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## PUBLIC ENTERPRISE PERFORMANCE BENCHMARKING

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## PUBLIC ENTERPRISE PERFORMANCE BENCHMARKING

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# Contents

# Foreword

The aim of *Public Enterprise Half-Yearly Journal* is to disseminate high quality scholarly research and add to the pool of knowledge on the subject of public enterprise by publishing theoretical and empirical academic articles in the field of governance of public enterprises.

In a context of increasingly changing markets, globalization of economies, and technological breakthroughs, public enterprises are being increasingly challenged to achieve the highest levels of performance. As such, Public Enterprise Performance is an area of growing interest to both researchers and practitioners around the world, with a significant body of research focusing on the measurement of the same. Furthermore, the use of benchmarking techniques as tools for transferring best practices into the public enterprises has been of increasing importance in the long-standing drive to assess performance efficiency objectively while exposing areas in need of improvement.

This Special Issue on Public Enterprise Performance Benchmarking of *Public Enterprise Half-Yearly Journal* includes seven research articles by authors from Argentina, India, Pakistan, Peru, Singapore, the UK, and USA. It spans a spectrum of research areas such as national competitiveness and economic growth, efficiency of public water companies, international trade, travel and tourism industry, operating and financial leverage and the systematic risk of enterprises, performance evaluation systems and operational efficiency, and efficiency of public banks.

In the paper titled "*Public Enterprises and the Enhancement of National Competitiveness*", Peter K. Kresl examines the operation of public enterprises in two developing countries, India and Nigeria. He first evaluates the evolution of the concept of competitiveness over time and relates it to both the private sector firms and the political and geographic area. Then, the author critically reviews the policy discussion with regard to the enhancement and loss of competitiveness and the role of the local authorities. Subsequently, he discusses the contribution of the public enterprises to the enhancement of the competitiveness of cities, regions, and private sector firms. The author finds that public enterprises have been very useful in the development of the infrastructure and support of education and research that are required by successful private sector firms, the entities that contribute most directly to competitiveness.

Providing incentives for the efficient performance of public water enterprises is a complex matter. In the paper titled "*Benchmarking the Efficiency of Public Water Companies in Peru: A Conditional DEA Approach*", Guillermo Diaz aims to contribute to the literature on incentive regulations by proposing a method, within the DEA framework, to benchmark the productive efficiency of the firms in the Peruvian water sector, but taking into account the heterogeneity in the operating context that the companies face. In order to keep the practical applicability at a simple level, the method is applied within a deterministic DEA approach. The results indicate that conditioning on the population density in each firm's area of operation affects the estimated efficiencies in a significant way, and therefore can affect the performance benchmarking of water companies in Peru.

Trade costs are the costs that are incurred to move a good from the production site to the site of the final consumer. In the paper titled "*Measurement of Trade Costs, its Determinants and Trade Growth Accounting for India with its Asian Trading Partners*", Sarbjit Singh, Rahul Arora, and Somesh K. Mathur aim to attain three objectives: to measure the trade costs for India with its trading partners from the Asian region; to find out the determinants of these calculated trade costs by using the data on the available trade cost proxies; and to decompose the growth of Indian trade with the Asian partners into the contribution of growth to income, the contribution of the decline to bilateral trade costs, and the contribution of the decline to multilateral resistance. Among others, the results indicate that the trade costs of India with all its Asian partners have declined across the period of study.

The significance of the travel and tourism industry as a driver of economic growth and development has long been established in the economic literature. Furthermore, tourism is one of the vibrant economic sectors in the Southeast Asian countries, being stimulated by the growth of this industry in Thailand and Singapore. In the paper titled "*Drivers of Growth in the Travel and Tourism Industry in Thailand and Singapore: A Geweke Causality Analysis*", Tan Khee Giap, Evan Tan Beng Kai, and Vincent Kwan Wen Seng aim to empirically understand the causal factors that drive the growth of the travel and tourism industry in Thailand and Singapore, using quarterly data from 2000-2012, under a Geweke causality framework. The paper also contains a discussion of policy insights that could serve as a useful guidance to policymakers to boost the capacity and enhance the quality of the domestic travel and tourism industry in both the countries.

In the paper titled "*On Discerning the Implications of Operating and Financial Leverage Ratios on the Systematic Risk of Enterprises: Evidence from Sensex Firms in India*", N. R. Parasuraman and Ullas Rao endeavor to contribute to the practitioner and the academic literature by proposing a robust model that seeks to explain the implications of corporate decisions surrounding operating and financial risk on the systematic risk of firms in India. As such, their primary objective is to determine the influence of business risk and financial risk on the systematic risk of a firm (represented by security beta). In this regard, the authors develop a multiple regression model isolating extraneous variables bearing an influence on beta by relying upon financial measures represented by operating leverage (business risk) and financial leverage ratios operating as explanatory variables to capture the influence on the systematic risk of a firm.

