IMPACT OF TELECOMMUNICATION INFRASTRUCTURE AND INSTITUTIONAL QUALITY ON INTRA-SAARC TRADE EFFICIENCY

By

Hafiz Sajid Imran
08/Mphil-ECO/PIDE/2014

Supervisor

Dr. Hafsa Hina

Co-Supervisor

Dr. Ahsan ul Haq Satti

A dissertation submitted to the Department of Economics, Pakistan Institute of Development Economics Islamabad, in partial fulfillment of the requirements for the degree of Masters of Philosophy in Economics.

Department of Economics
Pakistan Institute of Development Economics
Islamabad

2017

Pakistan Institute of Development Economics

CERTIFICATE

This is to certify that this thesis entitled: **"Impact of Telecommunication Infrastructure and Institutional Quality on Intra-SAARC Trade Efficiency"** submitted by Hafiz Sajid Imran is accepted in its present form by the Department of Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree of **Master of Philosophy in Economics**.

External Examiner:

Dr. Javed Iqbal
Assistant Professor
Quaid-i-Azam University
Islamabad

Supervisor:

Dr. Hafsa Hina
Assistant Professor
PIDE, Islamabad

Co-Supervisor:

Dr. Ahsan ul Haq
Assistant Professor
PIDE, Islamabad

Head, Department of Economics:

Dr. Attiya Y. Javid
Professor/Head
Department of Economics
PIDE, Islamabad

DEDICATION

To my loving parents without whom this never possible

ACKNOWLEDGEMENTS

In The Name of Allah, Most Gracious, Most Merciful

I would like to start this page with my heartfelt, deepest gratefulness and gratitude presented to Allah Almighty "Praise be to Allah, the Lord of the worlds". His benevolence, affection, generosity, and blessings are even beyond our imaginations and deeds. The completion of this dissertation would have been entirely a dream without the strength and guidance provided by Allah Almighty. Thanks to Allah for wisdom and perseverance which has been bestowed upon me as we can turn impossible in to possible through Him who gives us strength. I am indebted to all those who were a part of my entire journey during my Mphil.

First, I would like to offer special thanks to my supervisors, Dr. Hafsa Hina, and Dr. Ahsan ul Haq Satti who are no doubt a professional, competent and expert economist along with strong personal traits as being the most generous, affectionate, and patient and loving ones. However, their excellent guidance, professional advice and availability throughout my dissertation period have been the most supportive factor in the completion of this dissertation. I feel lucky and among the blessed ones to get an opportunity to work under their supervision.

With due regard and respect, I would also like to thank my loving teacher Hafiz Abdul Sattar, for his encouragement and best wishes. I also want to thank my brothers for their unequivocal support. I owe the deep gratitude to Muhammad Naveed, Wasim Saleem and Furqan Maqsood who are amongst my dear friends and are blooming and emerging young economists. They were very helpful in all kinds of discussion. I would also like to thank my friends, Muhammad Mujahid Iqbal, Ali Raza Cheema, Muhammad Waqar, Junaid Nasrullah, Khawar Shehzad and Mahmood Yousafzai.

Hafiz Sajid Imran

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ABSTRACT

Regional cooperation increases productivity and efficient allocation of resources. The difference in institutions and other inputs across countries will determine the trade pattern of a country. it is widely held believe that open access institutional structure and improved infrastructure increase the productive capacity of a country that leads to more trade. One important determinant of regional integration is the investment in telecommunication infrastructure. This will not only reduce the transportation cost but also improve the institutional quality of a region. So, investment in telecommunication has direct and indirect impact on trade. This study, explore the role of telecommunication in enhancing the trade within SAARC countries. The study will use the data from 1995-2015 for all member countries of SAARC and use structural equation modelling with confirmatory factor analysis will be used to estimate the factor scores. Then these factor scores are used in data envelopment analysis and regression splines to find the trade efficiency. The study found that in SAARC telecommunication infrastructure has a positive and significant impact on trade and institutional quality. The study estimates that one unit increase in telecommunication infrastructure will lead to 0.98 units increase in trade within SAARC. The study also finds that the investment in telecommunication infrastructure requires a certain level of institutional quality without this the impact will be negative. The study recommends that SAARC should focus on improving telecommunication infrastructure as well as the institutional quality of the region.

Keywords: Regional Integration, Structural equation modeling, Data envelopment analysis, Multiple Regression splines analysis

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

From many decades, trade has been used as a tool to stimulate growth. The recent literature shows that economic cooperation among countries accelerates the trade and growth. (Sapir, 1992; Baldwin & Venables, 1995; Vamvakidis, 1998; Kamau, 2010). South Asian Association for Regional Cooperation (SAARC) is an example of such cooperation and integration. SAARC has been created to enhance cooperation and trade among south Asian countries.

In the digital world, telecommunication plays an important role to enhance trade among countries. The telecommunication facilitates the flow of information and reduces the distance between countries and markets (buyers and sellers). Easy and quick access to information is necessary for markets to perform their functions. The information will also create demand for idle resources and improve the overall efficiency and productivity of the country (Edmund Phelps, 1970).

The level and quality of telecommunication infrastructure are necessary for enhancing trade efficiency and level of development of a developing country. In the start of 1960 research began to concentrate the impacts of telecommunication framework on output. There are considerable amount of studies (Jip, 1963 & Hardy, 1980) that experimentally demonstrate the positive connection between telecommunication foundations and economic development.

Recent world growth in network infrastructure and tele-accessibility reflects the important role telecommunications play in economic growth. Between 2005 to 2016 the world telephone line decreased from 1243 million to 1013 million (average annual decrease of 1.9 percent) but on the other hand mobile-cellular telephone subscriptions and fixed broadband subscriptions increased from 2205 million to 7377 million and 220 million to 884 million (average annual increase of 10.2 and 11.73 percent) respectively (ITU, 2016).

The New Institutional Economics suggests that a social order includes the political, economic, cultural, religious, military and educational systems. Therefore, changing the social order involves changes in each of these elements and the relationship between them[1].Empirical evidence, particularly the series of papers by La Porta, Lopez-de-Silanes, Shleifer and Vishny (e.g. 1997, 1998), and Acemoglu, Johnson and Robinson (e.g. 2001, 2002), suggested two important facts. First, for better economic performance institutions matter. Second, developed countries have much better institutions than the developing countries.

The trade models based on gravity equation show that better institutions can foster the trade. Anderson and Marcouiller (2002) finds that institutional quality effects bilateral trade volumes between the trading countries positively. De Groom *et al* (2004) finds that the institutions and governance quality have a positive and significant impact on bilateral trade flows. Helble *et al* (2007) looks at the institutional transparency on trade of countries in Asia-pacific region. They find that the trading environment with higher transparency through greater obviousness and clarification of regulations has reduced trade cost significantly.

South Asia is the least integrated region, the main reason for this low integration is the intra-regional conflicts. In 2009 25th anniversary of the advent of South Asian Association of Regional Cooperation (SAARC) has been observing by the world. In 2006 South Asia Preferential Trade Agreement (SAPTA) is converted in to

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[1] Douglass C. North, Johan Joseph Wallis and Barry R. Weingast. Violence and social orders a conceptual framework for interplaying human history.Institutions and institutional change

South Asia Free Trade Agreement (SAFTA). Six South Asian countries except Afghanistan and Bhutan have been practicing the Most Favored Nation (MFN) principles and are members of World Trade Organization (WTO).

It is predicted that intra-regional formal trade growth will be US$11 billion in 2007 to US$40 billion in 2015[2] due to SAFTA (RIS2008). But South Asia is far behind to achieve this goal. In South Asia, intra-regional performance of trade is very stumpy.

The share of SAARC countries in the world trade is 2.6 per cent and the intra-SAARC trade is less than 5% of total trade. Whereas, the shares of intra-regional trade in ASEAN and EU are 35% and 60% respectively (World Bank, 2016). Many Studies tried to explain the bad performance of SAARC, one of the reason is the high transportation and transaction cost between two largest member countries, World bank estimated that it is 20 per cent expensive for India to trade with Pakistan than Brazil (World bank, 2016).

Some regional organizations could not perform well when member countries are underdeveloped. They have lack of industrial basis, small size of markets, producing consumer goods and have weak infrastructure and socio-economic condition. Due to political differences, border conflicts and poor economic performance of member states, SAARC almost failed to achieve its main objective during last 25 years due to above stated reasons (Maryam Akhtar, 2014).

The ineffectiveness of SAARC is due to the demographic distinctiveness of SAARC region (Zaman, 2014). Some consider economic system and education backwardness as major reason for the failure of SAARC (Atif & Farooq, 2014). One of the SAARC's key priorities is regional cooperation but growth in region is imped by lack of connectivity, limited intraregional trade, and tiny trade in energy. To get rid of

[2] (Prabir De, 2010)

life-threatening level of poverty a serious thinking to boost regional cooperation is the need of time for South Asian countries. Go forward, what South Asia can do to enhance its regional trade and for achievement of better integration?

