports and aggregate global exports, respectively. As can be seen on the right-hand side of (1), the Balassa index compares the export share of a sector for a country to that sector's share in global exports. If $BI_{ijt} > 1$ ($BI_{ijt} < 1$), we infer that country i has a comparative advantage (disadvantage) in sector j at time t.

Although the Balassa index has been widely used in empirical studies,[12] it suffers from a weak theoretical foundation and empirical distribution (the range for comparative disadvantage is between 0 and 1 while the range for comparative advantage runs from 1 to ∞). Due to its inconsistency and poor ordinal ranking property, numerous attempts have been made to overcome the deficiencies of the Balassa index. Since the early 1990s, the Lafay index (1992), the symmetric revealed comparative advantage index (1998), the weighted revealed comparative advantage index (1998), the additive revealed comparative advantage index (2006) and the normalized revealed comparative advantage index (2009) have all been created to address the Balassa's index shortcomings with each carrying their own benefits and drawbacks.

The Lafay Index (LI) is unique in that the index accounts for a country's imports and trade volume in a given sector and in aggregate and does not compare them with a reference country or global imports and exports. It is very much related to the Grubel-Lloyd index used to measure intra-industry trade and takes the following form:

$$LI_{ijt} = 100\left[\frac{X_{ijt}-M_{ijt}}{X_{ijt}+M_{ijt}} - \frac{\sum(X_{it}-M_{it})}{\sum(X_{it}+M_{it})}\right]\frac{X_{ijt}+M_{ijt}}{\sum(X_{it}+M_{it})} \qquad (2)$$

where X_{ijt} and M_{ijt} measure country i's imports and exports of sector j at time t and the summations $\sum(X_{it} - M_{it})$ and $\sum(X_{it} + M_{it})$ measure country i's trade balance and trade volume at time t, respectively. Positive (negative) values imply that a country has a comparative advantage (disadvantage) in sector j at time$t$.

The Symmetric Index (SI), Additive Index (AI), and Weighted Index (WI) are transformations of the original Balassa index to try to normalize the

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[12] Kojima (1970), Yamazawa (1970), Reza (1983), Yeats (1985), Peterson (1988), Crafts (1989), and Ferto and Soós (2008) are just a few examples of papers that employ the Balassa index in empirical work.

distribution. The Symmetric Index (SI), first suggested by Vollrath (1991), is an approximation of a log transformation and takes the following form:

$$SI_{ijt} = \frac{BI_{ijt}-1}{BI_{ijt}+1} \ . \tag{3}$$

The range of the SI is between ± 1 where positive (negative) values denote comparative advantage (disadvantage). Similarly, the Additive Index (AI), proposed by Hoen and Oosterhaven (2006), transforms the Balassa Index by examining the difference between a sector's share in the country's total exports and the sector's share in total global exports:

$$AI_{ijt} = \frac{X_{ijt}}{\sum X_{it}} - \frac{X_{wt}}{\sum X_{wt}} \ , \tag{4}$$

with the range and interpretation the same as the SI. The Weighted Index (WI), developed by Proudman and Redding (2000), normalizes a country's BI with the cross-sectional mean:

$$WI_{ijt} = \frac{BI_{ijt}}{\frac{1}{N}\sum BI_{ijt}} \ , \tag{5}$$

where the denominator is the mean Balassa index in country i across the N sectors at time t. Unlike the two previous transformations of the Balassa index, the weighted index does not address the problem of symmetry as its range goes from 0 to ∞ and the comparative advantage neutral point is not fixed and sensitive to the classification of sectors.

Recently, Yu et. al. (2009) developed a new index, the Normalized Index (NI) that examines a hypothetical world in which exports were comparative advantage neutral and then calculated by how much the actual data deviated from this hypothetical situation. The hypothetical world is one such that the Balassa index is equal to unity for all sectors and therefore it shares a similar foundation with the other indices. Mathematically, the normative index is calculated as:

$$NI_{ijt} = \frac{X_{ijt}}{\sum X_{wt}} - \frac{X_{wjt}\sum X_{it}}{(\sum X_{wt})^2} \ . \tag{6}$$

The NI initially ranges from $\pm.25$ but since the index normalizes a country's sectoral export and world exports in that sector by total world exports, the resulting value tends to be very small. Yu et. al. (2009) therefore suggests scaling the value of the NI by multiplying it by 10,000. Although there is no perfect index of revealed comparative advantage to use in empirical work, the statistical properties of the symmetric index (SI) and the normalized index (NI), namely having normal and symmetric distributions, make them preferred for our current study. Dalum et. al. (1998) employed the symmetric index for this very reason before the normalized index was created.

3.3 Data and Methodology

We employ two different sets of data for our analysis, one sourced from the World Trade Organization (WTO) and the second sourced from the United Nation's Comtrade database. The purpose of using two different samples comes from the way that the sources aggregate and define sectors. The WTO data, which includes annual data comprising nine disaggregated sectors for China, the U.S., and EU-15 from 2000-2015, employs a unique classification system for aggregated sectors and details are provided in Appendix A. The UN Comtrade data ranges from 1996-2014 and the sectors are aggregated using one digit SITC Rev. 3 codes. The slightly longer time frame allows for analysis of both the short-run (1996-2005 and 2005-2014) and long-run trends that are not possible with the WTO data. As Dalum et. al. (1998) point out, sectoral analysis tends to be very sensitive to the degree of aggregation which is why in both samples we used the highest level of aggregation possible.

Table 3.2 provides country-specific summary statistics for both revealed comparative advantage indices using the WTO data. One thing that is immediately apparent is the fact that the distribution of the symmetric index seems to have a similar range across countries but the normalized index has a much greater variance for larger economies.[13] This is due to the fact that the

[13] Similar results are obtained for the summary statistics using the UN Comtrade sample.

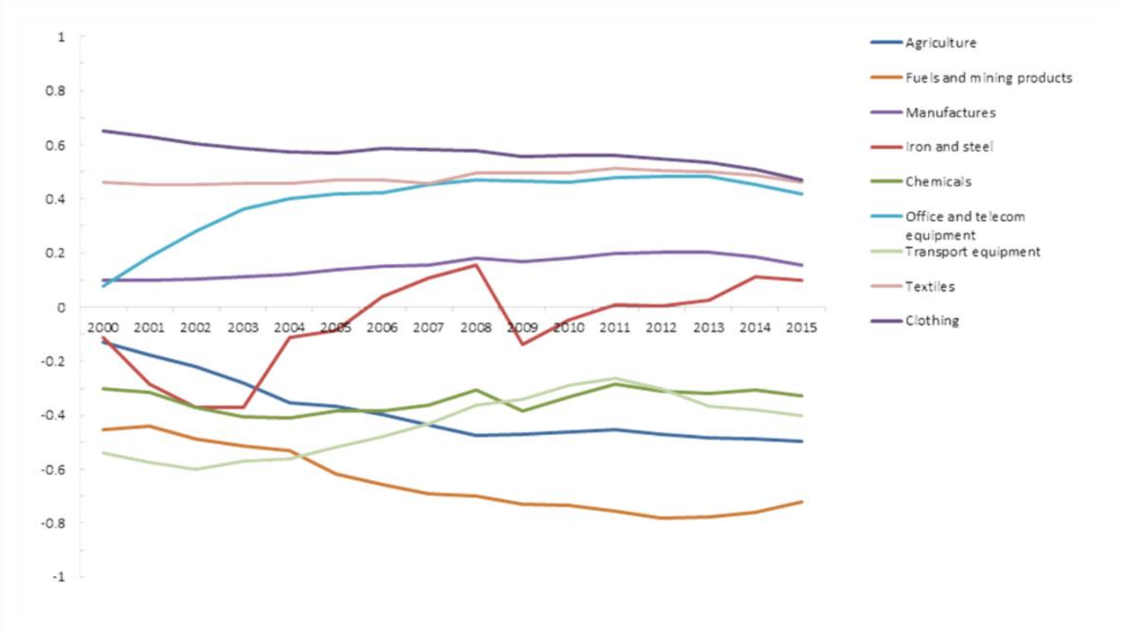
normalized index uses aggregate world exports to normalize every countries value, meaning that countries with larger exports in a given sector will have a larger value for the normalized index in that sector. While this should not affect the interpretation of whether a country is becoming more specialized (de-specialized) in the country-specific regressions, caution has to be used when using the normalized index in cross-country regressions to examine convergence (divergence).

Table 3.2: Country-Specific Descriptive Statistics (WTO Classification)

	Symmetric Index			**Normalized Index**		
Country	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
China	-0.87	0.65	-0.06	-170.48	346.87	15.84
United States	-0.74	0.26	-0.08	-117.69	144.84	12.00
Austria	-0.53	0.37	-0.07	-9.65	15.29	0.52
Denmark	-0.84	0.61	-0.17	-11.15	11.52	-1.33
Finland	-0.74	0.66	-0.25	-4.83	12.12	-0.09
France	-0.58	0.32	-0.06	-45.62	61.71	5.38
Germany	-0.56	0.39	-0.08	-81.50	139.38	16.12
Greece	-0.97	0.62	-0.22	-5.59	4.07	-0.62
Ireland	-0.94	0.79	-0.23	-14.85	34.93	2.17
Italy	-0.78	0.35	-0.14	-39.32	58.69	-2.33
Netherlands	-0.47	0.41	-0.04	-19.16	34.26	0.79
Portugal	-0.89	0.58	-0.12	-3.33	4.63	-0.21
Spain	-0.92	0.46	-0.11	-18.63	27.21	1.52
Sweden	-0.86	0.56	-0.08	-10.17	15.44	1.11
United Kingdom	-0.73	0.42	-0.07	-18.36	39.99	2.90

Using the two samples that differ in their classification, we then construct symmetric and normalized indices for each country and sector for the corresponding year. Figure 3.1, for example, shows how revealed comparative advantage, as measured by the symmetric index, has changed over time across sectors in China in the WTO sample.

Figure 3.1: Symmetric Index for China (WTO Data: 2000-2015)



In order to compare comparative advantage convergence and divergence patterns for the countries in our sample, we will conduct Galtonian regression as in Cantwell (1989) and Dalum et. al. (1998). The idea behind a Galtonian regression is to check the similarity or dissimilarity in the distribution of a sample at different points of time (a comparison of cross-sections in panel data). We similarly employ the following Galtonian regression in order to test whether a particular country i has experienced specialization or de-specialization in their comparative advantage across aggregated sectors using the following specification:

$$X_{ijt_2} = \alpha_i + \beta_i X_{ijt_1} + \varepsilon_{ij} \qquad (7)$$

where X_{ijt} denotes the revealed comparative index for country i in sector j in years t_1 and t_2, respectively. The coefficient α_i is a constant term and the error term, ε_{ij}, is assumed to be normally distributed.

The coefficient of interest, β_i, will determine whether a country has tended to specialize or not. When $\beta_i > 1$, Dalum et. al. (1998) classify the country as experiencing β-specialization. This means that sectors with a larger comparative advantage, relative to other sectors, in the first time period experienced growth in their comparative advantage in the second time period while sectors that experienced comparative disadvantage in the first time period had an even worse comparative disadvantage in the second time period, on average, within a country.