The absence of an appropriate performance evaluation system is frequently the major cause of inefficiencies in public enterprises. Furthermore, an evaluation system, which is based on clear and quantifiable targets linked with an incentive system, minimizes vagueness and motivates managers to achieve specified performance levels. In the paper titled "*Application of Performance Evaluation System and Benchmarking to Improve Operational Efficiency of Public Enterprises*", Istaqbal Mehdi advances a discussion on various experiences and options for establishing performance targets and then evaluating them. The discussion is corroborated by a case study involving the establishment of a target-based performance evaluation system in Pakistan.

The performance of the banking sector has always been of interest, especially to policy makers, since banks in general are considered to be a key component of a country's development prospects. In the paper titled "*Technical Efficiency Analytics for the Public Banks in Argentina*", Vincent Charles, Claudia Peretto, and Tatiana Gherman seek to contribute to the efficiency literature with evidence from Argentina, a still relatively little explored country with a banking system that has undergone major transformations. In this

regard, the authors employ the data envelopment analysis technique to rank the Argentinian public banks based on their performance over 17 years, between 1998 and 2014. The results indicate that, on average, the technical efficiency registered a sharp drop in the years 1999 and 2002, which could be attributable to the political and economic and financial crises, respectively; furthermore, the banks achieved high efficiency levels for the rest of the period, which were maintained until 2014 with little variation.

The many academics and researchers who contributed articles and the experts within the field who reviewed the articles have made this *Special Issue on Public Enterprise Performance Benchmarking* of the *Public Enterprise Half-Yearly Journal* possible. We wish you, our readers, informative reading!

**Vincent Charles**
**Special Issue Editor**

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# Public Enterprises and the Enhancement of National Competitiveness

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## Abstract

The operation of public enterprises and their capability to work to enhance the competitiveness of a nation's economy in an efficient and effective manner is quite controversial. The discussion has become more intense and wide-spread as the necessity of competitiveness enhancement has increased in importance in recent years. In this paper we will examine the operation of public enterprises in two developing countries, Nigeria and India. Since these two countries are former colonies, economic activities have long been seen as being directed from out of the country and not always in the interests of the country. In recent decades, however, as independent countries each has worked to have its public enterprises operate more in line with the needs of the country. In each country there have been some successes but performance has been short of what had been desired, although assistance to technological development and education have been relatively more successful. This sort of intervention has been shown to have been more suited to the level of the regional or the urban economy.

*Keywords*: Public enterprise, national competitiveness, growth

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## Introduction

One of the main economic challenges confronting all levels of government (federal, state and municipal), geographic scales (national, regional and local), and participants in the private sector, is the maintenance and/or enhancement of that entity's competitiveness. Loss of competitiveness or failure to attain it condemns that entity to loss of employment, desirable skilled workers, output, the capacity to generate tax revenues to support the whole array of programs and projects, loss of place in the larger hierarchy in which it is situated, and loss of its reputation and identity. This slide to stagnation and to marginality can be caused by something completely out of the control of actors in the local economy, such as a surge in imports following a new free trade agreement, or a technological change that makes local production uncompetitive, a depletion of a resource deposit, departure of a major local employer as the result of a take-over by a firm outside the region, or an outmigration of appropriately skilled labor.

On the other hand, in many instances, a loss of competitiveness is the direct result of decisions taken or not taken by local actors. This could allow local infrastructure investment to be ignored, failure to support adequately local educational institutions, unwise local tax and regulation/zoning policy, a laissez-faire approach to local community and business development, failure to mobilize and to integrate local actors and assets, or failure to develop the identity of the city or town and to market it beyond the local economic space. Obviously, each of the two causes of weakness in competitiveness requires its own distinct policy response on the part of local actors. This will be discussed as we progress through the argument of the text.

Work on the standard literature on competitiveness has taken as its subject either the private sector firm or the geographical/political entity such as a region, city or a metropolitan area, largely to the exclusion of public enterprises. This is because economists based in the industrialized world—that is the most familiar to them and where the data is both extensive and readily obtainable—have written much of this literature. There are certainly many studies developed by economists based in other parts of the world, and we will review the experiences of two of these developing countries: Nigeria and India.