South Asian Countries come together by cooperation, better institutions and better infrastructure (especially telecommunication infrastructure) because cost of trade within South Asia is higher than the cost of trade with world's other regions. Transaction cost is reduced by a better telecommunication infrastructure in numerous markets and in turn leads to economic growth.

1.2 Objectives of the Study

The primary objective of the study is to investigate the impact of telecommunication infrastructure and institutional quality on intra SAARC trade. The study will check the direct and indirect impact of telecommunication infrastructure on intra SAARC trade.

- Through direct channel study will check the impact of telecommunication infrastructure on intra SAARC trade.
- Through indirect channel, study will check the impact of telecommunication infrastructure on intra SAARC trade by using institutional quality as a mediatory variable.

1.3 Contribution of the Study

The revolution in telecommunication sector has not only increased the productivity, but also the cost of production has decreased significantly. The cost of production and transaction cost are the main determinates of trade. The dismal performance of SAARC is heavily discussed in literature and strategies to enhance trade within SAARC have been identified. None of the study as per my limited knowledge has yet analysed the impact of investment in ICT on trade within SAARC.

This study will contribute into literature by simultaneously estimating the impact of ICT and institutional quality on trade for SAARC.

1.4 Structure of the Study

The study has 5 chapters. The chapter 2 of the study provides a review of literature on the subject. The variables description, data sources and methodology used in this study for empirical analysis are given in chapter 3. The empirical outcomes and their explanation is provided in chapter 4. Based on the results, Chapter 5 caveats conclusion and policy implications.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews the literature on economic growth, telecommunication infrastructure, trade and institutional quality. Section 1 discusses the relationship between economic growth and telecommunication infrastructure. Section 2 discusses the relationship between economic growth and trade. Section 3 presents how institutions enhance trade and finally the last section gives the concluding remarks on review of literature.

2.1 Telecommunication Infrastructure and Economic Growth

Madden and Savage (2000) have studied the relationship between telecommunication infrastructure and economic growth through growth model of Mankiw *et al* (MRW, 1992). Panel data for 43 countries from 1975 to 1990 is used in this study. The study concludes that economic growth effected by telecommunication investment positively and significantly across the countries. Mattoo *et al* (2001) examined the impact of liberalization of services sector on output growth for the period 1990 to 1999. Regression analysis and two different approaches are used in the study. First they construct the indices for telecommunication and services sector and second were partial liberalization policy. The study concluded that the trade liberalization in telecommunication and services sector grow up 1.5 percent faster the economy.

Over the period of 1970 to 1990, a micro model for telecommunication investment with a macro production function is estimated by Roller and Waverman (2001) for 21 OECD countries. They estimated a structural model that endogenizes investment in telecommunication. The results indicate that relationship between telecommunication investment and economic growth is positive and significant.

Jacobsen (2003) estimated that whether telecommunication served as a mean to achieve economic growth in developing countries. The study has used panel data analysis, the sample period was from 1990-1999 and eighty-four countries were selected that represented all income groups and regions. In order to take into account, the reverse causality a micro model of supply and demand for telecommunications investments is specified then it estimated together with an aggregated production function. Both micro and macro model were estimated in a simultaneous equation system. The results proposed the positive correlation among indicators of telecommunication i.e. (main telephone lines and cellular telephones) and growth. However, the negative effect of computers on growth was found.

For 22 OECD countries, Datta and Agarwal (2004) examined the long run relationship between growth and telecommunication infrastructure. For estimation, dynamic panel method is used. Framework of Barro (1991) and Levine and Renelt (1992) is used for cross country. 1980-1992 was the time span. The study concludes that gross domestic product and telecommunication is correlated positively and significantly.

Zahra *et al* (2008) by using data for twenty-four high income, middle income and low income countries from 1985 to 2003. Study used dynamic models with fixed and random effects to estimate the panel data results. They conclude that telecommunication infrastructure has positive and statistically significant correlation to per capita GDP. Second for causality, they apply Granger’s causality test which shows significant causal relationship from telecommunication infrastructure to per capita GDP and insignificant in reverse.

Seetharam and Varadharajan (2008) for 63 developing countries investigated the effect of penetration of telephone on economic growth. For the time from 1990 to 2001 they take data from World Development Indicators and from book of international telecommunication. They used 3SLS to estimate such relationship. To consider the two-way causation between them they developed a structural model that navigates from the micro-level demand and supply of telecom services to aggregate changes in telecom penetration and the macro production function. After controlling the effects of capital and labor they found a positive impacts of landline phones and mobile on output.

Hashim *et al.* (2009) for Pakistan analyzed the influence of infrastructure of telecommunication on economic development. The sample based on the period from 1968 to 2007. Economic development was measured by gross domestic product, while investment in telecommunication sector and tele-density were used as predictors. Their model was same like as proposed by Alleman *et. al* (2003) for their empirical. Both key independent variables showed the significant and positive impact on gross domestic product. Czernich *et al* (2011) analyzed the impact of broadband infrastructure on economic growth. Using instrumental variable approach for a panel of OECD countries, they found that GDP per capita growth had effected by the introduction and diffusion of broadband. By controlling the fixed effects for country and year, GDP per capita was 2.7-3.9% higher on average after broadband had introduced in a country than before its introduction. Annual per capita GDP growth raised by 0.9–1.5 percent by increase in the broadband penetration rate in terms of subsequent diffusion.

Chavula (2012) evaluated the impact of diffusion of telecommunication on living standards via growth of per capita income. For 49 countries of Africa, subsample analysis categorization was done that divided the countries into three income groups; low-income, upper-middle income, and upper-low income countries. To investigate the effect of mobile lines, the use of the internet and main fixed telephone lines on per capita income endogenous growth model of Barro's (1991) was used. The results for whole sample indicated that mobile telephony and main telephone lines have positive influence on the living standards of peoples in Africa. On the other hand, the impact of internet use showed no contribution towards economic growth.

To examine the long-run relationship and to detect the causality between telecommunication infrastructure and growth, Pradhan *et al*. (2014) employed a panel vector auto-regressive model. The time was used from 2001–2012 for G-20 countries. Telecommunication infrastructure was measured through five different indicators i.e. number of telephone land lines (per 1000), number of mobile phone subscribers (per 1000), number of internet users (per 1000), number of internet servers (per 1000), number of fixed broadband (per 1000) and a composite index that was derived through principal component analysis by using the first five indicators. The evidence showed that telecommunication infrastructure causes economic growth.

Borrmann *et al*. (2006) has used panel data technique, the study has included 142 countries of the world. They estimated the models with and without interaction terms for trade and institutions. In both models, log-level of GNI per capita was used as a dependent variable. In this case, government regulations and good governance were used for measuring institutional quality. They firstly estimated by using OLS method. Finally, instrumental variable method was used to conclude the results. Their results proposed that the countries with low quality of institutions cannot take advantage of trade. However, it doesn't mean that countries which have weak institutions couldn't be able to achieve the gains from trade. Infect, the results demonstrated that these countries with their current institutional setting are not able to get benefit from trade.

Bankole *et al* (2015) for Africa have studied the effect of institutional quality and telecommunications infrastructure on efficiency of trade. They have used Panel data from 1998 to 2007 and for finding the results they used structural equation modelling with partial least square regression splines and data envelopment analysis. They have shown that telecommunication and institutional quality have significantly and positively affect the trade efficiency.

2.2 Trade and Growth

Extensive theoretical and empirical literature has been found on trade openness and economic growth. According to comparative advantage, the static gain from trade can be achieved through competition and specialization. While these gains with regard to the level of national production is collected yet to translate these growth effects, economies can adjust as new balance through the opening to international trade.

Theoretical progress in the trade and growth literature were supplemented by an increasing number of empirical literature has focused on the question of whether more open economies tend to grow.

For middle income developing countries the study of Tyler (1981) investigated the relationship between export expansion and growth empirically. The sample period was span from 1960 to 1977 and it comprised of inter-county cross-section data of 55 countries. The bivariate test shows the positive relationship between growth and other economic variable including export. He also establishes a production function and estimated results show that along with capital formation export performance is important.

Edwards (1992) uses the data of 93 advance and developing countries from 1960-90. He uses the nine different indicators of openness that have been used in earlier studies for examining the robustness of the openness-growth nexus, and concludes that the more open the economy the faster the productivity growth, the results are robust to the use of functional form, time period estimation technique and openness indicators that are used.

Frankel *et al*. (1996) used panel data comprising 100 to 123 countries. For the theory and testing the equation they considered the specification of Mankiw *et al.* (1992). The dependent variable was proxied by Gross domestic product. The outcomes of growth equations showed the role of openness in explaining rapid growth. The aim of study also to deal with the endogeneity of trade by using as instrumental variables. They also found that impact of openness on growth is even stronger when we correct for the endogeneity of openness.