When $\beta_i \in (0,1)$, termed β-de-specialization, comparative advantage across sectors become more similar, implying that a country has diversified their exports. While it is possible for $\beta_i < 0$, this reversal of comparative advantage does not occur with our samples and is rarely seen in previous studies. The term $(1-\beta_i)$ determines the 'regression effect' which indicates the degree to which de-specialization patterns have strengthened. A low β_i indicates a high regression effect with sectors with high (low) comparative advantage initially decreasing (increasing) over time.

With the estimated coefficients for β_i in our regression and using the Pearson correlation coefficient, R, we can also analyze whether the variance of the cross-sections have changed over time, referred to σ-specialization. Hart (1976) showed that the relative variance between the two cross-sections is equivalent to the following:

$$\frac{\sigma_{it_2}}{\sigma_{it_1}} = \frac{\beta_i^2}{R_i^2} \ , \qquad (8)$$

where β_i is the coefficient from the regression and R_i^2 is the coefficient of determination of the regression. Therefore, if $\beta > R$, the variance in the distribution of comparative advantage has increased between the two time periods and this is termed σ-specialization. An increase in the dispersion of the distribution can be seen as sectors moving away from each other in terms of comparative advantage. When $\beta < R$, the variance of the distribution has gotten smaller and termed σ-de-specialization. The term $(1-R)$ determines the 'mobility effect' which indicates the degree at which sectors are moving towards each other when σ-de-specialization is present. As Dalum et. al. (1998) discuss, it is possible for a country to experience β-de-specialization $(\beta < 1)$ with σ-specialization $(\beta > R)$ as a country specializes in a "narrow pattern" while the dispersion of comparative advantage grows.

In terms of whether our sample of countries are converging or diverging within a sector j, we similarly use the following Galtonian regression:

$$X_{ijt_2} = \alpha_j + \beta_j X_{ijt_1} + \varepsilon_{ij} \quad (9)$$

where the dependent and independent variables are the same as in the previous regression. When$\beta_j > 1$, countries that have a greater comparative advantage in a sector in the first time period have a greater comparative advantage in the second time period. Therefore, comparative advantage within a sector is spreading apart, known as β-divergence. When $\beta_j \in (0,1)$, comparative advantage within sectors are moving towards one another and we have β-convergence. While $\beta_j < 0$ is possible, in that the ranking of comparative advantage within a sector across countries switch places, it is something that once again is not observed in our sample. Similar to the σ-specialization above, we have σ-convergence or σ-divergence when $\beta < R$ or $\beta > R$, respectively.

3.4 Results

The main results of our within country regressions with both the symmetric and normalized indices are presented in the tables below. Table 3.3 uses the WTO sample and compares revealed comparative advantage across 8 sectors between 2000 with 2015.[14] The tables that follow use the UN Comtrade sample and compare the full time span (1996-2014 in Table 3.4) with the shorter periods (1996-2005 in Table 3.5 and 2005-2014 in Table 3.6) across 10 broad sectors.

[14] Manufacturing is excluded in the country-specific regressions since it includes other sectors in the sample.

Table 3.3: Country Stability and Specialization Patterns Across Sectors (WTO Classif.: 2000-2015)

	Symmetric Index				Normalized Index			
Country	α	β	**R**	β/R	α	β	**R**	β/R
China	0.078	0.939***	0.814	1.153	37.088	3.550***Ϯ	0.719	4.934
US	-0.044	0.725***Ϯ	0.768	0.944	-0.205	0.417***	0.816	0.511
Austria	0.001	1.016***	0.966	1.052	0.577	0.856***Ϯ	0.975	0.878
Denmark	-0.010	0.961***	0.914	1.051	0.795	0.629***Ϯ	0.871	0.722
Finland	-0.200	0.358Ϯ	0.414	0.865	-0.557	0.040Ϯ	0.157	0.255
France	-0.080	1.052***	0.848	1.240	-1.262	0.551***Ϯ	0.946	0.583
Germany	-0.018	1.072***	0.942	1.138	4.591	1.055***	0.995	1.061
Greece	-0.131	0.725***Ϯ	0.846	0.857	-0.022	0.972***	0.884	1.099
Ireland	-0.174	0.806***Ϯ	0.832	0.969	-0.499	0.632***Ϯ	0.668	0.946
Italy	-0.015	1.090***	0.955	1.141	1.210	0.646***Ϯ	0.977	0.661
Netherlands	0.031	0.942***	0.820	1.149	2.362	0.762***Ϯ	0.915	0.832
Portugal	-0.058	0.837***Ϯ	0.865	0.967	-0.291	0.555***Ϯ	0.874	0.635
Spain	-0.030	1.100***	0.899	1.224	-0.129	0.712***Ϯ	0.955	0.745
Sweden	-0.021	0.673***Ϯ	0.850	0.791	0.315	0.284***Ϯ	0.694	0.409
UK	-0.130	0.762**	0.496	1.536	-1.760	0.285Ϯ	0.407	0.701

Note: * significant at .10, ** significant at .05, *** significant at .01, Ϯ statistically significantly different from 1 at .10 level

Table 3.4: Long-Run Country Stability and Specialization Patterns Across Sectors (UN Classif.: 1996-2014)

	Symmetric Index				Normalized Index			
Country	α	β	**R**	β/R	α	β	**R**	β/R
China	-0.248	0.984**	0.725	1.358	-1.052	1.298	0.366	3.547
US	-0.032	0.675**	0.650	1.038	-0.679	0.296	0.454	0.652
Austria	0.024	0.582**Ϯ	0.706	0.825	-0.043	0.831**	0.804	1.033
Denmark	0.003	0.801***Ϯ	0.888	0.902	-0.036	0.481***Ϯ	0.914	0.526
Finland	0.034	0.81***Ϯ	0.793	1.021	-0.022	0.433***Ϯ	0.940	0.461
France	0.026	0.784***Ϯ	0.868	0.904	-0.081	0.790***	0.849	0.930
Germany	-0.034	0.860***Ϯ	0.894	0.962	-0.148	1.126***	0.913	1.233
Greece	-0.083	0.643***Ϯ	0.780	0.824	-0.011	0.654**Ϯ	0.740	0.883
Ireland	-0.055	0.902***	0.892	1.011	0.012	1.675***	0.853	1.963
Italy	0.060	0.904***	0.924	0.978	-0.141	0.566***Ϯ	0.833	0.680
Netherlands	-0.099	0.808	0.526	1.536	-0.176	0.731***Ϯ	0.931	0.785
Portugal	0.089	0.860***	0.920	0.935	-0.021	0.574***Ϯ	0.822	0.698
Spain	0.081	0.723***Ϯ	0.885	0.817	-0.078	0.916**	0.747	1.226
Sweden	-0.011	0.401**Ϯ	0.756	0.530	-0.058	0.364**Ϯ	0.760	0.479
UK	0.002	0.509Ϯ	0.536	0.949	-0.223	0.194Ϯ	0.231	0.840

Note: * significant at .10, ** significant at .05, *** significant at .01, Ϯ statistically significantly different from 1 at .10 level

Table 3.5: Short-Run Country Stability and Specialization Patterns Across Sectors (UN Classif.: 1996-2005)

	Symmetric Index				Normalized Index			
Country	α	β	R	β/R	α	β	R	β/R
China	-0.215*	0.934***	0.774	1.207	-0.512	0.848	0.507	1.674
US	-0.052	0.907***	0.882	1.028	-0.296	0.753***Ϯ	0.908	0.829
Austria	0.010	0.423Ϯ	0.543	0.779	-0.057	0.737***Ϯ	0.855	0.862
Denmark	0.030	0.682***Ϯ	0.872	0.783	-0.034	0.730***Ϯ	0.971	0.752
Finland	-0.026	0.965***	0.977	0.987	-0.027	0.693***Ϯ	0.924	0.750
France	0.022	0.738***Ϯ	0.841	0.877	-0.127	0.849***	0.903	0.940
Germany	-0.046	0.793***Ϯ	0.908	0.873	-0.196	1.208***	0.926	1.305
Greece	0.035	0.794***Ϯ	0.918	0.865	-0.007	0.612***Ϯ	0.947	0.646
Ireland	-0.059	0.740**	0.751	0.986	0.003	2.130***	0.885	2.407
Italy	0.069*	0.864***Ϯ	0.947	0.913	-0.136	0.713***Ϯ	0.923	0.772
Netherlands	-0.018	0.984**	0.753	1.306	-0.147	0.839***	0.776	1.081
Portugal	0.065	0.647***Ϯ	0.870	0.743	-0.019	0.604***Ϯ	0.870	0.694
Spain	0.058	0.999***	0.982	1.018	-0.051	1.104***	0.904	1.221
Sweden	0.010	0.613***Ϯ	0.951	0.644	-0.057	0.632***Ϯ	0.894	0.707
UK	0.001	0.517*Ϯ	0.583	0.886	-0.278	0.204Ϯ	0.241	0.846

Note: * significant at .10, ** significant at .05, *** significant at .01, Ϯ statistically significantly different from 1 at .10 level

Table 3.6: Short-Run Country Stability and Specialization Patterns Across Sectors (UN Classif.: 2005-2014)

	Symmetric Index				Normalized Index			
Country	α	β	R	β/R	α	β	R	β/R
China	0.001	1.111***	0.988	1.125	0.078	2.074***Ϯ	0.980	2.117
US	0.003	0.712**	0.705	1.010	-0.547	0.415Ϯ	0.527	0.787
Austria	-0.035	0.954***	0.901	1.059	0.019	1.110***	0.926	1.199
Denmark	-0.026	1.049***	0.910	1.153	-0.015	0.633***Ϯ	0.904	0.700
Finland	0.025	0.736***	0.712	1.033	-0.013	0.493***Ϯ	0.803	0.614
France	0.004	1.094***	0.994	1.100	0.055	0.981***	0.991	0.990
Germany	0.018	1.099***	0.997	1.102	0.066	1.055***	0.998	1.057
Greece	-0.099	0.726**	0.762	0.952	-0.005	0.926**	0.677	1.367
Ireland	-0.053	0.932***	0.909	1.025	0.011	0.805***Ϯ	0.986	0.817
Italy	-0.014	1.022***	0.953	1.073	-0.020	0.837***Ϯ	0.951	0.880
Netherlands	-0.020	-0.083Ϯ	0.070	-1.186	-0.189	0.391Ϯ	0.539	0.726
Portugal	0.001	1.067***	0.847	1.259	-0.003	0.964***	0.958	1.006
Spain	0.039	0.761***Ϯ	0.947	0.804	-0.018	0.940***	0.936	1.004
Sweden	-0.010	0.723***Ϯ	0.878	0.823	-0.017	0.649***Ϯ	0.957	0.678
UK	0.007	1.062***	0.992	1.071	0.046	0.967***	0.976	0.991

Note: * significant at .10, ** significant at .05, *** significant at .01, Ϯ statistically significantly different from 1 at .10 level

The results in Table 3.3 and 3.4 show that β generally tends to be between zero and 1 (statistically significantly greater than 0 and less than unity for over half the countries in both samples), implying that countries have tended to become less specialized, or more diversified, in their exports. Only China has statistically significant values of $\beta > 1$ in the WTO sample (Germany has $\beta > 1$ but not statistically significantly so) and only when using the normalized index. When using the UN Comtrade sample with the normalized index, specialization is hinted at only in Ireland, Germany, and China. As previous papers have found, we can reject $\beta < 0$ for all countries, indicating that the pattern of a country's comparative advantage or disadvantage does not tend to fundamentally change over time.