Public enterprises are thought to be primarily features of developing countries, especially those with centrally directed economies. They are seen as principally concerned with infrastructure, public health, education, and business and community development. But many developed market-based economies have public enterprises that have responsibilities for, among others, transportation, broadcasting, and even agricultural marketing and management. Of equal interest is the fact that there are many private sector firms in specific sectors, such as transportation, education and health care, which are tightly regulated and managed by central authorities so they can be thought to function almost like public enterprises. These will be referred to here as *quasi-public enterprises*, defined as enterprises that are government-directed but that pursue attractive objectives to the private sector firms and that even develop these in conjunction with them. This control over private firms is done in the interest of, among others, public safety and health, and to achieve society wide minimum standards of performance or achievement. Thus, we are discussing a widely found institution.

The essential characteristic of public enterprises is that they are owned and funded by the State, they are intended to give service to the public and meet its needs; they are guided by specific socio-economic and political objectives; performance is monitored by a committee of the State; they are not designed to earn profits, they operate, as Bishnoi (2015) specified, "at the whims of the government." They usually have a monopoly in the work they do, and, in the words of Singh (2012) "there is little scope for initiative and dynamism." They are not intended to be entrepreneurial and usually have little scope for innovation. Hence, there is a general bias against public enterprises on the basis of efficiency, although that, of course, is not their *raison d'être*.

This would suggest that these institutions have little to do with dynamic, market responsive activities such as competitiveness. However, this is far from the truth, as it will become clear when we have examined both competitiveness as a concept and as a policy area, and how public and quasi-public enterprises can have positive or negative impacts on a city's or region's competitiveness. In the text that follows, first, we will examine competitiveness: What it is, and how it is perceived by economists and geographers. How has the notion of competitiveness evolved over time? Second, we will then relate this concept to both the private sector firms and the political or geographic area: the city and the region. How do the two applications of the concept of competitiveness differ? Third, we will review the policy discussion with regard to the enhancement and loss of competitiveness. What can local authorities do to ensure their city or region does not lose dynamism and design a strategy to achieve the desired future economy. Finally, we will get to the public enterprise and how it is related to the competitiveness of cities, regions, and private sector firms. What can the public enterprise offer that will serve the long-term interests

of firms and the city and the region? We will suggest, in conclusion, that there is a very positive synergy between competitiveness and public enterprises in its various manifestations.

## Competitiveness as a Concept

In recent decades, economists have discussed extensively both the concept of competitiveness, as it relates to geographical or political entities, and the measurement of it. Competitiveness and comparative advantage go back over two hundred years to Adam Smith and David Ricardo, and to many others, including Friedrich List in the intervening years. Almost all of them, until Alfred Marshall, focused on the national economy. Marshall (1920) introduced the concept of the industrial district, a concept that has had a great influence on the recent work on clusters as an element in competitiveness. Bruce Scott (1985) published a book based on a symposium on competitiveness at Harvard University. In his contribution he focused on two aspects: competitiveness at the level of the nation; and a rising standard of living as the primary indicator of competitiveness. This focus on the nation set the tone for many studies in the years that followed. Nevertheless, in the last decade of the 20$^{th}$ century, a second track developed as cities and urban economies began to emerge as competitive actors. In 1989, Eurocities declared that "now is the time for the cities!" and the race was on (Eurocities, 1989).

Following Scott's approach, some economists countered that only the nation was an appropriate level for the study of competitiveness. Most famously, Michael Porter (1990) began a small industry with his book *The Competitive Advantage of Nations*. Paul Krugman (1994) found even this to be an "elusive concept", and that competitiveness was properly the concern of firms. Nations, he observed, "do not go out of business". Roberto Camagni (2002) countered that this might be the case, but that they do the equivalent experiencing long-term outmigration, stagnant investment, falling per capita income, and rising unemployment. Many economists have followed Camagni's path.

But what is competitiveness? The Oxford Compact English Dictionary (1968) defines it as "having a strong urge to win". This assumes that the purpose of the exercise is externally given, which is to win, that two or more entities strive to win the race, and that all but one of them will lose. The Random House College Dictionary (1968) states it is, among other things, "the struggle among organisms for food, space, and other requirements for existence", or "a struggle or rivalry". Here, there may be no single winner and one or more losers; each can gain food, etc., and each can participate in a rivalry as siblings and friends do, without one of them being declared the winner. Indeed, one can be competitive in the sense of being able to play the game as good as the others. Many golfers or tennis players are considered to be competitive at any given moment. Although none of them win all of the time, they are still in the game or competitive.

The notion that there is a single end to competition is one that must be contested, especially in the context in which this study is situated. There is no reason why all cities and regions cannot meet successfully the objectives of their strategic-economic plan; each will presumably have an objective that is distinctive so being successful will not preclude another city or region from achieving its specific objective(s).