Ekanayake (1999) by using annual data from 1960 to 1997 and co-integrations and error-correction model for estimation of eight developing countries in Asia studies the causal relationship of growth in export and economic growth. He concludes that the hypothesis of export led growth is strongly supported by the study. The bi-directional causality between economic growth and growth of export in all countries is also supported by study. Economic growth to growth in export granger causality exist except one country, while granger causality in reverse direction doesn't exist for all countries. Ghani (2011) analysed the impact of trade liberalization on imports, exports and per capita GDP for the period of 1975 to 2004 in Pakistan. Bop model was used in the study. The result shows that little bit increment in per capita GDP but overall economic situation has not significantly improved after trade liberalization.

Because of Engle and Granger, through unit root test and Error Correction Modelling(ECM) approach, problem of non-stationary of variables have been addressed by single country analysis using time series technique for finding the association between economic growth and international trade.

Fajana (1979) analyzed the effect of international trade on growth of Nigeria. The data of all relevant variables were taken over the period 1954 to 1974. Moreover, the data was abstracted two sources., *International Monetary Fund* and the *Federal Office of Statistics Nigeria.* The study also assessed the relative impact of two main export (petroleum and agricultural produce) on the growth of Nigeria. The empirical outcomes concluded that for Nigeria trade is a vital engine of growth.

Piazolo (1995) studied the determinant of South Korean economic growth using time series annual data from 1955-90 and conclude that export enhances the economic growth along with human capital and investment, using co-integration and error correction technique. Henriques and Sadorsky (1996) using the annual time series data from 1870 to 1991 for Canada, studied the hypothesis, Export-Led Growth or Growth-Driven Export. They had constructed a (VAR) for testing the Granger (1969) causality between the said variables. Like the study of Kunst and Marin (1989) for Austria they also concluded that for Canada a long run steady state exists among variables and Growth-led Export hypothesis can’t be rejected.

Din et al (2003) studied the association between trade and growth for Pakistan. The analysis was based on time series data from 1960 to 2001 taken annually. They adopted bivariate (VAR) framework, for examining the relationship between openness and economic growth the concept of granger causality is employed. They conclude that in the short run no causality exist between trade openness and growth, but for the long run bi-directional causality is present that indicates openness and trade fortify each other in the long run.

Khan and Qayyum (2007) for Pakistan inspected the impact of financial and trade liberalization on economics growth. The data was collected from annual observation over the period of 1961-2005. Bound testing approach was used in the study. The results showed that financial and a trade policy increases the growth rate in long run but, in short run responses of deposit and trade are very low. Asma Arif and Hasnat Ahmed (2012) studied that either the long run relationship is exist between trade openness and growth output in Pakistan or not for the period from 1972 to 2010 and applying Engle-Granger co integration and Error Correction Term (ECT) for estimation. They found that there is a positive and significant relationship between variables showed by (ETC) term and there exist bi-directional causality between variables shown by Engle-Granger co integration.

2.3 Institutions and Trade

Anderson and Marcouiller (2002) developed a model to measure the reduction in trade by using a structural model of import demand for 48 developing and developed countries. In the model insecurity acts as a hidden tax on trade and they didn't construct a political economic model. They abstracted data from the World Economic Forum to measure the quality of institutions. Finally, the outcomes suggested that imperfect contract enforcement and corruption dramatically reduce international trade. Moreover, they found that inadequate institutions constrain trade as much as tariffs do.

Beugelsdijk *et al*. (2004) measure the different dimensions that explain variations in pattern of trade. Apart from physical dimensions, they evaluated the impact of culture and institutional distance that affect the amount of trade between countries. Bilateral trade data was taken from IMF Direction of Trade Statistics for 178 countries over the period 1948-1999. Institutional difference was measured by the Kaufmann governance indicators. They proposed that above two explained dimensions are important for variation in trade pattern. The results suggested that inverted U shaped exist regarding culture distance and a negative hyperbolic regarding institutional distance is found.

De Groot *et al.* (2004) estimated gravity equations to identify the effects of institutions on bilateral trade for more than 100 countries. They focused on trade patterns in 1998. The study contributed in existing literature in two ways: Firstly, they used the most recent data set to measure the quality of governance. Secondly, with analyzation of effect of institutional the effect of similarity in governance quality is also examined. They constructed dummy variables for the various dimensions of governance to capture the similarity in institutional quality. However, the findings concluded that institutional quality has a positive impact on bilateral trade flows and institutions play a dominant role in explaining why rich countries trade more as compared to poor countries.

Gani and Prasad (2006) investigated the relationship between export, import total trade determinants with an institutional focus for six Pacific Island countries over the period 1996-2005. They used four indicators of institutional quality., government effectiveness, rule of law, regulatory quality, and control of corruption. Based on the fixed effect method their results indicated that improvements in institutional quality matter for improved levels of trade.

Levchenko (2006) studied the impact of institutions like property rights, quality of contract enforcement and shareholders' protection on the international trade. In this study researcher modeled the institutional differences within the context of incomplete contracts. Results showed that because institutional differences less developed countries may not gain from international trade and factor process may diverge. Study also found that institutional differences are significant determinant of international trade flows.

Francois (2007) examined the institution, infrastructure, and trade nexus. To check the pattern of bilateral trade they used institutional quality infrastructure and trade preferences data. Study revealed that institutional quality and infrastructure are the significant determinants of export level. Propensity to take part in trading system and export performance all depends upon access to communication and transportation infrastructure and institutional quality.

Iwanow (2008) traced the impact of institutional quality on trade performance by using the bilateral trade data of 109 developing and developed countries. Through gravity model approach author showed that institutions can contribute to the export performance. Size and geography are important for export performance. Secondly business environment also the robust factor of export performance. Thirdly the countries with good institutional setting tend to export more.

Meon and Sekkat (2008) used a panel of 59 countries over the time span from 1990 to 2000. They examined the impact of different indicators of institutional framework on exports of manufactured goods, total exports, and exports of nonmanufactured goods. Their results indicated that only exports of manufactured goods are positively affected by quality of institutions. However, the outcomes demonstrated that the quality of the regulatory framework is the most robustly associated with manufactured exports. While the relationship of other dimensions of the institutional framework i.e. government effectiveness or rule of law with manufactured exports is less robust.

Batuo and Fabro (2009) conducted a research about the economic development, institutional quality, and regional integration in African countries. They used data of 49 countries for the period of 1996 to 2004 and employed the method of moments for estimation of dynamic panel. Results indicated that African regional groups where institutions are better, degree of regional integration is high and investment in human capital is higher have high per capita income.

Francois *et al* (2013) analyzed the impact of institutions and infrastructure on the trade. Authors used Poisson estimator, Baier and Berstrand method on the variable of bilateral trade, geographic specification, and income, trade policy and institutional quality. They are of the view that trade depend on the traders (exporters and importers), access to modern transportation and telecommunication infrastructure and institutional quality. Result showed that institutions quality and traders access significantly affect trade.

Fakher (2014) examined the role of intuitional quality on trade and foreign direct investment in Egypt. Two step analysis was used for the period of 1995-2010. In first step, he checked the impact of institutions quality on trade and in second step he checked the impact of institutional quality on the FDI. The empirical results revealed that Quality of Institutions have a positive and significant impact on trade flows and FDI. Study also found that quality of Institutions has larger statistically significant effect on FDI than trade.

2.4 Concluding Remarks

It appears from the review that in developing countries afterwards 2000 the telecom sector has gained importance for enhancing economic growth. Overall studies proposed that telecommunication plays an important role by providing a way of exchanging information that helps to advance a valuable commodity market and then it lead to economic growth. The literature on trade explored the positive relationship with economic growth. Over the past three decades’ trade liberalization has become widespread among developing and transition economies. Mostly studies concluded that the increased international trade facilitate the diffusion of knowledge from the direct import of high technology goods that result in enhancing economic growth. The above studies relating with institutional quality and trade mostly concluded the positive relationship between them.

In nutshell, we can say that telecommunication infrastructure and institutions can stimulate to trade and economic growth. We found that only some previous studies analysed the importance of both telecommunication infrastructure and institutional quality at the same time for many cross countries. While according to our knowledge no one evaluate the impact of both key variables for SAARC countries. So, in present study we attempt to examine the impact of infrastructure of telecommunication and institutions on trade by focusing on SAARC countries.

CHAPTER 3

METHODOLOGY AND DATA DESCRIPTION

This chapter presents the methodology used for the study and data sources along with the variables description. We have used the methodological framework developed by Bnkole *et al* (2014) to analyze the impact of infrastructure investment on trade efficiency in Africa. The primary objective of the study is to estimate the direct and indirect impacts of telecommunication infrastructure and institutional quality on the trade efficiency of SAARC countries. This chapter is divided into two sections. Section I describes the methodology used in the study for estimating the impact of telecommunication infrastructure on trade efficiency. Section II provides the detail description of each variable used in the study.

3.1 Model Description

This section is divided into three subsections; first section describes the structural equation modeling technique. Second section gives the detail description of data envelopment analysis used for estimating the trade efficiency. Last step is to estimate the interaction and conditional effects of institutional quality and telecommunication trade efficiency for SAARC region. So, the last section will discuss the multiple regression splines analysis technique used to analyze the impact of telecom index on trade efficiency. We have used structural equation modeling technique with confirmatory factor analysis to estimate the factor score. Further, we have used institutional quality a mediator variable to find the indirect impact of telecommunication on trade within SAARC.