As for dispersion in comparative advantage, we find no consistent pattern of σ-specialization or σ-de-specialization. China, Germany, and Ireland tend to show an increasing dispersion in comparative advantage which hints at the fact the β-specialization and σ-specialization tend to move in the same direction. We also find more cases of σ-specialization when using the symmetric index with the WTO sample relative to the normalized index. These results are mostly aligned with those found in Dalum et. al. (1998) where they find a general trend towards dispersion of export specialization. As for the short-run trends in Tables 3.5 and 3.6, the results do not change greatly. One insight that is gleamed is the fact that China's trend towards specialization seems a more recent phenomena that stands out in the 2005-2014 sample but does not occur in the 1996-2005 sample. Germany once again displays β's greater than unity, suggesting specialization, but the values are not statistically significant.

Table 3.7 presents the result for convergence (divergence) across countries for a given sector using the WTO sample. The results show broad convergence across countries with the exception of the manufacturing sector using the symmetric index. This is consistent with findings in previous studies. The normalized index displays divergence in some sectors, but as previously mentioned, the sample statistics show that larger countries tend to have larger values relative to smaller countries. In 6 out of the 9 sectors, $\beta > R$ implying σ-divergence. This means that as comparative advantage across countries are converging, the variance of revealed comparative advantage is growing for most sectors.

Table 3.7: Sectoral Stability and Convergence Patterns Across Countries (WTO Classif.: 2000-2015)

	Symmetric Index				Normalized Index			
Sector	α	β	**R**	β/**R**	α	β	**R**	β/**R**
Agriculture	0.014	0.898***	0.864	1.039	-4.880	1.082**	0.577	1.876
Fuels and mining	0.086	0.966***	0.841	1.148	-9.316	0.654*	0.480	1.364
Manufactures	-0.020	1.295***	0.911	1.422	8.057	1.045*	0.505	2.069
Iron and steel	0.044	0.935***	0.930	1.006	0.502	0.618***Ť	0.776	0.797
Chemicals	0.063	0.997***	0.960	1.038	-6.810	1.671***Ť	0.847	1.973
Office and tele. equipment	-0.261	0.616**	0.579	1.063	5.884	0.605	0.270	2.238
Transport equip.	0.032	0.806***Ť	0.938	0.860	-3.620	1.163***	0.869	1.338
Textiles	-0.141	0.950***	0.966	0.984	1.520	1.516***	0.826	1.835
Clothing	-0.057	0.688***Ť	0.831	0.828	3.040	1.275***Ť	0.968	1.318

Note: * significant at .10, ** significant at .05, *** significant at .01, Ť statistically significantly different from 1 at .10 level.

Tables 3.8, 3.9, and 3.10 show the sectoral convergence results for the UN Comtrade sample time periods 1996-2015, 1996-2005, and 2005-2016, respectively. We find that using the symmetric index, the only sector that seems to have experienced divergence is once again the manufacturing sector but σ-divergence is present in 6 out of the 10 sectors. Primary good sectors show a convergence of comparative advantage across countries. This could be due to income convergence decreasing the comparative advantage in producing homogeneous goods across our sample group of countries. These results are in line with Soete and Verspagen (1994) and Dalum et. al. (1998) which show β-convergence to be prevalent across most aggregated sectors.

Table 3.8: Long- Run Sectoral Stability and Convergence Patterns Across Countries (UN Classif.: 1996-2014)

	Symmetric Index				Normalized Index			
Sector	α	β	**R**	β/**R**	α	β	**R**	β/**R**
Food and live animals	0.037	0.663***Ϯ	0.811	0.817	-0.223	0.580*Ϯ	0.501	1.158
Beverages and tobacco	0.090	0.720***	0.682	1.056	-0.042	0.615**Ϯ	0.608	1.012
Crude materials, inedible, except fuels	-0.077	0.833***	0.831	1.003	-0.290	0.770**	0.538	1.431
Mineral fuels, lubricants, etc.	0.003	0.936***	0.770	1.216	-1.660	1.190*	0.480	2.477
Animal and vegetable oils, fats and waxes	-0.114	0.853***	0.886	0.963	-0.051	1.050**	0.612	1.716
Chemicals and related products	0.081	0.885***	0.884	1.001	-0.310	1.220***	0.650	1.876
Manufactured goods	-0.020	1.110***	0.962	1.154	0.192	0.530***Ϯ	0.748	0.708
Machinery and transport equipment	-0.046	0.698**	0.640	1.091	0.673	-0.079	0.070	-1.129
Miscellaneous manufactured articles	-0.050	0.579***Ϯ	0.754	0.768	0.721	1.580***	0.841	1.879
Unclassified commodities	-0.102	0.367*Ϯ	0.459	0.800	-0.251	0.852	0.365	2.334

Note: * significant at .10, ** significant at .05, *** significant at .01, Ϯ statistically significantly different from 1 at .10 level.

Table 3.9: Short-Run Sectoral Stability and Convergence Patterns Across Countries (UN Classif.: 1996-2005)

	Symmetric Index				Normalized Index			
Sector	α	β	**R**	β/**R**	α	β	**R**	β/**R**
Food and live animals	0.017	0.822***Ϯ	0.914	0.899	-0.085	0.593***Ϯ	0.848	0.699
Beverages and tobacco	0.078	0.845***	0.749	1.127	0.001	0.687***Ϯ	0.783	0.878
Crude materials, inedible, except fuels	-0.044	0.911***	0.917	0.993	-0.136	0.724***Ϯ	0.838	0.864
Mineral fuels, lubricants, etc.	-0.211	0.619***Ϯ	0.813	0.761	-0.906	1.365***	0.854	1.599
Animal and vegetable oils, fats and waxes	-0.032	0.943***	0.929	1.015	-0.015	0.781***Ϯ	0.829	0.942
Chemicals and related products	0.045	0.843***	0.797	1.058	-0.103	1.052***	0.706	1.490
Manufactured goods	-0.023	1.128***	0.967	1.166	-0.084	0.607***Ϯ	0.933	0.650
Machinery and transport equipment	-0.006	0.686***Ϯ	0.829	0.828	0.478	0.615***Ϯ	0.680	0.904
Miscellaneous manufactured articles	-0.029	0.746***Ϯ	0.966	0.772	0.242	1.021***	0.922	1.107
Unclassified commodities	0.019	0.405**Ϯ	0.576	0.703	-0.022	0.279Ϯ	0.217	1.287

Note: * significant at .10, ** significant at .05, *** significant at .01, Ϯ statistically significantly different from 1 at .10 level.

Table 3.10: Short-Run Sectoral Stability and Convergence Patterns Across Countries
(UN Classif.: 2005-2014)

	Symmetric Index				Normalized Index			
Sector	α	β	**R**	β/R	α	β	**R**	β/R
Food and live animals	0.023	0.869***Ϯ	0.958	0.907	-0.102	1.431***	0.863	1.657
Beverages and tobacco	0.016	0.907***Ϯ	0.968	0.937	-0.058	1.091***	0.946	1.153
Crude materials, inedible, except fuels	-0.030	0.965***	0.955	1.010	0.006	1.502***Ϯ	0.907	1.657
Mineral fuels, lubricants, etc.	0.156	1.173***	0.734	1.598	0.531	1.300***	0.839	1.550
Animal and vegetable oils, fats and waxes	-0.087	0.897***Ϯ	0.945	0.949	-0.015	1.681***Ϯ	0.924	1.819
Chemicals and related products	0.038	0.880***Ϯ	0.929	0.947	-0.213	1.218***Ϯ	0.966	1.261
Manufactured goods	0.002	0.964***	0.977	0.987	0.293	0.944***	0.867	1.089
Machinery and transport equipment	-0.028	1.174***	0.891	1.317	0.191	0.805***	0.647	1.244
Miscellaneous manufactured articles	-0.026	0.826***	0.830	0.995	0.311	1.652***Ϯ	0.976	1.693
Unclassified commodities	-0.200	0.296Ϯ	0.260	1.138	-0.270	0.715	0.393	1.818

Note: * significant at .10, ** significant at .05, *** significant at .01, Ϯ statistically significantly different from 1 at .10 level.

3.5 Conclusions

To summarize, this paper has examined the specialization and convergence patterns for the U.S., China, and EU-15 following a similar strategy to Dalum et. al. (1998). Our main results, that there has been broad convergence across sectors and mixed findings of trade specialization within countries, are mostly in line with earlier results even with our use of different measures of comparative advantage and the use of different sectoral classifications. Our inclusion of China does lead us to find that they have shown a movement towards specialization (due primarily to their increase in comparative advantage in manufacturing over the time period) and that, in aggregate, the manufacturing sector is characterized by a pattern of divergence unlike all other sectors. This new result is due to China's rise in global trade and the decline in export manufacturing in industrialized countries export relative to China's export growth in manufacturing.

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Appendix A - WTO Industrial Classification

The data from the WTO is defined in product groups following the third revision of the Standard International Trade Classification (SITC). Below, we list the sectors we employ and their corresponding two-digit SITC codes as defined in the WTO's technical notes.[15]

Primary Products

Agricultural Products (SITC 01-09, 11-19, 21-26, 29, 41-49)
Fuels and Mining Products (SITC 27, 28, 31-39, 68)

Manufactures

Iron and Steel (SITC 67)
Chemicals (SITC 51-59)
Office and Telecommunications Equipment (SITC 75, 76)
Transport Equipment (SITC 78, 79)
Textiles (SITC 65)
Clothing (SITC 84)

[15] The technical notes, with the product definitions, are available at http://stat.wto.org/Statistical Program/WSDBStatProgramTechNotes.aspx

Chapter 4 - Determinants of labor productivity growth in SAARC countries: A Long-Run Panel Analysis

4.1 Introduction

The countries of the South Asian Association for Regional Cooperation (SAARC) make up one of the largest (in terms of population) but least integrated regions of the world since its formation in 1985. After Sub-Saharan Africa, SAARC is the second largest region in poverty, consisting of 47 percent of the population living under 1 dollar per day (Kumar 2009). With economic growth stagnant, productivity and efficiency gains have become a great concern for these countries. Labor productivity growth is imperative since it has been shown that, in the long-run, it reduces poverty, enhances per worker output and it is one of the key drivers of rising living standards.