Competitiveness of a firm is radically different from that of a political/ geographic area, such as a region or a city. The firm has a well-defined objective: to capture a market or beating some other firm in the competition for a contract or an order. Usually there is one winner and some losers. The ultimate objective of the firm is profit maximization and returns to shareholders. This is the same for all firms, so we can see how one firm is doing better than others. We can perceive this is reflected in the share prices on the stock exchange. Winning or losing a contract in competition with other firms will affect share prices of both the winner and the losers. Movements in share prices can be seen as a success measure or ranking in competition.

This is not the way it works with regions and cities. While some analysts chose to evaluate cities on the basis of growth in per capita income or in the increase in GDP per capita and to rank them according to such a variable, this measure is better seen as being easier than as being relevant. This approach is similar to that of many consultants who move from one city to another like traveling vacuum cleaner salesmen, who sell the same product to all customers. In reality, not all regions or cities seek the same objective in their strategic-economic planning. They have different economic legacies, current capabilities, unique strengths and weaknesses/assets and liabilities, and aspirations. Rather than having the objective determined from above and applied in several dissimilar situations, the best city economic planning is done from the bottom up where the residents articulate their objectives for their city and its future development. There is no market or contract to be won, no movement of the share price to indicate success; there is rather a nuanced set of individualized objectives that the residents seek to achieve.

Needless to say, firms, cities and regions need the infrastructure and public goods that in most countries are provided through the activities of public enterprises. Usually, these goods are not goods that can be provided by the private sector. The investments are sometimes too great and the return on them is not high enough to be attractive. Private initiatives have given us individual toll roads, but not national road grids. Railroads are often run by the private sector today, but this is only after the initial system of tracks and rolling stock was developed by the government, and often in collaboration with a public enterprise. We will develop this linkage later in the paper but for now it is sufficient to understand that there is a direct linkage between the actions of public enterprises and competitiveness of firms, cities and regions.

The measurement of a city's or a region's competitiveness can be done using either of the two principal approaches. The first is a form of benchmarking that gathers data for a large number of variables to rank each of dozens of cities in accordance with each of the variables, and then to sum the ranking values for each city. The scores of variables are generally not carefully selected, but they are rather the variables for which data are available. The many cities can then be evaluated against the others in accordance with their "competitiveness". One is never certain if various weights should be given to each of the variables or really which of them can be taken as being important for a city's ranking or competitiveness. The second is that of selecting perhaps three variables that the literature argues are of importance to a city's economic vitality and using them to create a weighted variable that can be used as the independent variable in a multiple regression analysis. This method generates a set of perhaps 8-12 variables that can be used as determinants of competitiveness. Cities are then ranked accordingly. Here the number of variables used in the analysis is limited in comparison with the first method but the results of the exercise may be considered to be more objective.

The point of this discussion is simply to argue that competitiveness can be considered as a legitimate concept in the study of urban and regional economies, and that there are methodologies we can use to evaluate an entity's relative competitiveness. Now we must examine how competitiveness can be related to the city or urban economy.

## Competitiveness and the Political/Geographic Area

The discussion has been rather general about competitiveness to this point. In this section of the paper we want to set ourselves up for the specific treatment of public enterprises and competitiveness in the final substantive section of this paper. Competitiveness of the firm, as has been noted above, is fairly straightforward with there being a general agreement as to what would indicate a competitive firm. The approach to achieving this would also be relatively unambiguous. Things will vary a bit due to the industry in which the firm is positioned, but other than this there

would be a general agreement with regard to the policies and strategies the firm should pursue. It is all in the execution, of course.

With cities and regions, the issue is far more complex. If we accept that the ultimate objective of competitiveness enhancement for these entities is single mindedly to achieve maximum per capital GDP or productivity, things would be relatively simple. We would want to orient the local economy toward one of the industries that are perceived to be dominant or rising. Biopharmaceutical production, ICT, or nanotechnology would be three candidates. Each of these is an industry that is projected to be one of the building blocks of the future global economy. Every geographical entity that has the possibility of succeeding in this area would be advised strongly to do orient itself to doing so. These are all high technology activities that require research facilities, a highly skilled and educated labor force, venture capital or a connection with a major multinational corporation, some investment in infrastructure, and a local environment that makes it an attractive place for the skilled workers to live, raise families, and work. It would be fairly easy to design a strategic economic plan to make a city congenial to one or the other of these industries. Invest in education and some infrastructure, establish linkages with important entities out of the area, and then sit back and let take-off. In fact, many consultants make a decent income doing just this for many cities and regions. This is the essence of top-down planning where the final objectives of the initiative are determined without significant participation of local residents or even local elites.