The stage one of the analysis that is SEM contains three variables, TC, IQ, and TR. Where TC is, a latent exogenous variable having three factors, IQ is a latent endogenous variable with five factors and TR is a latent endogenous variable along with seven factors. There are two models involve in SEM estimations, one is the measurement model and other is structural regression model.

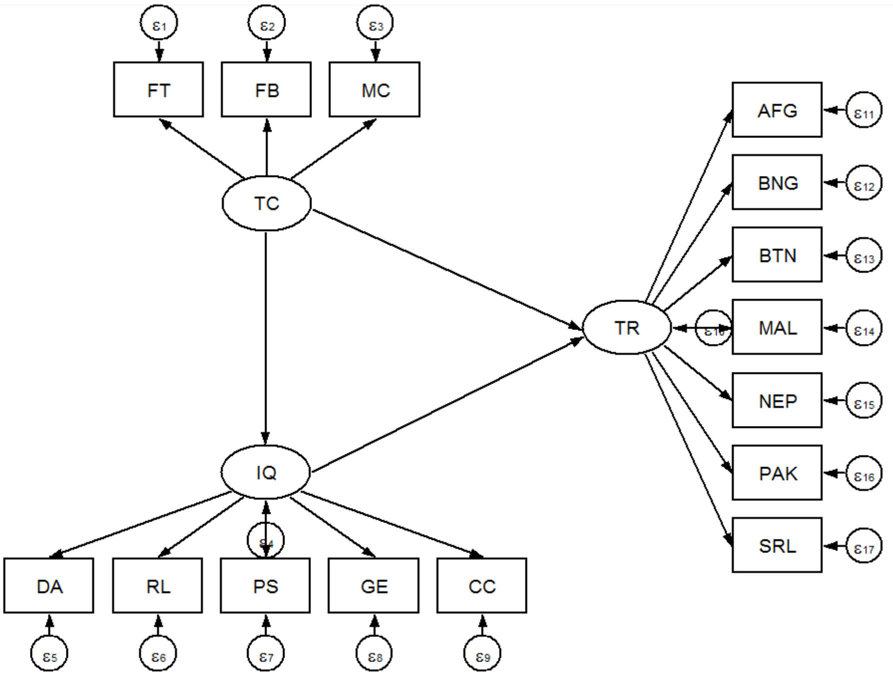
3.1.1 Structural Equation Modelling

Structural equation modeling (SEM) is a multi-equation modeling technique. This extends the general linear regression model (Fox, 2002). The ability of SEM to model the liaison among manifold independent and dependent variables is the biggest advantage of SEM over other modeling techniques (Hoe, 2008). It further helps to deal with all the variables that may affect other variables via direct channel or indirect channel (Fox, 2002). Since, SEM is a simultaneous equation modeling technique it is possible that dependent variable in any equation may also appears as independent variable in other equations (Urbach & Ahlemann, 2010).

Another advantage of SEM over other econometric techniques is that it allows the use of mediator variables. This is useful in case of finding indirect effect. The other econometric techniques deal the variables either controlled or exogenously. In order to estimate the intermediate effects, the studies suggested the use of SEM (Fox, 2002).

Most studies have used partial least squares (PLS) method to estimate the parameters in SEM (Morales, 2011). There are two iterative procedures in SEM with PLS approach; first multi component models and second the use of least squares estimation (Urbach & Ahlemann, 2010). Variance of dependent variable is minimized by these above mentioned iterative procedures. The SEM analysis is useful while developing a theory (Chin, 1998). Following diagram shows the conceptual framework of the SEM used in this study.

Stage 1: The impact of Telecommunication and Institutional Quality on intra SAARC Trade.



3.1.1.1 Mathematical Model for SEM

There are two parts of mathematical model, first is the measurement model and second is structural regression model.

3.1.1.1.1 Measurement Model

$$FB = \alpha_1 + \beta_1 TC + \epsilon_1 \text{ --------------------------------------- } (3.1)$$

$$MC = \alpha_2 + \beta_2 TC + \epsilon_2 \text{ --- } (3.2)$$

$$FT = \alpha_3 + \beta_3 TC + \epsilon_3 \text{ -- } (3.3)$$

TC: is the telecommunication infrastructure latent exogenous variable

Errors: ε_1, ε_2, ε_3

FB: fixed broadband users per hundred inhabitants, MC: mobile cellular users per hundred inhabitants and FT: the fixed telephone users per hundred inhabitants are the observed endogenous variable in this model measures of TC.

$$CP = \alpha_4 + \beta_4 IQ + \epsilon_4 \text{ --- } (3.4)$$

$$BQ = \alpha_5 + \beta_5 IQ + \epsilon_5 \text{ --- } (3.5)$$

$$GS = \alpha_6 + \beta_6 IQ + \epsilon_6 \text{ --- } (3.6)$$

$$RL = \alpha_7 + \beta_7 IQ + \epsilon_7 \text{ --- } (3.7)$$

$$DA = \alpha_8 + \beta_8 IQ + \epsilon_8 \text{ --- } (3.8)$$

IQ: is for institutional quality which is latent endogenous variable

Errors: ε_4, ε_5, ε_6, ε_7, ε_8

The measures of IQ in this model are CP: corruption perception, BQ: Bureaucratic quality, GS: government stability, RL: for rule of law and DA: democratic accountability.

$$AFG = \alpha_9 + \beta_9 TR + \epsilon_9 \text{ --- } (3.9)$$

$$BGD = \alpha_{10} + \beta_{10} TR + \epsilon_{10} \text{ --- } (3.10)$$

$$BTN = \alpha_{11} + \beta_{11} TR + \epsilon_{11} \text{ --- } (3.11)$$

$$MDV = \alpha_{12} + \beta_{12} TR + \epsilon_{12} \text{ --- } (3.12)$$

$$NPL = \alpha_{13} + \beta_{13} TR + \epsilon_{13} \text{ --- } (3.13)$$

$$PAK = \alpha_{14} + \beta_{14} TR + \epsilon_{14} \text{ --- } (3.14)$$

$$LKA = \alpha_{15} + \beta_{15} TR + \epsilon_{15} \text{ --- } (3.15)$$

(TC, IQ, TR, FB, MC, FT, CP, BQ, GS, RL, DA, AFG, BGD, BTN, MDV, NPL, PAK, LKA, ϵ_i) ~ i.i.d. with mean μ and variance Σ

Σ is constrained such that

$$\sigma\epsilon_i, \epsilon_j = \sigma\epsilon_j, \epsilon_i = 0 \quad i = 1,2, \ldots, 14 \; and \; j = i + 1$$

$$\sigma \, TC, \epsilon_i = \sigma \, \epsilon_i \, , TC = 0 \quad i = 1,2 \; 3$$

$$\sigma \, IQ, \epsilon_i = \sigma \, \epsilon_i \, , IQ = 0 \quad i = 4,5,6,7,8$$

$$\sigma \, TR, \epsilon_i = \sigma \, \epsilon_i \, , TR = 0 \quad i = 9,10,11,12,13,14,15$$

TR: for trade is the latent endogenous variable

Errors: ε_9, ε_{10}, ε_{11}, ε_{12}, ε_{13}, ε_{14}, ε_{15}

AFG: bilateral trade flows with Afghanistan, BGD: bilateral trade flows with Bangladesh BTN: bilateral trade flows with Bhutan, NPL: bilateral trade flows with Nepal, PAK: bilateral trade flows with Pakistan and LKA: bilateral trade flows with Sri Lanka are observed measures of TR.

3.1.1.1.1 Structural Regression Model

$$IQ = \gamma_1 + \gamma_2 TC + \varepsilon_1 \text{ -- } (3.16)$$

$$TR = \gamma_3 + \gamma_4 TC + \gamma_5 IQ + \varepsilon_2 \text{ -------------------------------------- } (3.17)$$

In structural regression model TC is a latent exogenous variable, IQ is a latent endogenous variable but plays a role of mediatory variable and TR is a latent dependent variable.