The growth of an economy is determined by the rate of expansion of its productive resources and the growth rate of total factor productivity (Nishimizu and Robinson 1984). Total factor productivity measures the level of economic and technical efficiency with which inputs are converted into outputs. In the case of developing countries of Asia, the real issue is how to achieve rapid rates of economic growth through labor productivity growth, possibly through an increase in their investment in R&D, openness to international trade (which can exploit their comparative advantage), foreign direct investment (FDI), improvement in human capital and in tackling the gender disparity issue which is prevalent in the region.

Gender inequality is a reality which is becoming more and more evident all over the world. In recent years, many macro models have explained the role of gender in influencing economic well-being[16]. Much progress has been made recently towards closing the gender gap in developed countries, although sizeable disparity still exists in terms of salary and employment levels (Olivetti and Petrongolo 2014: 2016). Gender disparity is a critical problem in developing countries especially in South Asia, where the gender gap in salary and employment is very high. (Klasen and Lamanna 2009). In South Asia alone, income loss due to the gender gap is 28%, which is the highest in the world after the Middle East and North Africa (34%) (Cuberes and Teignier 2014). This issue is likely to result in lower productivity growth due to inefficient utilisation of females' potential human capital. As such, narrowing gender differences is not only important to attain social equality but also to have larger macroeconomic benefits. It is also a great challenge in reducing poverty and getting sustainable development which is a big issue for much of the developing world.

This paper aims to discuss the importance of the determinants of labor productivity as a source of productivity growth in the four largest countries in South Asia: Bangladesh, India, Pakistan and Sri Lanka. Recently, much of the research focus has been on policy analysis of East Asian and industrialised countries. This has perhaps been due to their outward oriented policies and its perceived success while South Asian countries are viewed as having followed unsuccessful inward-looking policies. Consequently, it is time to look at how these policies have changed the determinants of labor productivity growth over time and which factors have the biggest impact on economic growth.[17]

This paper sets out to contribute to the following areas of research: Firstly, there has been a great amount of research on the determinants of labor productivity for OECD countries, but very little material on developing countries, particularly in Asia. Secondly, the role of gender parity has not been considered as a determinant of labor productivity even though it can play a big role in productivity growth in developing countries. As of a result, this paper demonstrates the need for policy makers in developing countries to focus more on the issue of gender disparity. Lastly, the above issue has been

[16] See, for example, Stotsky (2006), Seguino (2010), Nallari and Griffith (2011), Elborgh, et. al. (2013), Kabeer and Natali (2013), Onaran (2016), Braunstein (2015), and Seguino (2017).
[17] This is the first attempt to look at labor productivity and its determinants in SAARC countries, including gender parity in the production equation.

analysed through a newly developed panel cointegration and error correction techniques which have not been used in this setting before.

4.1.1 Objectives

The current paper provides a study on the determinants of labor productivity growth in SAARC countries. It deals with the effect of the elementary factors of the productivity growth such as investment in R&D, trade openness, foreign direct investment (FDI), human capital index (HCI), and gender disparity (Gender parity index is the gross enrollment ratio in primary and secondary education which is the ratio of girls to boys enrolled at primary and secondary levels in public and private schools.).[18] South Asia is the poorest, most illiterate and least gender sensitive region in the world and therefore lags behind many other regions in terms of labor productivity and economic growth. In this paper we study how, in addition to gender disparity, FDI, HCI, investments in R&D (as % of GDP) and trade openness affect labor productivity.

To address this question, the paper performs an empirical analysis using panel data for Bangladesh, India, Pakistan and Sri Lanka from 1980-2013 using two data sources, the World Bank and the TED database.[19] Panel data is used to develop the new cointegration technique proposed by Baltagi (2014) that investigates the interaction between labor productivity and R&D investment, as well as trade openness, FDI, HCI, and gender disparity. After finding the cointegration relationships, a vector error correction model (VECM) is used to check for short-run and long-run relationships among the variables considered in this study.

We find that labor productivity is highly influenced and positively affected by: research and development, the gender parity index, trade openness, human capital index and FDI. However, trade openness has a less

[18] Reason why we are using this index is that in SAARC female education attainment facilities and employment share is very low in comparison to their population share. The Gender Parity Index (GPI) indicates parity between girls and boys. A GPI of less than 1 suggests girls are more disadvantaged than boys in learning opportunities and a GPI of greater than 1 suggests the other way around (WB definition).

[19] We omitted Bhutan, Maldives, Nepal and Afghanistan as we had insufficient data on R&D, trade openness and FDI.

significant relationship with labor productivity. This may partly be due to the fact that these countries are less integrated and trade less within the region. Finally, a test for vector error correction finds significant short-run relationships among the variables.

This chapter is organized as follows. The rest of the section presents a brief background of the relevant theory. Section 4.2 highlights the latest trends of labor productivity and its determinants in developing countries. Section 4.3 reviews the literature related to the determinants of labor productivity. Section 4.4 presents the econometric specification. Section 4.5 presents and discusses the empirical results obtained from the panel cointegration and the VECM, while section 4.6 concludes with some final remarks.

4.1.2 Background

One overreaching theme of research on countries in southern Asia is the importance of policies and institutions on productivity growth, sustainability, poverty reduction and improved living standards. In this paper, the basic concern is to look at the determinants which foster labor productivity in countries in this region in order to guide policy makers to make better policies to enhance productivity growth in the region.

The role of labor productivity is important, especially for developing countries, because it has been shown to lead to better living standard and economic growth (Harrod 1939 and Domar 1946). Solow (1956) delimited labor productivity as a function of capital and showed that labor productivity could be improved by capital deepening. Grossman and Helpman (1991), Dowrick (1994), Frankel and Romer (1999), and Dowrick and Golley (2004) include trade openness in this framework. Lucas (1988) highlighted the effect of human capital on productivity growth and explained how increases in human capital expand productivity and economic growth. Barro (1991), Barro and Sala-i-Martin (1995), and Day and Dowrick (2004) emphasized the significance of education. Lynde and Richmond (1993), Gramlich (1994), Madden and Savage (1998), and Milbourne et. al. (2003) introduced fixed capital and public infrastructure as key drivers of productivity and growth. Some of the recent literature has found that high tech investments and public infrastructure can be accelerators for productivity growth (Greenstein and

Spiller 1995; Karunaratne 1997; and Díaz-Bautista 2002).

Before going into details, we first decompose labor productivity into three components that are directly influenced by structural policy controls, as the impact of labor productivity on economic growth depends on the relative share of labor in GDP. This is because total factor productivity is derived from the weighted sum of input components (labor, capital etc.). By applying a Cobb-Douglas approach as in Hall and Jones (1999), labor productivity can be disintegrated into three sub-components. Assume output, Y, is given as follows:

$$Y = K^{\alpha}(AL)^{1-\alpha} \quad (1)$$

where K is the stock of physical capital, L stands for the amount of labor, and A is labor enhancing productivity. In the above equation, labor as human capital is considered by giving different weights to different kinds of labor subject to their age, gender and level of education.

In the standard labor productivity function, we introduce FDI, R&D, HCI, trade openness, and gender parity as independent inputs, which can be specified as:

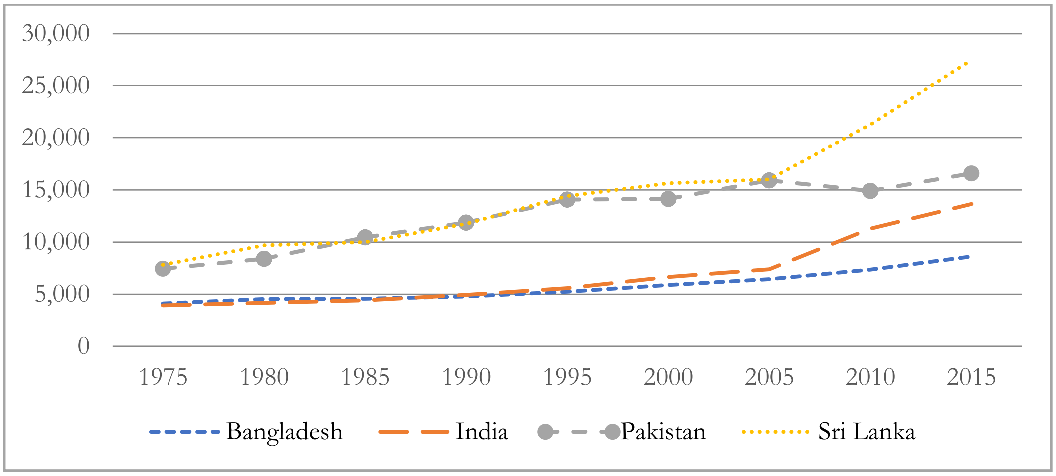
$$LP_{it} = \alpha_0 + \beta_1 FDI_{it} + \beta_2 GP_{it} + \beta_3 TOP_{it} + \beta_4 RD_{it} + \beta_5 HCI_{it} + \mu_{it} \quad (2)$$

As per the above equation, we expect positive impacts of foreign direct investment, research and development, human capital index, trade openness and gender parity on labor productivity.

4.2 Labor Productivity Trends and its Determinants

Labor productivity is defined as the quantity of output per person or per hour worked. It explains the productivity or efficiency of the worker input engaged in the production of goods and services. When productivity improves, it can lead to increases in real income of workers. Figure 4.1 shows the evolution of labor productivity between 1975 and 2015 in selected Asian developing countries.

Figure 4.1 Labor Productivity in SAARC Countries (US$)

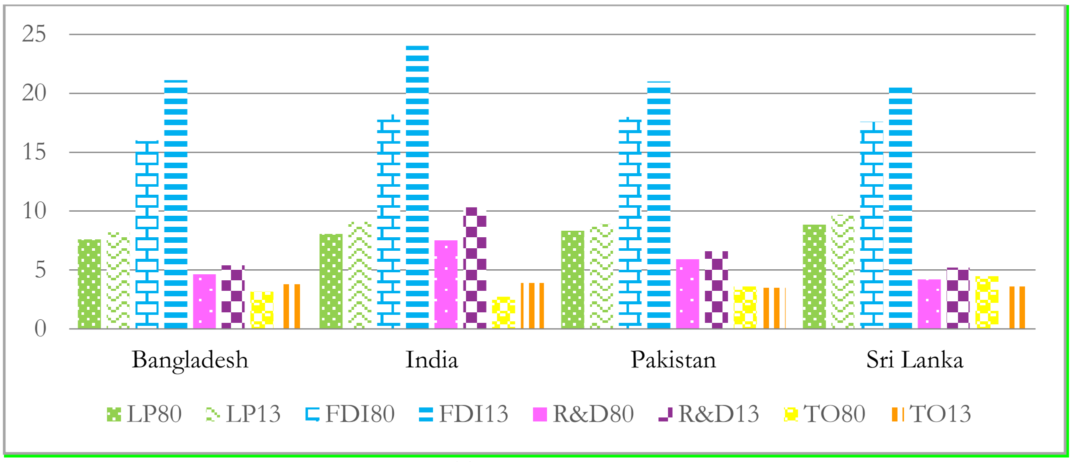


Note: Sourced from Total Economy Database (TED)

Figure 4.2 below shows the performance of labor productivity determinants among these same countries in 1980 and 2013. Labor productivity expanded but at a low rate. However, in India and Sri Lanka it increased from 8.06 to 9.10 and 8.84 to 9.74 percent between 1980 and 2013, respectively. Similarly, it expanded in Bangladesh and Pakistan from 7.60 to 8.20 and 8.34 to 8.90 percent between 1980 and 2013, respectively.