When we take a less standardized approach to regional and city competitiveness, the process becomes considerably more complex and nuanced. Each entity is unique in many ways and must be approached with this in mind. The residents of each place will have distinct memories of their past, understandings of what they do and do not like about the present situation, and aspirations about the future. Was the past something to cherish or to escape from? Do they think the present economy and community sustains them and gives them pleasure or does it fail them? Can they imagine a future that will meet their aspirations, including jobs for young people, the degree of social exclusion and income inequality they can tolerate, the neighborhoods, retail options and cultural and recreational activities they desire? Or do they approach the future with fear and despair? Clearly, in these regards, each region and city will be distinctive and not likely to be satisfied by a planning proposal taken "off the shelf" by someone from outside the community.

One of the first choices that must be made by a region or city that seeks to enhance its competitiveness and the vitality of the local economy is whether path dependency or path departure is to be pursued. Path dependency occurs when one location choses to build its future on the foundation and economic sectors that served it well in the past. Path departure is when the place strikes out on a new path. A classic pair of cities that capture the essence of each of these strategies and illustrates the difference between them is Chicago and Pittsburgh, in the United States. Both cities were powerfully affected by the collapse of the Industrial Heartland during the 1980s. Vital, indeed dominant, cities in the US Mid-West and Mid-Atlantic regions suffered rapid de-industrialization and deterioration as a consequence of the hike in the price of petroleum products following the action by OPEC countries in 1973 and 1979. Unemployment soared, there was out-migration of workers and their families, residential areas deteriorated, social pathologies increased, and industrial sites became derelict. Some cities such as Detroit, Youngstown and Buffalo, have been very slow to recover; however, others such as Chicago and Pittsburgh have managed to recover and to reconstitute their economy very well. The two cities took approaches to a new economy that were quite different (Kresl & Ietri, 2015).

Chicago's past was based on three activities: heavy manufacturing, most notably steel production in the South-east quarter of the city; financial activities; transportation. In the 19$^{th}$ century, the economy was oriented to meet the needs of agricultural production. Manufacturing made farm implements as well as rails; finance was primarily loans to farmers, and financing and marketing agricultural products; and transportation was to a significant degree based

on the movement of grains and corn. For the resurgence of the Chicago economy in the late 20th century and into the 21st, each of these activities was modernized. Manufacturing evolved into specialty steel and high tech products; finance developed new products such as currency futures and derivatives; and transportation moved from rail and canals to rail, trucking and air travel. Each activity was linked closely to the previous strength but was made competitive in the 21st century context: this is the essence of path dependent development.

Pittsburgh was one of the principal steel production cities of the US into the post-WWII period. After the collapse of this sector, in part due to its movement to centers with modern technology and lower cost in other parts of the US and of the developing world, Pittsburgh developed economic competitiveness and strength in two new areas, areas that were in no way linked to the earlier steel economy. At the University of Pittsburgh, a very impressive collection of regional health care, medical research and medical technology was developed. At the Carnegie-Mellon University a contract for robots to do work that could no longer be done by humans in the highly-contaminated Three Mile Island nuclear facility after its melt-down in 1979 (the same year as the second of the OPEC price hikes) led to development of one of the country's primary centers of robot technology, computer science and information security. This is a classic example of the "eds and meds" (education and medicine) approach that has been successful in many cities of all sizes in recent years. Both Chicago and Pittsburgh have developed modern economies that are based on education, skilled labor, venture capital, and technology. One broke with its past, while the other built upon it and, as we shall see later, in both instances with some participation of public enterprises – in today's economy principally in education and in research.

Other cities have taken approaches to modern and competitive economies that are quite different from either Chicago or Pittsburgh. Some cities have developed as centers of recreation and leisure activity, while others are centers of culture and education. Sophisticated inter-modal transportation has sustained many urban economies, as have research and high-tech manufacturing. While some of these strategies can be pursued without much participation from outside entities, others offer classic opportunities for participation of public enterprises. There is no single approach to city competitiveness, and what a city choses to do is always a combination of local capabilities and local aspirations as expressed by the residents.

Technology and research have been the core of what Joel Kotkin refers to as "nerdistans", the cities with universities and colleges that support both research and start-ups, and highly skilled and educated workers (Kotkin, 1990). From Boston to Austin to Silicon Valley, and dozens of other cities in between, technology and the institutions that support it have been the structural core and support of some of the most dynamic urban economies in the country. This same mechanism has been applied in many other cities in Europe, Asia and elsewhere. Kotkin argues that the young skilled workers find this to be an attractive alternative to suburbs, considered to be boring, and to big cities, considered to be too frenetic and disordered. He also discusses the "revenge of the small towns", where the young skilled worker, especially those with a family, finds even the nerdistan to be unsatisfying. The advantages of small towns are basically life style and amenities, good schools, access to recreation sites such as mountains, forests, and beaches. The disadvantages of smaller cities and towns are sufficiently off-set by advantages in technological advances in telecommunications and transportation.