3.1.1.2 Mediation Test

Baron and Kenny (1986) have proposed a method to test the mediation in SEM. Equations 3.18 to 3.20 explain the mediation test developed by Baron and Kenny (1986). Where telecommunication infrastructure (TC) is the independent variable, trade (TR) is dependent variable and institutional quality (IQ) is mediator variable.

$$IQ = \alpha_1 + \alpha_2 \, TC + \epsilon_1 \text{--------------------------------------- } (3.18)$$

$$TR = \beta_1 + \beta_2 TC + \epsilon_2 \text{ -- } (3.19)$$

$$TR = \gamma_1 + \gamma_2 TC + \gamma_3 IQ + \epsilon_3 \text{ ------------------------------- } (3.20)$$

Where α_1, β_1, γ_1 are the intercepts; $\in_1, \in_2, \in_3$ are the error terms in all three models and α_2, β_2, γ_2 and γ_3 shows the relationship between all variables used in the model. We have used the above equations for mediation test, IQ is said to be a mediator if following are true:

i) The term α_2 in equation (3.18) shows the relationship between IQ and TC and it should be significant, this confirms that there exist a linear relationship between the mediator IQ and TC explanatory variable.

ii) in equation 3.19 the regression coefficient β_2 shows the relationship between trade (TR) and telecommunication index (TC). The significance of the β_2 implies that there exist a linear relationship between the trade flows (TR) and telecommunication (TC)

iii) The term γ_3 in equation 3.20 shows the relationship between TR and IQ. The significance of γ_3 shows that the mediator IQ explained variation in TR even in the presence of TC. The parameter γ_2 shows the direct effect of TC on TR even in the presence of mediator and another thing to note that the magnitude of γ_2 will be less than β_2 in equation 3.19.

(Sobel, 1982) has developed a z-test; equation 3.21 gives the test statistic. Equation 3.21 uses the parameters estimated in equations 3.18 to 3.20.

$$z = \frac{\alpha_2 \times \gamma_3}{\alpha_2 S_\alpha^2 + \gamma_3 S_\gamma^2} \text{---} (3.21)$$

Where α_2 and S_α^2 obtained from equation 3.18, while γ_3 and S_γ^2 are obtained from equation 3.20.

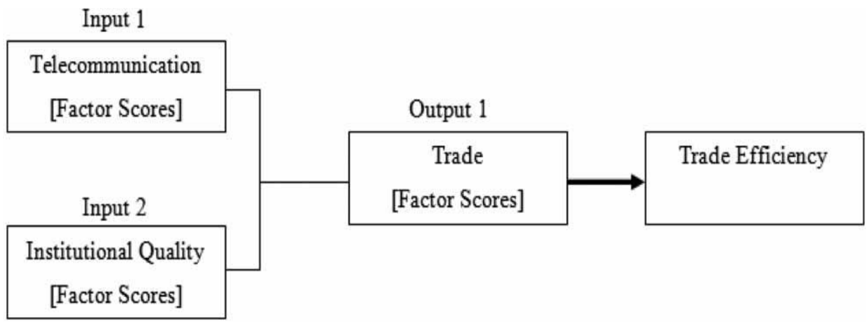
There is said to be no mediation if α_2 or γ_3 is not significant. If 3.18 and 3.20 holds, then we can conclude that there exists a "partial mediation". The mediation is said to be perfect if 3.18 to 3.20 hold and γ_2 is also significant.

Incorporating Multiple Indicators of TC, TR and IQ

The above-mentioned method is applicable to frameworks of maximum three variables, in this case only one indicator measure for all the variables. The present study uses the variables with a multiple indicator measure for each variable. The following figure illustrate the scenario of the multiple indicators of TC, TR and IQ. The situation in which latent variables are measured with multi-item scales, structural equation modelling (SEM) is the appropriate technique for examining mediation structure.

3.1.2 Data envelopment analysis (DEA)

Stage 2: Analysis of Trade Efficiency in SAARC Countries.



Data envelopment analysis (DAE) is used to measure the relative efficiencies for all the objects that have some decision making abilities, it is very famous and non-parametric method (Charnes *et al* 1978 & Farrell, 1957). The most important feature of DAE is its model specification, this requires that all decision making units (DMUs) should have functionally similar (Samoilenko & Bryson, 2010). In simple words DEA extract information for a population of interest for evaluating the efficiency given an efficient production plan. The DEA method estimates uneiqe production frontier for each DMU. It uses the linear programming to estimate efficiency for all decision-making units relative to other decision making units (Coelli, 1996 & Cooper *et al* 2011).

Farrell (1957) & Charnes *et al* (1978) have done pioneer work in DEA. Generally it is assumed that DEA model worked under constant returns to scale, but Banker *et al,* (1984) used DEA model with assumption of increasing & decreasing returns to scale. The constant return to scale implies that output increases proportionally to inputs. We can infer that when all decision-making units are operation at optimal scale, constant returns to scale assumption is suitable. As DEA is developed on theory of production, so we can use DEA model for both dimensions the cost minimization problem or output maximization problem. These are known as Input orientation or output orientation (Cooper *et al* 2011).

3.1.2.1 DEA Model

There are two different models of DEA i) ratio model by Charnes, Cooper and Rhodes (1978) ii) BCC model by Banker, Charnes and Cooper (1984).

To simply we suppose that, n DMUs are to be assessed. Every DMU uses different amount of *m* inputs to generate *s* different outputs. Explicitly DMUj consume amount *xji* of input i and generate amount *yir* of output *r*. we suppose that *xji* *≥0* and *yir ≥ 0.* It is further supposed that every DMU has at least one positive input and the one positive output.

The indispensable characteristic of the CCR model is that it reduce the dimensions of the model from multiple input and multiple output to single input and single output model. The output input ratio will give us the efficiency of a production plan and our objective function is to maximize the output per unit of input the above mentioned ratio for a particular DMU.

$$\max_{u,v} \; h_0 \; u, v \; = \sum_{r} u_r y_{r0} \; / \sum_{i} v_i \, x_{i0}$$

In the above equation u's and υ's are the variables (the x_{io}'s are the input used to produce output y_{io}'s for a DMUo to the DMU to be evaluated). Above equation is not bounded so we have to add some constraints in order to bound the above objective function.

We have introduced set of constraints, for each data measuring unit, the first constraint specify that the virtual output virtual input ratio of every data measuring unit should be less than or equal to 1. This constraint rules out the possibility of increasing returns to scale. It only captures constant returns to scale or decreasing returns to scale (see equation 2 below). The precise programming problem for the CCR ratio is given as

$$\max_{u,v} = \sum_r u_r y_{r0} \Big/ \sum_i v_i x_{i0}$$

$$\sum_r u_r y_{rj} \Big/ \sum_i v_i x_{ij} \leq 1$$

$$u_r, v_i \geq 0$$

Above mentioned ratio gives infinite number of solutions, if (u*, v*) is optimal, then (αu*, αv*) is also optimal for α > 0. We can define an equivalence relation, which screens the set of feasible solutions of (IR) into equivalence modules. The transformation developed by Charnes and Cooper (1962) for linear fractional programming chooses a representative solution from each equivalence module and vintages the equivalent linear programming

$$\max z = \mu^T Y_0 + u_*$$

$$\text{s.t.} \quad \upsilon^T X_0 = 1 \qquad (DI_0)$$

$$\mu^* e^T + \mu^T Y - \upsilon^T X \leq 0,$$

$$\mu^T \geq 0,$$

$$\upsilon^T \geq 0.$$

LP dual Problem is

min θ,

s.t. $Y\lambda \geq Y_0$,

$\theta X_0 - X\lambda \geq 0$, (PI$_0$)

$\theta X_0 - X\lambda \geq 0$,

We can solve any of the above equivalent problems. The optimal solution θ*, produces an efficiency score for a specific data measuring unit. The process is repeated for each DMUj, i.e., solve PI_θ, with $(X_\theta, Y_\theta,> = (Xj, Y_j)$. DMUs for which θ* < 1 are inefficient, while DMUs for which 0* = 1 are boundary points.

PI_θ, and DI_θ, denote one of the models to be examined. We will represent this model, one of the four input-oriented models to be considered, by I_θ .

The other models result from adding an additional constraint, involving $\Sigma_i^n = i\lambda_i$ to PI_θ. The appearance of this additional constraint in PI_θ introduces a corresponding variable u * in DI_θ , which is constrained given below.

Envelopment Problem

min θ,

s.t. $Y\lambda \geq Y_0$,

$\theta X_0 - X\lambda \geq 0$, (PI$_\rho$)

$\theta X_0 - X\lambda \geq 0$,

For *PI$_0$*: Append Nothing

For *PI$_1$*: Append $e^T\lambda \leq 1$,

For *PI$_2$*: Append $e^T\lambda \geq 1$,

For *PI$_3$*: Append $e^T\lambda = 1$.

Multiplier Problems

max $z = \mu^T Y_0 + u_*$

s.t. $\upsilon^T X_0 = 1$ (DI$_\rho$)

$\mu^* e^T + \mu^T Y - \upsilon^T X \leq 0,$

$\mu^T \geq 0,$

$\upsilon^T \geq 0.$

Where

$u_* = 0$ in *DI_0,*

≤ 0 in *DI_1,*

≥ 0 in *DI_2,*

Free in *DI_3.*

Output Ratio form

We have started with the output side and considered instead the ratio of virtual input to output as shown by

Min $\upsilon^T X_0 / \mu^T Y_{0,}$

s.t. $\upsilon^T X_j / \mu^T Y_j \geq 1,$ $j = 1 ,\ldots\ldots\ldots\ldots, n,$ (OR)

$\mu \geq 0,$

$\upsilon \geq 0.$

Again, the Charnes-Cooper (1962) transformation for linear fractional programming produces model DO_θ with related dual problem PO_θ. As before, the effect of appending a constraint involving to PO_θ is the introduction of a variable, v*, in DO_θ. The various possible dual forms for $O_{\rho,}$ $\boldsymbol{\rho}$ **=** 0, **1,2,3,** are

Envelopment Problem

max ϕ,

s.t. $X\lambda \leq X_0,$

$\phi Y_0 - Y\lambda \leq 0,$ (POρ)

ϕ free, $\lambda \geq 0.$

For PO_0: Append Nothing

For PO_1: Append $e^T \lambda \leq 1$,

For PO_2: Append $e^T \lambda \geq 1$,

For PO_3: Append $e^T \lambda = 1$.