If we consider the determinants in 1980 and 2013, there is not much difference. For example, FDI expanded the most of all three determinants, especially in India and Bangladesh, but research and development expanded very slowly except in India where it increased by 10.3 percent in 2013. During the past three decades, trade openness has increased slowly and the growth rate of this factor declined in Sri Lanka and Pakistan. In this paper, we will look at the causal relationship between these determinants and labor productivity growth.

Figure 4.2 Growth Rates of Labor Productivity, FDI, R&D and Trade openness between 1980 and 2003.

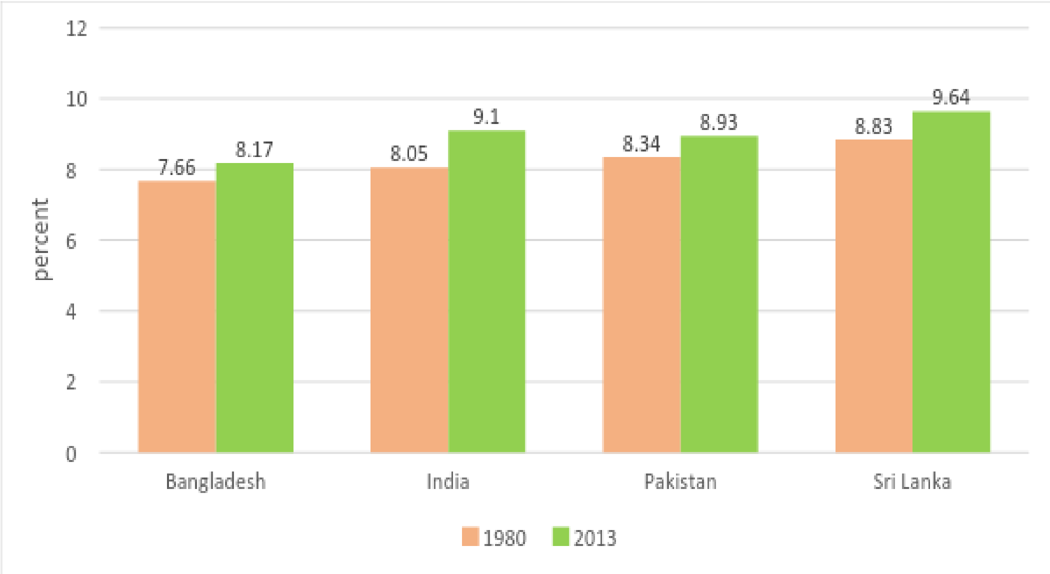


Note: Data for labor productivity is taken from Total Economy Database and the World Bank for the remaining variables

4.3 Review of the Determinants of Labor Productivity

The SAARC economic block is one of the emerging groups in the world and there has been increased attention towards the countries that exist within this region. The region consists of eight countries and four countries are considered in this research (Pakistan, Bangladesh, Sri Lanka and India). The SAARC was founded in December 1985 and initially included Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. Afghanistan later became a member in 2007. These countries are highly endowed with natural resources. They are heterogeneous in their population size and in other characteristics. Figure 4.3 shows labor productivity growth for the four major SAARC countries. There is only a slight increase in productivity in last three decades.

Figure 4.3 Labor productivity growth per person employed (US$)



Note: Sourced from Total Economy Database (TED)

4.3.1 Research and Development

The surge in productivity level in the long run, mostly results from innovation or advancement. In fact, in most of the models, knowledge (generally measured by R&D) is found to be the main source of economic growth (Helpman 2004) and development. The empirical evidence has largely shown a positive relationship between innovation spending and labor productivity growth at macro and micro levels for developed countries (Guellec and Van Pottlesbergue 2004).

Most of our selected countries have underdeveloped research and development practices. Te Velde (2011) indicates that the budgetary allocation for countries in this region towards R&D is not appropriate to spur economic prosperity. However, Chowdhury (2015) reports that India is among the leading countries with respect to innovations. Through investment in innovations and research, India has been in a position to export innovations to other member nations. For instance, most innovations in Bangladesh companies come from India (Chowdhury 2015). Duval et. al. (2008) assert that the level of economic disparity among South Asian developing nations has made it difficult to have a uniform level of investment towards R&D. Pakistan does not have distinct technological initiatives to support its industries and also depends on imports from India and other trading partners (Khilji 2012). Ellahi and Khan (2011) reveal that Sri Lanka also has begun initiatives that have increased budget allocations towards R&D.

4.3.2 Investment in Human Capital and Productivity Growth

The role of education as a major factor, as highlighted by endogenous growth models, and has been very evident as documented by Romer (1986) and Lucas (1988). Several studies have been done to explain the importance of education on economic growth and have showed that education is a substantial determinant of growth.[20] Moreover, education has regularly been considered as a proxy for human capital (Mankiw et. al. 1992).

The increase of skills and competencies is viewed as a major factor of productivity growth since it enables the formation and flow of new technologies. In this respect, a well-functioning education system at the secondary and post-secondary level is important to boost the implementation of skills in science and technology that foster the talent, research experience and innovation capabilities in a work force.[21] This highly skilled workforce can boost a country's productivity when they reach their professional life. The competency of the school system provides undergraduates a strong background in the field of different sciences which will foster the economic efficiency in the future. Moreover, secondary education is worth more for a society than primary education as it provides the skills that are more relevant to productivity growth (Mankiw 1997). Figure 4.4 shows the enrolment ratio for primary, secondary and tertiary education for some developing countries. Since 1999, this ratio has expanded significantly and countries have tried to deliver improved accessibility to primary schools. The graph shows that in primary education, all countries significantly increased their gross enrolment ratio (GER) from 2001 to 2013 except Sri Lanka.

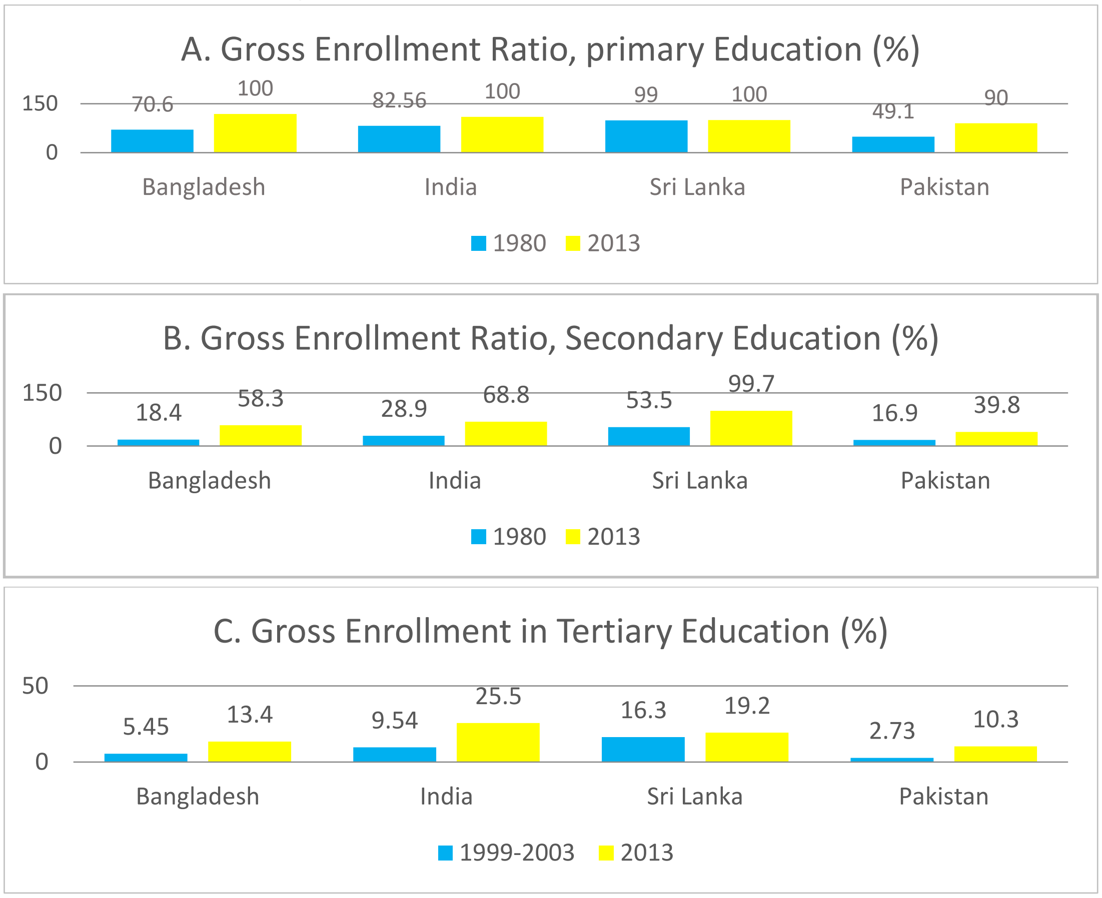
It is largely accepted that human capital and good quality education are essential to achieve a higher level of labor productivity. It fosters the process of economic development and the ability to adopt new technologies.

[20] For instance, See Barro (1991) and Barro and Lee (2013).

[21] Mankiw, Romer and Weil (1992) showed that human capital, in the form of secondary education, is a significant element of economic growth.

Therefore, we look at a country's current education attainment ratio and its link towards labor productivity. In fact, in the absence of an obvious link between resources and performance, there may be no best practice in education but instead some other combinations of better policies that interact to generate similar outcomes (Hanushek 2004). Our selected countries have shown slight increase but still need improvements in the level of secondary education as shown in the Figure 4.4 (B). However, Sri Lanka has maintained an almost 100 percent (UNESCO Institute for Statistics 2015).

Figure 4.4 Educational Outcomes across SAARC Countries



Note: Calculations from UNESCO Institute for Statistics (2015)

4.3.3 Trade Openness, Foreign Direct Investment and Productivity Growth

The arguments in favour of a positive correlation between trade liberalisation and productivity growth are well documented. For instance, openness endorses resource allocation efficiency through comparative advantage which allows knowledge distribution and technological progress (Chang et. al. 2009). Openness indicates a long-run growth pattern when there is trade specialization and increasing returns to scale.[22] According to Jain and Singh (2009) South Asian countries provide one of the ideal areas for investment. Unlike other regions that have placed trade restrictions and embargoes, the region has trade partners from every region in the world. These countries are among the leading exporters of rice (Raghuramapatruni 2011). Through political neutrality, these countries do not experience trade restrictions in the international market.