Charles Landry and Franco Bianchini (1995) alerted us to the phenomenon of the "creative city" and shortly thereafter Richard Florida (2001) analyzed the "creative class". Closely linked to this was the notion of innovation as a base for the competitive city, the "innovative milieu" of Roberto Camagni (1995). Peter Maskell and Gunnar Tönquist (2001) studied the Öresund region that links Denmark and Sweden as a learning region. These approaches all capture the necessity of recognizing that the contemporary economy, in almost any strategic approach requires giving attention to creativity, innovation, education, and knowledge, in what has been widely described as a

*knowledge economy*. There is clearly an ample need for participation of public enterprises whatever the nature of the specific economy in a knowledge economy happens to be.

Another issue for local leaders is that of whether the competitiveness they seek is relative or absolute competitiveness. Relative competitiveness means that a city is simply doing better than another city; so that in a ranking it would be positioned higher than others. Absolute competitiveness refers to the fact that a city is actually doing better, according to some standard, than it was at an earlier time. One can be doing better relatively while all are sinking, as was the case in the 1980s in the US Industrial Heartland when all cities were negatively impacted by a general cause of decline. Chicago did better than Youngstown, but how satisfying was this? Absolute competitiveness can occur when a city is doing better when all other cities are also doing better. Does it matter that a city's 10 per cent gain in competitiveness is less than the 15 per cent gain of another city as long as the city's own objectives are being met? Hence, the usage of the term competitiveness has to be taken with the proverbial grain of salt. What usage will be most satisfying and meaningful to the residents of the community, relative or absolute?

As one can see from this discussion, the approaches taken by different cities to achieve competitiveness are quite distinctive and different and each will impose its own unique demands for resources and, of course, its own needs for assistance from public enterprises. We will examine this after we have reviewed briefly the policies that cities and regions adopt in the furtherance of their struggle for competitiveness.

## Policies to Enhance Competitiveness

Cities and regions have become very active in tending to their competitiveness, their position in the global urban hierarchy, their attractiveness as a headquarters site for international organizations and corporations, their attractiveness to a desired labor force, their assets in culture and recreation that are so important for tourism, and their education and research institutions. Few cities of any size have been passive in this regard, although for some cities the task has been exceedingly difficult. To achieve these objectives, active cities and regions have aggressively promoted a number of structural and relational developments. As seen in the following discussion, this has opened the door to collaboration with public enterprises. We will develop this more extensively and explicitly in the following section.

Much of this activity has been done with reference to spatial and institutional structures. The spatial structures have received a great deal of attention during the past quarter century and we will begin our discussion with them. This all began with Marshall's (1959) treatment of industrial districts in 1890. An industrial district was comprised of a collection of firms in associated industries, or the same industry, in close proximity. This closeness would facilitate their sharing ideas, technologies, innovations in management and production, and tacit information, and they could share ideas about joint projects and generate economies of agglomeration. It was explicitly desirable for them to establish contacts with firms in other parts of the world so they could share developments taking place elsewhere; lack of this contact would lead to stagnation and ultimate collapse since they were not able to move beyond their own ideas.

Perhaps the economist who made the most of Marshall's ideas is Michael Porter (1990), who a century later, began to develop and to promote the idea of clusters as key elements in the promotion of competitiveness. Clusters are firms that are situated in close proximity; they consist of a spatial concentration of firms in the same industry and one would expect that they would have all of the interaction that Marshall argued would take place in an industrial district. Many clusters do in fact operate in this way and cluster development has been a primary element in the planning for industrial development of a city or a region. The Competitiveness Institute, founded on Porter's

writings and concepts, states boldly and unequivocally that "competitiveness is clusters". However, in many industries dominated by large firms with subsidiaries where proprietary knowledge is important, there may be little or no interaction among the subsidiaries of various firms in one spatial "cluster". In biopharmaceutical this is the case and the flow of information may be principally downward from the parent to the subsidiary (Simmie, 2005). In other clusters, links with the world beyond the cluster are lacking and the cluster stagnates since it misses out on the technological innovations that are taking place elsewhere (Malmberg, 2002). Finally, in some clusters knowledge transfer comes from outside the cluster and the tacit transfer of knowledge among cluster participants—so vital to Marshall's industrial districts and to true clusters—is missing. In short, clusters are not always true to the essential characteristics of Marshall's conceptualization of industrial districts. When properly functioning they are very important to development of a regional urban economy, but they are not a panacea.