Multiplier Problem

$$\min q = \psi^T Y_0 + u_*$$

$$\text{s.t.} \quad \upsilon^T Y_0 = 1 \qquad \text{(DP}\rho\text{)}$$

$$\upsilon^* e^T - \mu^T Y + \upsilon^T X \geq 0,$$

$$\mu^T \geq 0,$$

$$\upsilon^T \geq 0.$$

Where

$u_* = 0$ in DO_0,

≥ 0 in DO_1,

≤ 0 in DO_2,

Free in DO_3.

Table 3.1: DEA Models

Input-oriented	
Envelopment problem (*PIρ*)	Multiplier problem (*DIρ*)
min θ, s.t. $Y\lambda \geq Y_0$, $\theta X_0 - X\lambda \geq 0$, $\theta X_0 - X\lambda \geq 0$,	max $z = \mu^T Y_0 + u_*$ s.t. $\upsilon^T X_0 = 1$ $\mu^* e^T + \mu^T Y - \upsilon^T X \leq 0$, $\mu^T \geq 0$, $\upsilon^T \geq 0$.
For PI_0: Append Nothing For PI_1: Append $e^T \lambda \leq 1$, For PI_2: Append $e^T \lambda \geq 1$, For PI_3: Append $e^T \lambda = 1$.	Where $u_* = 0$ in DI_0, ≤ 0 in DI_1, ≥ 0 in DI_2, Free in DI_3.
Output-oriented	
Envelopment problem (*POρ*)	Multiplier problem (*DOρ*)
max ϕ, s.t. $X\lambda \leq X_0$, $\phi Y_0 - Y\lambda \leq 0$, ϕ free, $\lambda \geq 0$.	min $q = \psi^T Y_0 + u_*$ s.t. $\upsilon^T Y_0 = 1$ $\upsilon^* e^T - \mu^T Y + \upsilon^T X \geq 0$, $\mu^T \geq 0$, $\upsilon^T \geq 0$.
For PO_0: Append Nothing For PO_1: Append $e^T \lambda \leq 1$, For PO_2: Append $e^T \lambda \geq 1$, For PO_3: Append $e^T \lambda = 1$.	Where $u_* = 0$ in DO_0, ≥ 0 in DO_1, ≤ 0 in DO_2, Free in DO_3.

Table 3.1 presents these eight DEA models, each consisting of a pair of dual linear programs. The $I_{\theta} \ldots I_3$ are input-oriented and each of these is paired with an output-oriented model, $O_{\theta} \ldots O_3$

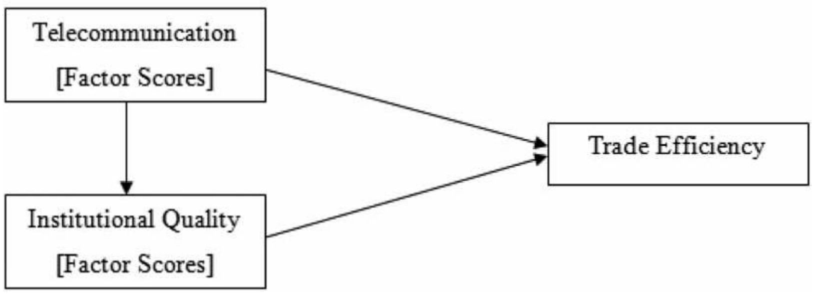
3.1.3 Multivariate Adaptive Regression Splines

According to (Friedman, 1990) the multivariate adaptive regression splines (MARS) can be used for linear and nonlinear functions. Like DEA it is also non-parametric technique and it can be used to estimate such relationships between variables which are not possible for any other regression model (Balshi et al 2009).

MARS divides the data into different locales (nonlinear data) and each locals shows a linear relationship between variables and it estimate the values of the model for a given locals. Usually, these locales are known as Knot and it is referred a point in the data at which the slope changes. We can write each function for a knot in MARS, these function are knows as the Basis Functions (BFs; Splines). These BFs can be a function of a single variable or it has some interaction of other BFs (Balshi *et al* 2009). The MARS model determines not only the parameters for each knot, but also the total number of BFs (Friedman, 1990). This feature of MARS allows him to eliminate the least useful set of variables, and it only uses the most relevant set of variables. The knot and variable pairs that provide the best model fit are preserved by the forward algorithm, and the linear functions that are non-zero on one side of the Knot utilize to preserve the response (Balshi et al 2009).

For our analysis, a better explanation (causal links, order of importance and interaction effect) can be provided by a predictive model such as RS (Ko & Osei-Bryson, 2006). In Information Systems (IS) research the use of MARS analysis is not new. To explore the impacts of information technology on firm performance it has been successfully applied (Ko & Osei-Bryson 2006, Kositanurit, Ngwenyama, & Osei-Bryson 2006, Osei-Bryson & Ko 2004) and recently to investigate the impact of ICT on country-level development (Bankole *et al* 2013b).

Stage3: The Conditional Impact of Telecommunication and Institutional Quality on intra SAARC Trade Efficiency (Regression Splines).



3.1.3.1 Mathematical Model

Let X = (X_1, X_2, ………X_P) be a matrix of P inputs and y be the dependent responses. Then it is assumed that based on an unknown "true" model data are generated.

y = f (X_1, X_2, ………X_P) + e = f(X) + e

In which f is the MARS model, comprising on the BFs which are splines polynomial functions and e is the fitting error. With a knot defined at value t piecewise functions follow the form max (0, x – t).

Max (0, x – t) = {x – t if x ≥ t ; 0, Otherwise

The MARS model f(X), which is the linear combination of BFs and their interactions, is expressed as

$$f \; X \; = \beta_0 + \; {}_{m=1}^{M} \beta_m \lambda_m \, (X)$$

Where by using least square method the term β is estimated and each λ_m is a BF. It can be an interaction BFs produced by multiplying an existing term with a truncated linear function involving a new/different variables or splines function.

3.2 Data Description

3.2.1 Data Sources

The present study take data for several variables over the time span form 1995–2015. The data of variables taken from different sources: i.e. for telecommunication we take data from *International Telecommunication Union* (ITU), data for trade is taken from *Direction of Trade Statistics* (DOT), for institutional quality we take data from *Worldwide Governance Indicators* (WGI). The data set was collected for eight SAARC countries. India is chosen as home country based on its high level of telecommunication infrastructure and trade flows. The variables which we take for telecommunication infrastructure termed as information communication technology access at ITU site. All variables of institutional quality are in percentile rank ranging from 0-100.

3.2.2 Description of Variables

Trade: As in present study, dependent variable is total trade. Data on trade includes the exports and import of each country by their trade partners within SAARC. Data on imports are reported on a cost, freight and insurance basis.

Telecommunications: To evaluate the impact of telecommunication infrastructure we used some proxied variables that are: mobile cellular subscribers per 100 inhabitants, fixed telephone subscribers per 100 inhabitants and Internet users per 100 inhabitants (ITU, 2016).

Institutional quality: For the purpose to analyse the impact of institutional quality we used the following variables. The explanation of variables that used to measure the institutional quality is as follows:

Bureaucratic quality: This measure is used to evaluate the effectiveness of government by considering the quality of civil service, the degree of protection from political pressure, the quality of implementation and formulation of policy and the reliability of commitments of government to that policies. The data in percentile rank illustrate the rank of country ranging from 0 to 100 with lowest rank to highest rank respectively among all countries.

Government stability: This specifies the political stability in a country. It also takes into account the perception of extent of absence of violence or the possibility that government will be political unstable. The data in percentile rank illustrate the rank of country ranging from 0 to 100 with lowest rank to highest rank respectively among all countries.

Corruption perception: This measure of institutional quality considers the degree to which public office is used for private gains and indicates the private interest of elite of a state. The data in percentile rank illustrate the rank of country ranging from 0 to 100 with lowest rank to highest rank respectively among all countries.

Rule of law: This measure of institutional quality captures the degree to which agents or citizens can confidently abide the rules of society. Moreover, it particularly includes the quality of implementation of contract, the police, property rights, the courts and the possibility of crime. The data in percentile rank illustrate the rank of country ranging from 0 to 100 with lowest rank to highest rank respectively among all countries.

Democratic accountability: This measure specifies that how government is responsive to its people. If the government is less responsive, then the government will fall. It is the combination of two essential elements of democracy as follows:

(a) The regulatory quality that consider the ability of government for implementing regulations through which private sector can developed. The range of its rank starts from 0-100.