FDI is considered as one of the important determinants of growth, especially for developing countries. China is the prime example of a developing country that has benefitted greatly from FDI. Since these countries are among the most populated in the world, they offer a large supply of labor to any prospective investor. Saqib et. al. (2013) find that most electronic companies have plants within this region. However, Srinivasan et. al. (2011) state that one of the reasons for increased investor interest in the SAARC region is because of accommodative laws for foreigners. In most countries, there are punitive laws that tend to reduce direct foreign ownership of investments. Due to this situation, most global companies are setting up their plants in this region since the region does not have prohibitive laws on ownership of foreign investments. Increased foreign investment in this region might lead to a reduction of unemployment rates in the region. Mottaleb (2007) indicates a significant impact of FDI on GDP growth rate of 60 developing countries through advanced infrastructure and friendly business environment which is achieved through the inflows of FDI. Srinivasan et. al. (2011) find a long-run bi-directional causal link between GDP and FDI for South Asian countries except for India. For India, they find a uni-directional

[22] This is documented in the endogenous growth literature; for instance, see Grossman and Helpman (1990) and Eicher (1999).

causal link from GDP to FDI.

4.3.4 Gender Parity and Productivity Growth

As we show in the sections that follow, gender parity is directly linked to labor productivity growth. Greater gender equality fosters economic growth and reduces poverty, hunger, diseases, and unemployment issues. Complete gender equality exists where both male and females are given equal opportunities in all fields of life and are given equal shares in the distribution of power and influence, health, education, employment and business opportunities. While labor force participation, income inequality, health facilities, legal rights and other similar factors can also affect productivity, our primary focus is educational attainment. We will specifically be considering secondary level education data because of its direct correlation with skills and productivity.[23] Previous studies find secondary education as the most robust variable in explaining growth empirically (Levine and Renelt 1992; and Sala-i-Martin 1997). Furthermore, gender gaps in education and health are largely transmitted through their impact on labor productivity (Dollar and Gatti 1999; Knowles et. al. 2002; Klasen and Lamanna 2009; Bandara 2015).

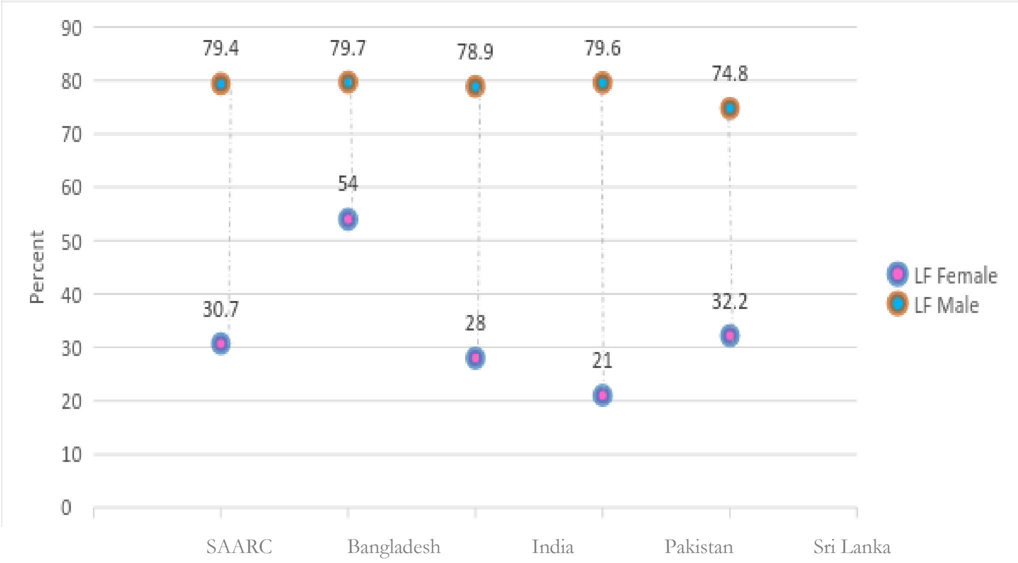
Much of the existing growth models have put more emphasis on education level but few have considered the possible significances of gender disparity within education (Brummet 2008). Gender equality in education positively influences economic growth because this has an effect on fertility and the human capital of children (Lagerlöf 2003). According to Psacharopoulos (1994), female education returns are positive and higher as compared to males. Moreover, Esteve-Volart (2004) find that in some states in India, where higher rates of gender differentials are present, the growth rate is lower as compared to other states.

In our selected panel group, we will look at the overall picture of gender parity/disparity and analyse how it affects labor productivity growth. Figure 4.5 indicates the ratio of male and female labor force participation rates in 2012. There are on average 40 percent more males in the labour force than female labor in SAARC. Due to domestic work and their role in informal

[23] Mankiw (1997) for instance, proved this fact in his study stating that year of school in secondary education provides skills which are directly related with the productivity growth.

sectors, females' contribution to the economy is not reported and is not accounted for in GDP. Moreover, market constraints are another issue which does not let women enter in the labor force in the form of social values, unequal gender pay system, etc.

Figure 4.5: Male and Female Labor Force Participation Rates (2012)[24]



Source: Own Calculation World Bank data

Tisdell et. al. (2001) reveal that the role of women in countries such as India is significant. Women in India are very active in the informal sector. The informal sector, such as the weaving industry in most of the countries in the South Asia, has led to labor productivity growth. If the role of women in the informal sector improves productivity growth, one can imagine how influential it would be for labor productivity growth if they were given equal opportunities in formal sectors as well. The impact of women on economic activities has improved a bit because of affirmative actions that promote equal job training opportunities (Ellahi et. al. 2010). However, certain cultural norms in South Asia (such as the belief that women are to concentrate on taking care of children) have reduced the role of women in contributing to economic status of these countries (Ellahi et. al. 2010).

[24] See Appendix A to check the trend among male and female labor force participation rate in 1990 and 2014.

Due to gender disparity, the important role of trade benefits is neglected, because the advantage of trade openness for labor productivity is lost. When almost half of the population is not benefitting from trade openness, for instance from the spill over effect of research and development, technology and innovation. Gender disparity is therefore a key issue in South Asian countries; when this is controlled, it will be possible for the rest of the variables to play their role. This is a big challenge for policy makers to widen the employment opportunities to control gender disparity and create a society where both males and females can contribute and benefit the economy and society as a whole.

4.4 The Econometric Specification

The core contribution of this paper is investigating the importance of the determinants of labor productivity growth in some Asian developing countries. We focus our analysis on FDI, R&D, HCI, trade openness and gender disparity, defined by the gross enrolment ratio in primary and secondary education.

To that end, we implement two different econometric techniques: panel cointegration and a vector error correction model (VECM). Our main regression is based on the following specification:

$$LP_{it} = \alpha_0 + \beta_1 FDI_{it} + \beta_2 GP_{it} + \beta_3 TOP_{it} + \beta_4 RD_{it} + \beta_5 HCI_{it} + \mu_t \quad (3)$$

where LP_{it} is labor productivity for the SAARC countries in our sample at time t, FDI_{it} is foreign direct investment at current US dollars and GP_{it} is the gender parity index. TOP_{it} is our measure of trade openness and RD_{it} is the investment in research and development. HCI is the index of human capital per person based on years of schooling (Barro and Lee 2013) and returns to education (Psacharopoulos 1994).

4.4.1 Data and Descriptive Analysis

We employ a panel cointegration technique as well as vector error correction model (VECM) to check short-run and long-run relationships among the variables considered in this paper. This model includes five endogenous variables: Foreign direct investment (FDI) refers to direct investment equity flows in the reporting economy and it is the sum of equity capital, reinvestment of earnings, and other capital; gender parity index (GPI) is a ratio of gross enrolment ratio for primary and secondary education between males and females.[25] Trade openness (TOP) measured as the sum of imports and exports of goods as percentage of gross domestic product; investment in research and development (RD) is expressed as a percentage of GDP; and human capital index per person (HCI) is based on years of schooling and returns to education.

The World Bank national accounts data and OECD National Accounts data files are the main sources used to collect the data for FDI, RD, GP and TOP. Labor productivity figures are taken from the TED database for the period 1980-2013[26] and HCI data is retrieved from FRED (Federal Reserve Bank of St. Louis). Table 4.1 provides the panel data summary statistics for labor productivity, FDI, trade openness, gender parity index, human capital index and research and development.

[25] Ratio of female gross enrolment ratio for primary and secondary education to male gross enrolment ratio for primary and secondary education. It is calculated by dividing the female value for the indicator by the male value for the indicator. A GPI equal to 1 indicates parity between females and males. In general, a value less than 1 indicates disparity in favor of males and a value greater than 1 indicates disparity in favor of females.

[26] The Conference Board Total Economy Database, May 2015, http://www.conference-board.org/data/economydatabase/

Table 4.1 Descriptive Statistics for Observed Variables

	Mean	Median	Minimum	Maximum	Std. Deviation
LP	9.755	9.320	8.402	11.036	0.951
GP	0.900	0.932	0.604	1.035	0.111
FDI	21.232	21.425	16.994	24.494	1.743
RD	0.471	0.487	0.061	0.945	0.259
TOP	3.786	3.817	3.070	4.485	0.326
HCI	1.900	1.790	1.264	2.899	0.494

Note: Data from World Bank, OECD, FRED Economic data and TED Database

4.4.2 Econometric Modelling

In time series analysis, the data exhibits a time trend and the variables are non-stationary, which means that the means, variances and covariances of the variables are not time-invariant. In this case, the direct application of OLS and GLS regressions gives us spurious results (Engle and Granger 1987). The regression results are likely to produce performance statistics that are inflated in nature, for example, high values of R^2 and t-statistics which lead to Type I errors (Granger and Newbold 1974).

There are several benefits of using panel data listed by Hsiao (2003) and two of them are particularly relevant in this paper. Firstly, it allows us to control for individual heterogeneity across countries. Time-series and cross-section data do not control for such heterogeneity which can bias results (Baltagi 2014). Secondly, panal data gives more informative data controlling for collinearity among the variables. For instance, in our case, there is high collinearity between FDI and trade openness in the aggregate time series for a single country which can be problematic if looking at this country in a vacuum. This issue is less likely using panel data.

In recent years, panel based unit root test methods have been developed by Levin, Lin and Chu (2002), Breitung (2000), Im, Pesaran and Shin (2003), Maddala and Wu (1999), Choi (2001) and Hadri (1999). They have shown that panel unit root tests are more powerful relative to individual unit root tests because information in the time series data is improved by that contained in the cross-section data (Ramirez 2007). This means that we are less likely to commit a Type II error. Moreover, panel unit root tests lead to statistics with a normal distribution in the limit where as individual unit root tests have complicated limiting distributions (Baltagi 2008).