For smaller cities, where mere size precludes any significant development of clusters, an attractive option is participation in one or more networks. A network is essentially a cluster that lacks proximity and may be extended to whatever scale is most useful to its participants. They can be thought of as clubs with limited membership, with obligations for activity and members can be expelled from the network if the participation is not of benefit to other members. They can gain access to knowledge and technology, build coalitions, participate in joint projects, and share the best practices. This structure is also of importance to cities that are on the periphery or are isolated from other city contacts. Capetown, Lisbon, and Brisbane are three good examples. Advances in both telecommunications and transportation make networks feasible and not excessively costly.

Another structure that has been given a lot of attention is that of the "triple helix". This structure is made up of three entities: universities, the private sector, and government. The objective of establishing this structure is to promote technological advance and transfer, and to generate the start-up of small firms that benefit most from such a structure (Etzkowitz, 2001). Etzkowitz writes of one model found in the Soviet Union and more recently in Latin America in which the government was central and supreme and in which universities and companies were subordinate to state-owned industries that were dominant. A second model was found in the US in which the state, universities and industry were distinct and separate entities. This model had the advantage over the Soviet-Latin American one in that it was bottom-up in its orientation and therefore oriented to the market and to useful products, rather than top-down and oriented to internal government objectives. The "triple helix" model by contrast has the three set as overlapping circles in which each is responsive to, supportive of and supported by the other two entities.

While it is clear that clusters and networks may have no need for government or for public enterprises, other than for funding of infrastructure and some educational institutions, the "triple helix" has government, and by extension public enterprises, at its core. Government is now seen as a central player in the development and application of technologies – communication, production and transportation, in collaboration with universities and the private sector. We will discuss this in greater detail in the next and final section of this paper.

The final aspect of policy for regions and cities we will examine is that of provision of amenities that will attract skilled workers and desired firms to the location. Highly skilled and educated workers are very mobile. They do not have to work in any specific city if it is not congenial to them and if they do not provide the life style and amenities they insist on having for their families. Hence, it is the responsibility of any region or city that wants this sort of labor force to ensure that there is adequate provision of schools, health care, recreation, cultural institutions, parks, housing in pleasant neighborhoods, and so forth. In some of these aspects the advantage goes to larger cities while in others smaller cities are more desirable. Many tech workers have no need of a major hub airport since they find it more convenient to share ideas, plans, etc., through modern telecommunication. This, of course, mandates that competitive cities ensure that high-speed connectivity, etc., are available at reasonable cost.

Similar concerns are present with regard to making a region or city attractive to firms that local authorities would like to have as key entities in the local economy. Here facilities such as a hub airport, major highway and rail connections for logistics, zoning and local regulations, local taxes, access to capital and an array of professionals in certain areas, and so forth can be instituted by local authorities. Depending on the national culture and political structures, some of this may be done by quasi-public enterprises. Most cities have a local chamber of commerce, a better business bureau, and other organizations that, with assistance from local government, integrate a firm in the local business community. Obviously this is of greater interest to smaller firms and to start-ups.

## The Role of Public Enterprises in Competitiveness

We have taken a rather long road to get to the key issue at hand – the role of public enterprises in competitiveness. Partly, this was done to give a sufficiently clear notion of what competitiveness is and how it relates to the policies of regions and cities; partly, it was done to gain an understanding of what spaces there are for public enterprises to contribute to the effectiveness of local efforts to maintain and enhance competitiveness. Due to the experience and knowledge of the author the discussion that follows will be concentrated on the role of public and quasi-public enterprises in the US. Following this will be a much shorter examination of the role of public enterprises in two key countries in the developing world – India and Nigeria.

### *In the United States*

Public enterprises have had a long history in the US, but owing to the predominant role played in the US economy by the private sector; these institutions have been overshadowed when it comes to playing a central role in the competitiveness of the national economy. But throughout the past 150 years public enterprises have at times been crucial to the development of the economy. The event that made this possible was the Civil War between 1861 and 1865. During these years the Senate and House of Representatives were devoid of any legislators from southern, conservative, and anti-national government states. In their absence Washington was able to pass legislation that established the government role in the creation of the trans-continental railway (the Pacific Railroad Acts), pre-courser to the Inter-State Highway Act almost a century later, the Land Grant College Act (the Morrill Act) that established a system of public, state universities, and the Homestead Act that opened the west to settlement. These acts created initiatives and public enterprises that promoted the development and competitiveness of the national economy.