(b) The measure of voice and accountability in a country captures the degree to which its citizen can freely participate in selecting their government and also have freedom of association.

CHAPTER 4

RESULTS AND DISCUSSION

The methodology used in this study has been explained in the previous chapter. This chapter presents the estimated results of the model. This chapter consists of 3 sections. The result of the structural equation modelling presents in section 4.1. Section 4.2 gives the estimated results for the data envelopment analysis and section 4.3 presents the results for the regression splines analysis.

4.1 Measurement Model

This section presents the estimated structural equation modelling results. We have described the methodology in the previous chapter. Table 4.1 below gives the results of the structural equation modelling. There are three latent variables one is latent independent variable telecommunication infrastructure (TC), one latent mediator variable institutional quality (IQ) and one is latent dependent variable trade (TR).

First, we discuss the results of TC, it is a latent variable that has three indicators: Fixed broadband users (FB), mobile cellular subscribers (MC) and fixed telephone users (FT) in the Table 4.1 the value of FB shows that one standard deviation change in TC will bring 1.002 units change in FB. Second is mobile cellular per hundred inhabitants (MC), the value 0.994 indicates that one standard deviation change in TC leads to 0.994 standard deviations change in MC. Third measure is fixed telephone users per hundred inhabitants (FT), the value 0.288 shows that one standard deviation change in TC will bring 0.288 standard deviation change in FT.

The second latent variable is the institutional quality (IQ) and as explained in the previous chapter the IQ has five indicators. The value of CP in Table 4.1 shows that one standard deviation change in IQ leads to a 0.989 standard deviation change in corruption perception (CP). Similarly, the value of bureaucratic quality (BQ) shows that one standard deviation change in IQ will bring 0.997 standard deviation change in BQ. The value of government stability (GS) is 0.982, it shows that one standard deviation change in IQ leads to 0.982 standard deviation change in GS. The value of rule of law (RL) is 0.984 indicates that one standard deviation change in IQ will bring 0.984 standard deviation change in RL and 0.998 shows that when IQ goes up by one standard deviation democratic accountability (DA) goes up by 0.998 standard deviation.

The final latent variable is trade (TR) there are seven flows in this variable. The value of AFG shows that one standard deviation change in TR will bring 0.982 standard deviation change in bilateral trade with Afghanistan (AFG). The value of Bangladesh (BGD) is 0.961 shows that one standard deviation change in TR will bring 0.961 standard deviation change in bilateral trade with BGD. The value of Bhutan (BTN) is 0.98 indicates that one change in TR by one standard deviation will bring 0.98 standard deviation change in bilateral trade with BTN. The value 0.96 indicates that one standard deviation change in TR will bring 0.96 standard deviation change in bilateral trade with Maldives (MDV). The value 0.977 shows that bilateral trade with Nepal (NPL) will change by 0.977 standard deviations in response to one standard change in TR. The value of Pakistan (PAK) is 0.958 shows that one standard deviation change in TR leads to 0.958 standard deviation change in bilateral trade with PAK and the value 0.971 of Sri Lanka (SLK) shows that if TR changes by one standard deviation then SLK changes by 0.971 standard deviation.

Table 4.1: Estimates of Measurement Model

	TC	IQ	TR
FB	1.002 (0.000)		
MC	0.994 (0.000)		
FT	0.288 (0.178)		
CP		0.989 (0.000)	
BQ		0.997 (0.000)	
GS		0.982 (0.000)	
RL		0.984 (0.000)	
DA		0.988 (0.000)	
AFG			0.982 (0.000)
BGD			0.961 (0.000)
BTN			0.98 (0.000)
MDV			0.96 (0.000)
NPL			0.977 (0.000)
PAK			0.958 (0.000)
LKA			0.971 (0.000)

4.2 Structural Regression Model

4.2.1 Total, Direct and Indirect Effects

Before inclusion of institutional quality (IQ) as a mediator in the analysis, first we find out the total effect of telecommunication infrastructure (TC) on trade (TR) separately. After that by including the (IQ) as a mediator variable we find out the total effect (combination of direct and indirect effect) of (TC) on (TR) under the mediating role of (IQ). The estimated results of total effect before and after the inclusion of (IQ) mediator enters the model are summarised in the table 4.2 & 4.3. Before the role of (IQ) as a mediator in the analysis, results show that the total effect of (TC) on (TR) is (0.974) units.

On the other hand, the total effect of (TC) on (TR) is decomposed into two parts, the direct and indirect effects, by using the mediation effect when (IQ) is used as a mediator. By using (IQ) as a mediator variable (0.704) is the direct effect of (TC) on (TR) and (0.786 * 0.337 = 0.265) is the indirect effect through (IQ) which are reported in Table 4.3 and 4.4 respectively. Thus, the effect of (TC) on (TR) before the role of (IQ) is (0.974) and under the role of (IQ) as a mediator is (0.704). Therefore, it can be said that the effect of (TC) on (TR) is reduced which is equal to (0.974 – 0.704 = 0.27) when there is (IQ) as a mediator in the analysis.

Table 4.2: Total Effect

	IQ	TR
TC		0.97 (0.000)
IQ		

Table 4.3: Direct Effect

	IQ	TR
TC	0.786 (0.000)	0.704 (0.000)
IQ		0.337 (0.000)

Table 4.4: Indirect Effect

	IQ	TR
TC		0.265 (0.000)
IQ		

Whether reduction in the effect of (TC) on (TR) is a significant reduction or not after the inclusion of (IQ) as a mediator in the analysis and whether the mediation effect of (IQ) is statistically significant or not is determined by Sobel test.

The total effect of the TC infrastructure on TR before the inclusion the mediator in the model is positive that is shown in the table 4.2 which means that rise in TC infrastructure will increase the TR i.e., one unit rise in TC infrastructure will lead to 0.97 unit rise in TR and vice versa. On the other hand, after the inclusion of mediator IQ in the model, the total effect of TC infrastructure is divided into two parts, one is direct effect and other is indirect effect as shown in table 4.3 and 4.4.

The direct effect is positive which shows that whenever there is one unit increase in TC infrastructure it will bring 0.704 units increase in TR and vice versa. The indirect effect which is also positive, indicates rise in TC infrastructure leads to a rise in IQ i.e., one unit increase in TC infrastructure will bring 0.786 unit increase in IQ and vice versa. Further the IQ as a mediator also positively effects the TR i.e., one-unit change in IQ will bring 0.337 units change in TR. Thus, indirect effect is equal to (0.786 * 0.337 = 0.265) and in this way, the total effect of TC infrastructure under the influence the IQ which is the combination of direct and indirect effect is (0.704 + 0.265 = 0.97). Therefore, the total effect of TC infrastructure on TR before and after the inclusion of IQ in the analysis is positive i.e., 0.97 and how much TC infrastructure contributes to TR directly and how much indirectly we can confirm with help of Sobel test.

At last in brief, it can be said that if telecommunication infrastructure is higher intra SAARC trade will also higher even under the mediation effect of institutional quality. The reason is that telecommunication infrastructure facilitates the people of different countries and regions by providing quick and easy access to the information of different markets and countries and reduces the distance between local and international markets across the border by the flow of information.

4.3 Sobel Test

Investigators contend that when a mediator is added to the analysis, to report whether the size of the relationship between the independent and the dependent variable ends up noticeably irrelevant (complete mediation) or littler (partial mediation) (Frazier, Tix, and Barron, 2004). In this manner, the Sobel (1982) tests were likewise connected to even more completely affirm the centrality of the mediated impact.

The mediated, indirect effect of the independent variable (TC) on dependent variable (TR) is defined as the product of the independent variable (TC) to mediator variable (IQ) path (α_2) and the mediator variable (IQ) to dependent variable (TR) path (γ_3). The estimate of the mediating variable is divided by its standard error for testing the statistical significance of mediation effect. Then this value is compared to a standard normal distribution. (Sobel, 1982; MacKinnon, Lockwood, Hoffman, West, & Sheets 2002).

$$z = \frac{\alpha_2 \times \gamma_3}{\sqrt{\alpha_2 S_\alpha^2 + \gamma_3 S_\gamma^2}}$$

4.3.1 Mediating Hypothesis

H0: Mediator (Institutional Quality) does not significantly mediates the relationship between Predictor (telecommunication infrastructure) and Outcome (Trade).

H1: Mediator (Institutional Quality) does not significantly mediates the relationship between Predictor (telecommunication infrastructure) and Outcome (Trade).

Table 4.5: Estimates for Sobel Test

	Estimate	S. E	C.R	P
TC → IQ	0.079	0.014	5.547	***
IQ → TR	29.540	5.271	5.605	***

Table 4.6: Sobel Test Results

	Sobel's Test	P	Remarks
TR → IQ → TR	3.95	***	Reject MedH0

Thus, the Table 4.6, explains that the mediator (Institutional Quality) significantly mediates the relationship between independent variable (Telecommunication Infrastructure) and dependent variable (Trade).