All of the abovementioned tests assume that there is a common unit root across the cross-section (Im, Pesaren and Shin 2003 being the exception).[27] In this model, a null hypothesis of non-stationarity is checked by using Im, Pesaren and Shin (2003), which is appropriate for balanced panels and is as follows:

$$\Delta y_{it} = \alpha_i + \tau_i t + \rho_i y_{it-1} + \sum_{j=1}^{h_i} \beta_{ij} \Delta y_{it-j} + \varepsilon_{it} \qquad (4)$$

where i =1,2,...,N and t =1,2,...,T , for y = LP, GP, FDI, RD, TOP, and HCI, i is the cross-sectional unit and t denotes time, ρ_i is the autoregressive root and h_i is the number of lags. The null hypothesis is that each series in the panel has non-stationary processes, so H_0: $\rho_i = 0, \forall_i$ which allows for a heterogeneous coefficient of y_{it} , and the alternative hypothesis is that some (however not all) of the individual series in the panel are stationary, i.e. H_1: $\rho_i < 0$ for at least one i . This test is built on the Augmented Dickey-Fuller (ADF) testing approach.

4.4.3 Error Correction Based Panel Cointegration Tests

To detect long-run relationship among the integrated series in a panel data, we use the panel-cointegration technique suggested by Westerlund (2007) and Persyn and Westerlund (2008). Up until very recently, the econometrics literature has mostly been using residual-based panel cointegration techniques suggested by Pedroni (1999 and 2004) and McCoskey and Kao (1998).[28] Conversely, we adopt the Westerlund (2007) error correction based cointegration technique where he developed four panel cointegration tests which are based on 'structural rather than residual dynamics and, for that reason, do not impose any common-factor restriction' (Persyn and Westerlund 2008). The rationale for using the Westerlund test statistics is to check whether error correction exists for the panel as a whole or for the individual countries in the panel:

[27] They assume individual unit root process.

[28] Also see Pedroni (2001), Kao and Chiang (2001) and Mark and Sul (2003).

$$
\begin{aligned}
\Delta \mathrm{LP}_{\mathrm{i,t}} = \alpha_i^L &+ \lambda_i^L\big(LP_{i,t-1} - \beta_i^L FDI_{i,t-1} - \gamma_i^L TOP_{i,t-1} - \delta_i^L GP_{i,t-1} \\
&- \varrho_i^L RD_{i,t-1} - \emptyset_i^L HCI_{i,t-1}\big) + \sum_{j=1}^{m} \theta_{i,j}^L \,\Delta L_{i,t-j} \\
&+ \sum_{j=1}^{n} \forall_{i,j}^L \,\Delta FDI_{i,t-j} + \sum_{j=1}^{o} \varphi_{i,j}^L \,\Delta TOP_{i,t-j} + \sum_{j=1}^{p} \tau_{i,j}^L \,\Delta GP_{i,t-j} \\
&+ \sum_{j=1}^{q} \rho_{i,j}^L \,\Delta RD_{i,t-j} + \sum_{j=1}^{k} \vartheta_{i,j}^L \,\Delta HCI_{i,t-j} + \varepsilon_{i,t} \qquad (5)
\end{aligned}
$$

where the parameters λ_i^L are the error correction parameters which are also known as the speed of adjustment parameters, providing the long-run equilibrium information for country *i*, whereas, the $\varepsilon_{i,t}$ is the white noise error terms.

The Westerlund panel cointegration technique is classified into two different tests to investigate the null hypothesis of no cointegration: group mean test statistics and panel test statistics. . Westerlund (2007) developed four panel cointegration techniques ($G_a, G_t, P_a, and\ P_t$) which are based on the Error Correction Model (ECM). In the group mean tests, the weighted sum of λ_i^L are estimates for individual countries, while the panel tests are based on only λ_k which is for the panel as a whole. All four statistics are based on normal distribution. It is worth mentioning here that for G_t and P_t, their computation is based on the standard errors of λ_i^K in a standard way, whereas, G_a and P_a are based on the standard errors of the model of Newey and West (1994), which are adjusted for auto-correlations and heteroscedasticity. All variables are integrated of order one I(1).

Cointegration is checked to determine the presence of error-correction for individual countries and for the whole panel. In this model, $\lambda_i^K < 0$ implies there is an error correction which suggests that $LP_{it}, FDI_{it}, TOP_{it}, GP_{it}, HCI_{it}$ and RD_{it} are cointegrated. However, $\lambda_i^K = 0$ would suggest no error correction and therefore no cointegration. Hence, the null of no cointegration for the G_a and G_t test statistics are; $H_O^G : \lambda_i^K = 0$ for all *i*, while the alternative hypothesis is $H_1^G: \lambda_i^K < 0$ for at least one *i*, which suggests that cointegration is present for at least one cross-section unit. Consequently, the coefficient of adjustment λ_i^K would then be heterogeneous across cross-sections. For the P_a and P_t test statistics, the null hypothesis is $H_O^P: \lambda^k = 0$, while the alternative hypothesis is $H_1^P: \lambda^k < 0$, which further suggests that cointegration is present for the whole panel.[29] Therefore, the rejection of the null means the presence of cointegration for the panel.

Lastly, we use the vector error correction model (VECM) to test for short-run as well as long-run behaviour of the variables. The vector error correction model demonstrates short-run dynamics as well as long-run properties of the variables because it comprises variables both in levels and in differences.

4.4.4 Vector Error Correction Model (VECM) Estimation

In the regression analysis, certain problems arise while estimating dynamic models with lags of the dependent variable. One is the obligation to use the lagged dependent variable. The causality test has a strict restriction as the timing of the variable is the focal point of the analysis. One advantage of using a vector auto-regressive (VAR) model is that the causality tests can be implemented in such a way where variables are permitted to be determined simultaneously. A vector error correction model (VECM) is a restricted VAR where restrictions from the co-integration model are built into the condition so that it is well designed to apply with non-stationary series that are said to be co-integrated. The VECM limits the long-run behaviour of the endogenous variables to come together to their co-integrating relationship while allowing an extensive series of short-run dynamics. The co-integration term is recognized as an error-correction term since any divergence from long-run equilibrium is adjusted through a series of partial short-run adjustment. The VECM will obtain the following form for the five variables used in the paper:

[29] The panel tests accepts that $\lambda_i^K = \lambda^k$ for all *i*. Therefore, the alternative hypothesis suggests that the equilibrium adjustment is homogeneous across sections.

$$\Delta LP_{it} = \alpha_0 + \sum_{i=1}^{m} \beta_{1,ik}\, \Delta LP_{j,t-i} + \sum_{i=1}^{n} \beta_{2,ik}\, \Delta FDI_{j,t-i} + \sum_{i=1}^{n} \beta_{3,ik}\, \Delta TOP_{j,t-i} + \sum_{i=1}^{n} \beta_{4,ik}\, \Delta GP_{j,t-i} + \sum_{i=1}^{n} \beta_{5,ik}\, \Delta RD_{j,t-i} + \sum_{i=1}^{n} \beta_{6,ik}\, \Delta HCI_{j,t-i} + \varphi_1 ECT_{t-1} + \varepsilon_{it} \quad (6)$$

where, Δ represents the first difference, FDI is the foreign direct investment, TOP is the trade openness, GP is the gender parity, RD is the investment in research and development, and HCI is the human capital index and β's are parameters to be estimated. ε_{it} is a white noise error term, and ECT_{t-1} is the error correction term resulting from the long-run equilibrium relationship which is expected to be negative, the value of ECT_{t-1} indicates how quickly the equilibrium is restored (Gujarati 2009).[30] A significantly negative value would be evidence of a stable, long-run relationship between labour productivity and its determinants.

4.5 Panel Identification and Empirical Test Results

The core idea is to estimate the labor productivity growth and its determinants in SAARC. The panel tests are more powerful than the time series tests due to the exploitation of cross-section dimension. To consider whether the cross-section dependence assumption is met or not, a cross-section dependence (CD) test is applied. Table 4.2 illustrates the findings for the CD test proposed by Eberhardt (2012). Under the CD analysis with the null hypothesis of cross-section independence in all panels, we find cross-section dependence in all variables except for the gender parity index.

[30] The negative error correction term indicates the speed of adjustment towards the long-run equilibrium and in our case if LP, FDI, TOP, GP, HCI and RD are above its equilibrium value, they will start declining in order to return to the equilibrium.

Table 4.2: Cross-Section Dependence Test Results

Variable	CD Test	P-value
LP	1.880	0.059
GP	-0.520	0.602
FDI	5.180	0.000
RD	1.810	0.071
TOP	3.220	0.001
HCI	13.609	0.000

Note: Null hypothesis states that the series are cross-section independent. CD~ N (0, 1).

The results of the panel unit root tests proposed by Levin, Lin and Chu (2002), Im, Pesaran and Shin (2003), Fisher Chi-square using ADF, and PP Tests ((Maddala and Wu (1999), Choi (2001)) (presented in Table 4.3 and 4.4) indicate that the panel series, at level, display a unit root and, at first difference, are stationary. All our series are I(0).

Table 4.3: Panel Unit Root Test Results (at level)

	Levin, Lin and Chu		**Im, Pesaran and Shin**		**ADF-Fisher Chi-Square**		**PP-Fisher Chi-Square**	
Variable	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
LP	4.407	1.000	5.454	1.000	3.011	0.933	3.480	0.900
FDI	5.218	1.000	5.938	1.000	0.404	0.999	2.532	0.960
GP	-0.289	0.386	0.471	0.681	7.647	0.469	7.531	0.481
TOP	3.442	1.000	2.910	0.618	6.258	0.618	6.962	0.541
RD	-0.863	0.194	0.527	0.701	2.963	0.813	6.424	0.377
HCI	-1.608	0.0539	0.054	0.521	7.062	0.529	9.888	0.273

Note: Probabilities for Fisher tests are computed using an asymptotic Chi-Square distribution. All other tests assume asymptotic normality.

Table 4.4: Panel Unit Root Test Results (at first difference)

	Levin, Lin and Chu		**Im, Pesaran and Shin**		**ADF-Fisher Chi-Square**		**PP-Fisher Chi-Square**	
Variable	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
LP	-3.109	0.001	-3.965	0.000	32.940	0.000	33.300	0.000
FDI	-8.035	0.000	-8.783	0.000	74.620	0.000	78.050	0.000
GP	-7.675	0.000	-7.326	0.000	64.070	0.000	68.310	0.000
TOP	-9.290	0.000	-10.870	0.000	92.920	0.000	95.500	0.000
RD	-3.737	0.000	-3.073	0.001	20.770	0.002	43.920	0.000
HCI	-1.992	0.023	-2.341	0.009	24.331	0.002	54.903	0.000

Note: Probabilities for Fisher tests are computed using an asymptotic Chi-Square distribution. All other tests assume asymptotic normality.

After the stationarity check, we proceed with the panel cointegration test. The results of the panel co-integration tests are presented in Table 4.5. We find strong cointegration for the group and pooled panel test statistics (Table 4.5) which suggests that all the variables are cointegrated, where a refers to the error correction estimation and t refers to the standard error estimations (Persyn and Westerlund 2008).