As the Sobel test value is 3.95 which is greater than 2 with $P < 0.05$, so partial mediation exists by the mediating variable. Hence the predictor (Telecommunication Infrastructure) wields some of its impact directly on the outcome (Trade) without mediating variable (Institutional Quality), and predictor also wields some of its impact on the outcome variable through the institutional quality.

4.4 Data Envelopment Analysis (DEA)

The results of data envelopment analysis (DEA) for efficiency of trade are discussed in this section. In Table 4.7, telecommunication and institutional quality are input variable and trade is output variable for DEA reported. Table 4.8, shows the results of DEA for home country with its partner countries in SAARC.

Table 4.7: DEA Variables

Input variable	Output variable
Telecommunications, institutional quality	Trade

Table 4.8: Bilateral Trade Efficiency Index for India

Partner Countries	India as Exporter	India as Importer
Afghanistan	0.59	0.42
Bangladesh	0.74	0.88
Bhutan	0.21	0.37
Maldives	0.13	0.26
Nepal	0.15	0.47
Pakistan	0.78	0.51
Sri Lanka	0.45	0.27
Average	0.44	0.45

Table 4.8, shows that the average bilateral trade efficiency index is 0.44 when India as an exporter and 0.45 as importer. As an exporter India perform well with Afghanistan, Bangladesh, Pakistan, and Sri Lanka because bilateral trade index of these four countries is above sample average. India not performs well in case of Bhutan, Maldives and Nepal, their efficiency index is very low from sample average. As an importer India performed well with Bangladesh, Nepal and Pakistan. These three countries efficiency index is above sample average and other countries index is below sample average. Only two countries Bangladesh and Pakistan have both efficiency indexes above average. On average India perform less than 50% within SARRC of its potential.

4.5 Multiple Regression Splines Analysis (MARS)

As explained in previous chapter this section presents the Regression Splines results. The primary objective is to find the role of telecommunication and institutional quality for efficient trade. This will enable us to find the minimum level of telecom infrastructure and institutional quality that is necessary for efficient trade with SAARC.

Now, we explain the results of the MARS. The R-square of the model is 0.788 and adjusted R-square is 0.76 (see Table 4.11). This shows that MARS model has enormous explanatory power and it explains 76 per cent variation of the target variable which is trade efficiency (TE) in this model. This confirms that this model is strong enough to explain large part of variations in TE.

The data of both variables telecommunication infrastructure (TC) and institutional quality (IQ) which are included in the Basis Functions is presented in Table 4.9. This is important to notice that trade flows efficiency is influenced in two regions by telecommunications infrastructure (as measured by TC) and in three regions by institutional quality (as measured by IQ), in this analysis. Table 4.10 provides the importance of the institutional quality (IQ) and Telecommunication infrastructure (TC) respectively. It is also interesting to note that with a relative score of 100 per cent IQ is the most important predictor of trade efficiency and TC with the relative score of 90.27 per cent is following the IQ. The Bankole *et al* (2015) also shows the same pattern that IQ is more important than TC, but in SAARC, the importance of telecom is higher as compare to its importance in Africa.

The next step is to find the nature, conditions and complementarities of IQ and TC in their impact on the trade efficiency. Table 4.11, gives the detailed analysis of the direction of the impacts of IQ and TC. The results show that trade efficiency (TE) is positively and statistical significantly influenced by TC, but it depends upon the value of TC, the value of IQ = 0.038 could be a lower bound on IQ level and the value of IQ = 0.082 could be an upper bound on IQ level. Hence the impact of TC on TE will be positive if IQ is laying between this range. This results show without some IQ level trade efficiency will not influenced by TC positively.

Table 4.9: Basis functions of MARS model (trade efficiency)

BF	Coefficients	Variable	Expressions
BF1	0.779	IQ	Max (0, IQ - 0.082)
BF2	12.538	IQ	Max (0, 0.082 - IQ)
BF4	-0.888	TC	Max (0, 0.094 - TC)
BF6	-2.938	IQ	Max (0, IQ - 0.038) * Max (0, TC – 0.094)
BF8	2.675	TC	Max (0, TC - 0.137) * Max (0, 0.082 - IQ)

Y = 0.0191 + 0.7791 * BF1 + 12.5376 * BF2 - 0.8879 * BF4 - 2.9378 * BF6 + 2.6754 * BF8

Table 4.10: Relative importance of variables (trade efficiency)

Variable	Importance
IQ	100.00
TC	90.27

The result shows that investment in telecom infrastructure directly affects the trade efficiency of the country but also it will improve the institutional quality of the country. Another important thing to note is that to reap the maximum benefit from investment in telecommunication infrastructure country needs a certain level of institutional quality otherwise the investment may lead to a negative impact on trade by increasing the trade deficit of the country.

Table 4.11: Regression Splines (trade efficiency)

Variable	Interval	BFs	Impact Expression	Direction of Impact
TC	< 0.094 (0.094,0.137) > 0.137	BF4 BF6 BF8 BF6	-2.938 * Max (0, 0.094 - TC) -2.938 * Max (0, IQ - 0.038) * Max (0, TC – 0.094) 2.675 * Max (0, TC - 0.137) * Max (0, 0.082 - IQ) -2.938 * Max (0, IQ - 0.038) * Max (0, TC – 0.094)	Positive Positive if IQ > 0.038 None otherwise Positive if IQ > 0.038 Or IQ < 0.082
IQ	< 0.082	BF2 BF8	12.538 * Max (0, 0.082 - IQ) 2.675 * Max (0, TC - 0.137) * Max (0, 0.082 - IQ)	Positive if TC > 0.137 + (12.538/2.675) Negative Otherwise
	(0.038,0.082)	BF2 BF8 BF6	12.538 * Max (0, 0.082 - IQ) 2.675 * Max (0, TC - 0.137) * Max (0, 0.082 - IQ) -2.938 * Max (0, IQ - 0.038) * Max (0, TC – 0.094)	Negative since (12.538 + 2.675) * Max (0, TC - 0.137) -2.938 * Max (0, TC –0.094) < 0
	> 0.082	BF1 BF8 BF6	0.779 * Max (0, IQ - 0.082) 2.675 * Max (0, TC - 0.137) * Max (0, 0.082 - IQ) -2.938 * Max (0, IQ - 0.038) * Max (0, TC – 0.094)	Positive if TC < 0.094
R^2 = 0.7881 Adj R^2 = 0.7621				

CHAPTER 5

CONCLUSION AND POLICY RECOMMENDATIONS

Overview of the present study is provided in this chapter. The chapter is divided into two sections. First section outlines the important point highlighted by the study and last section provides policy recommendations emerge from the study.

5.1 Conclusions

To analyze the impact of telecommunication infrastructure on institutional quality and trade within SAARC was the primary objective of the study, by analyzing the direct impact of telecommunication infrastructure on trade and indirect impact of telecommunication infrastructure on trade via its impact on institutional quality.

The study has used the methodology proposed by Bankole *et al* (2014) methodology, which is based on structural equation modeling to estimate the impact of telecommunication infrastructure on trade and institutional quality. For analysis the efficiency of trade within SAARC is analyzed by employment DEA.

The next step is to find the existing level of trade efficiency of the SAARC. The objective is to determine the current level of trade efficiency of these countries using Data envelopment analysis (DEA). In which we kept India as home country because of its higher level of telecom infrastructure and higher level of regional trade. The result shows that India perform less than 50 per cent of its potential level within SAARC. This indicates that all countries need to invest in infrastructure to reduce the gap between actual and potential level of regional trade.

The last piece of analysis is to find the minimum level of IQ to reap maximum benefits from investment in telecom for this we have used multiple regression splines analysis. The results show that trade efficiency (TE) is positively and statistical significantly influenced by TC, but it depends upon the value of TC, the value of IQ = 0.038 could be a lower bound on IQ level and the value of IQ = 0.082 could be an upper bound on IQ level. Hence the impact of TC on TE will be positive if IQ is laying between this range. This results show without some IQ level trade efficiency will not influenced by TC positively. The above result shows that investment in telecom infrastructure directly affects the trade efficiency of the country but also improves the institutional quality of the country. Another important thing to note is that to reap the maximum benefit from investment in telecommunication infrastructure country needs a certain level of institutional quality otherwise the investment may lead to a negative impact on trade by increasing the trade deficit of the country.

5.2 Policy Recommendation

This study based on findings would recommend following policy interventions; Government needs to improve the institutional quality of the country to reap the benefits from investment in telecommunication infrastructure. This requires serious efforts to control corruption and improvements in the rule of law, government effectiveness and public service delivery.

Study also recommends a low custom tariff on telecommunication trade within SAARC, this will enable all countries to increase and achieve a certain level of telecommunication infrastructure.

As we know, the telecommunication infrastructure has positive impact on trade, so this study suggest that all SAARC countries should introduce a common telecommunication network which reduces the cost of connecting people within all SAARC countries.

If a forum exists for the betterment of telecom sector in SAARC, then it is hard need of time to vibrate it, which provides easy access of SAARC's residents with each other.

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