Table 4.5: Westerlund Panel Cointegration Test Results

Statistics	**Value**	**Z-value**	**P-value**
Gt	-3.188	-2.887	0.002
Ga	-15.87	-2.582	0.005
Pt	-6.084	-2.632	0.004
Pa	-14.21	-3.150	0.001

Note: Results for H0: no cointegration; ‘xtwest’ Persyn and Westerlund (2008) is used

Table 4.6: Vector Error Correction Test Results

Dependent Variable: LP			
Regressors	**Coefficient**	**Standard Error**	**T-statistics (P-value)**
FDI	0.052	0.013	3.9053 (0.000)***
GPI	1.864	0.597	3.1202 (0.002)**
TOP	0.191	0.105	1.8084 (0.073)*
HCI	0.888	0.309	2.866 (0.004) **
RD	0.093	0.032	2.9066 (0.004)**

Note: * ,** and *** indicate significant at10%, 5% and 1% level of significance. Probability values of t-stats are given in parenthesis. R^2=*0.620* and *ECT(-1) -0.015*

Table 4.6 presents the estimated coefficients for the VECM test estimation. All of the coefficients are significant at the 5% level of significance except trade openness which is significant at the 10% level. The variable with the largest effect on labor productivity is the gender parity index, where we can say that for a one unit increase in GPI, we expect to see about a 6.45% (exponent of GPI, which is equal to 1.864) increase in labor productivity growth. The coefficients of FDI, TOP, R&D and HCI are also positively correlated with labor productivity. The error correction term is negative and statistically significant which implies that labor productivity has long-run association with its determinants and that the estimated coefficient indicates that about 1.5% of this disequilibrium is corrected annually.

4.6 Conclusions and Policy Recommendations

In this paper, we have examined the impact of four determinants (foreign direct investment (FDI), research and development, trade openness and gender parity) on labour productivity in four developing Asian countries for the period of 1980 to 2013. We applied a recently developed panel co-integration and vector error correction model for the determinants of labor productivity. Thirty years of observations of labor productivity, trade openness, gender parity index and R&D investments were used in estimating the long run interaction in the selected countries. In the short-run and long-run, all five variables i.e. FDI, GP index, trade openness, R&D, and HCI – show positive effects on labor productivity. The strong and positive relationship between labor productivity growth and the gender parity index suggests that improvement in gender parity can have a significant impact on labour productivity in the region.

Gender parity plays a strong role in the process of productivity growth along with FDI, HCI and R&D. Our results suggest that gender parity can have a strong impact on productivity growth, although one aspect of gender parity that is critical when analysing the relationship between gender parity and labor productivity for SAARC countries is the availability of quality of education attainment. The data shown in Figure 4.4 reflect some differences across countries in terms of equal access to colleges and universities for males and females and there are differences according to the cultural and social norms and the facilities provided to them, especially in Pakistan and Bangladesh. Gender disparity is a critical problem in developing countries especially in South Asia, where the gender gap in salary and employment is very high (Klasen and Lamanna 2009).

Findings of this study clearly show that FDI, GP index, trade openness, R&D, and HCI plays a key role in the labor productivity growth and have a great influence in the SAARC region. Hence, for the productive use of labor, government should have to ensure a secure and profitable environment for the investment in R&D, improvement in human capital and also have to create a balanced environment in providing equal opportunities to males and females so that desired level of productivity growth can be achieved and abilities of skilled women can be utilized.

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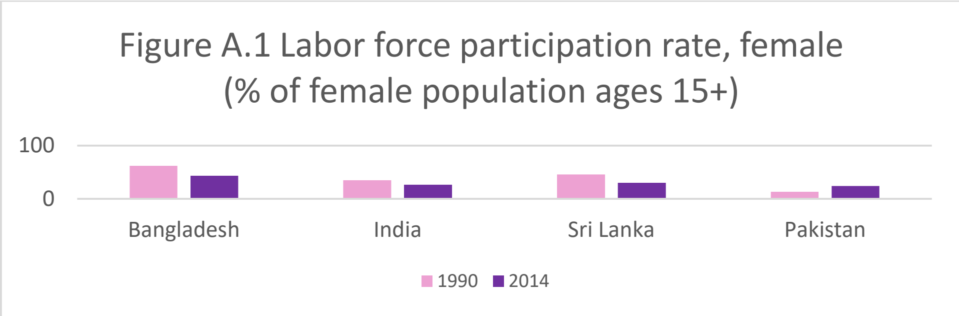
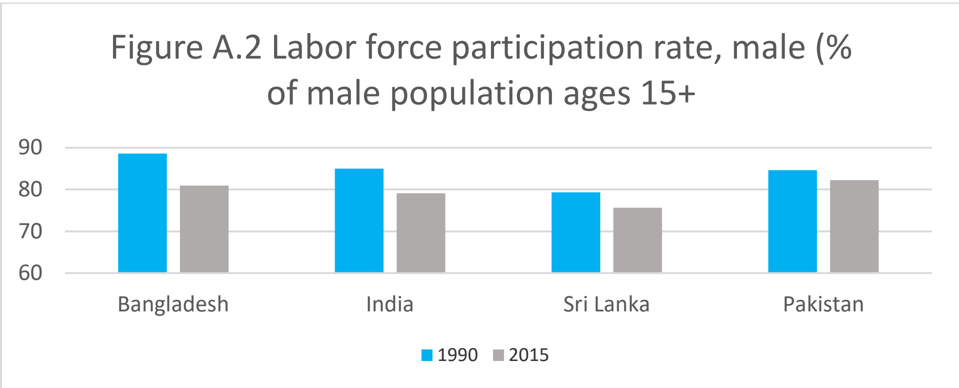
Appendix A - Labor Force Participation by Gender





Note: Calculations from UNESCO Institute for Statistics (2015)

Female labor force participation rate substantially decline across all countries except for Pakistan (Figure A.1). However, it also declines for males across all countries (Figure A.2).

Chapter 5 - Concluding Remarks: Main Findings and Future Research

The goal of achieving higher economic growth in the developing world is characterised by powerful dynamics that shape a country's comparative advantage and trade patterns. Countries trade because of their differences and to take advantage of scale economies. These reasons are captured in the theories of comparative advantage by Ricardo and new trade theory developed over the last 30 years beginning with Krugman. This goal seems distant particularly in Asian developing countries that face greater challenges due to low labor productivity growth. The aim of this thesis has been to analyse the relationship between comparative advantage, labor productivity and economic growth in Asian developing countries.

We have found that Asian developing countries that follow their comparative advantage can enhance their long-term economic growth. We have examined both the relationship between comparative advantage and economic growth and the long-run relationship between the determinants of labor productivity growth which can lead to further economic growth. In particular, the principal goal of this thesis has been to contribute to the body of available literature in understanding the relevance and importance of comparative advantage in the last 3 decades.

In the second chapter, the causal relationships between comparative advantage, exports, and economic growth has been analysed based on panel data set from Asian developing countries. In the third chapter, the comparative advantage specialisation (or de-specialisation) and convergence (divergence) patterns have been examined between China, the U.S., and the European Union for the last two decades for a variety of broad sectors. In the fourth chapter, we analysed the determinants of labor productivity growth in Asian developing countries. Lastly, this chapter provides a brief overview of the main findings and discusses paths of future research.

The second chapter analysed export patterns and economic growth by using panel cointegration and ARDL techniques. Our findings suggest that a country's existing comparative advantage plays an important role for economic growth for the specific countries under our analysis. The existing literature puts most of the focus on a country's deviation from their existing comparative advantage towards more dynamic and more competitive sectors. Development agencies and multilateral institutions advocated these thoughts and influenced economic policies but the results were at best controversial in achieving higher rates of growth. As was discussed in the second chapter, countries that follow their comparative advantage have performed better for the developing countries in our sample. We also examined the sectors that are most beneficial towards exports and economic growth. These results were interpreted as pointing towards the importance of comparative advantage and endowment structures of developing countries. As in the past, some of the governments were giving priority to the development of capital-intensive industries instead of focusing on the comparative advantage of their country and creating and enabling environment for the development of those sectors which matches a country's comparative advantage to become more competitive in the international market.

Chapter three examined convergence and divergence of trade patterns between China, the U.S., and the European Union (EU-15). The contribution of the paper is mainly empirical. We made a distinction between trade specialization within a country and trade convergence and divergence pattern within sectors across countries. Using Galtonian regressions, we find evidence towards trade specialization, where countries are focusing their exports in fewer sectors. We also find broad convergence across countries in different sectors using different measures of comparative advantage and different industrial classifications. The only outlier result was in the broadest classification of manufacturing.

Our main results, that there has been broad convergence across sectors and mixed findings of trade specialization within countries, are mostly in line with earlier results even with our use of different measures of comparative advantage and the use of different sectoral classifications. Our inclusion of China does lead us to find that they have shown a movement towards specialization (due primarily to their increase in comparative advantage in manufacturing over the time period) and that, in aggregate, the manufacturing sector is characterized by a pattern of divergence unlike all other sectors. This new result is due to China's rise in global trade and the decline in export manufacturing in industrialized countries export relative to China's export growth in manufacturing.

In chapter 4, the determinants of labor productivity for SAARC countries were analysed. We examined the impact of foreign direct investment (FDI), research and development (R&D), trade openness, human capital index and gender disparity on labor productivity for the period 1980 to 2013. We find that gender disparity plays an important role in limiting productivity growth in SAARC countries along with FDI, HCI, and R&D. The effect of trade openness is positive but significant at 10% only. It could be the case that for SAARC countries, further trade openness is not adequate to generate labor productivity growth as other factors are also relevant and play an important role nevertheless are difficult to control for empirical research.[31]

Our results suggest that gender parity has a strong impact on productivity growth, although one aspect of the gender parity that is critical when analysing the relationship between gender parity and labor productivity for SAARC countries is the availability of quality of education attainment. The data analysed do not reflect important cultural or social differences across countries in terms of equal access to higher education or education facilities between males and females. This is particularly indicative of patriarchal societies found in countries like Pakistan and Bangladesh. The econometric results deliver an indication on the significance of these differences to explain varied results for Pakistan and Bangladesh.

[31] For example, since the 1980s developments in trade liberalisation may also depend on some initial conditions, like the stock of knowledge and initial demand structure (Grossman and Helpman 1990).

Future Research

The research in this thesis has primarily focused on the analysis of a subset of developing countries in Asia but a similar analysis can be conducted for other developing regions of the world. The topics discussed also open the door for a more detailed analysis with the addition of product level data in order to better capture comparative advantage in the first and second papers. Moreover, it would be interesting if digital trade is considered in the analysis of comparative advantage between China, U.S, and the EU given the current news about copyright infringement and intellectual property theft by some Chinese firms.

The third paper examines the determinants of labor productivity in SAARC countries. It would be interesting to incorporate more years for the analysis and to add each of the SAARC country's policy influence on productivity growth. What would be the impact of structural policies on factor accumulation and multifactor productivity for a particular SAARC country? What would be the policy influence through investment in R&D, financial development and on labor utilization? This study also confirms the impact that gender disparity has on labor productivity in SAARC countries. It would be great to incorporate data for other SAARC countries and include them in this debate, particularly with respect to education level data and gender participation in their respective labor markets.

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