In more recent years we have other institutions such as the Tennessee Valley Authority that managed flood control, irrigation and rural electrification throughout much of the south. This was duplicated in other parts of the country, most notably with Hoover Dam on the Colorado River that generated electricity and managed water use in the south-west, and the hydro-electric dams on the Columbia and other rivers in the north-west. The latter were to provide the power that would convert bauxite into aluminum and stimulate the growth of aircraft production during the Second World War and in the ensuing years. In what follows we will examine more closely the role of public and quasi-public enterprises in four areas of the development of the competitiveness of US cities and regions.

Provision of an adequate transportation infrastructure is a primary responsibility of both federal and state government agencies. State highway commissions have done much to develop the high-speed road travel system in the country for by passenger and truck traffic. Quasi-public enterprises such as the Port Authority of New York and New Jersey are responsible for inter-state tunnels and bridges. Others have been responsible for working with the private sector to create the current array of airports, from regional airports to international hub airports in every significant city in the country. Other similar entities have created the efficient rail connections between the airport

and the city center in virtually all major cities. Previously this was done by taxi companies but when the corporate facilities dispersed throughout the metropolitan regional area, the city and the airport commission cooperated to construct the rail linkages to the city centers.

In Europe, the most dramatic transportation initiative in recent memory has been the high-speed rail system, starting with the TGV system in France. A few lines at the outset have been expanded to a network that covers much of the national space. Being France, the system has Paris as its hub, the center-south of the country is not well served, and east west links other than those based on Paris are almost absent. What is striking is the impact being on a TGV line has had on the fortunes of individual cities (Thompson, 1994). Cities such as Tours, Le Mans and Rouen that have good service can function as bed-room communities for Paris or as work places for Parisians. Other cities such as Orleans, Limoges and Clermant-Ferrand, as well as most smaller cities, are out of the system and do not have these options and many of them have become marginalized.

The French rail system is designed and managed by the state rail company, SNCF, and the system is responsive to the needs of national economic development rather than the needs of the regions, although regions with political clout do, of course, have an advantage. This suggests both the advantages and the disadvantages of having a public enterprise actively engaged in competitiveness enhancement policies in which a strong economic rationality is not always imposed on the decision-making process.

While the French model has been adopted by most of the rest of the Continental countries, the United Kingdom stands out as a contrast, and not to its benefit. When Prime Minister Thatcher destroyed the “greater x city councils” there was no municipal power that could be joined with that of other cities to pressure for infrastructure projects. The most glaring of these was the lack of a high-speed rail link from Scotland, via Manchester-Liverpool, and Birmingham to London, with connection with the continental network. Rail has always been provided by private companies in the UK, and governments have been reluctant to try to impose a national rail grid on the country. It is only now that there is some progress being made toward a west-coat high-speed rail link, and that in about ten years at best. There is no UK public or quasi-public enterprise in rail transportation as there is on the Continent; a very interesting contrast.

Another example of government involvement in an element that is important for regional or urban competitiveness is government support of municipal/public art and architecture. Major buildings of outstanding architecture can have the effect of giving a city an identity or brand that gives it recognition throughout the world. Many cities have artifacts and structures that have been inherited from the past but of more interest here are the structures that have been created or at least funded by local government. Perhaps the most famous of these structures is the Eiffel Tower in Paris, which was built for the 1889 World’s Fair under a contract from the government of France. It was to symbolize the abilities and art of modern engineering and the age of science and industry. It has served as an icon of the city ever since and has given an identity to people throughout the world. Needless to say its draw for tourism and business has contributed much to the success and competitiveness of Paris for a century and a quarter.

One of the most successful initiatives to create a building that would identify the city internationally is the Guggenheim Museum in Bilbao, Spain, in the Basque region. Funded by the Basque government, and designed by architect Frank Gehry, the museum was inaugurated in 1997. Gehry’s design of metal curved sheets evoking the sails of the ships that historically created Bilbao’s wealth, is so striking that it has become recognized as one of the premier buildings in the world and has revitalized the Bilbao economy through the impacts of tourism and business development.

In North America and Europe most of the notable buildings of recent years have been funded by the private sector: developers, or financial or industrial entities. However, one notable exception is the World Trade Center, which opened in 1973 and, after their destruction in 2011, One World Trade Center, or "Freedom Tower", in Manhattan. The agency behind the concept and the funding of these buildings that gave such an identity to New York City was the Port Authority of New York and New Jersey, an agency of the two states. A private developer was involved in the second building, One Freedom Tower. These buildings served the function of confirming the place of primacy of New York City in the world of finance.

Other significant buildings created by public enterprises are all in Asia. The objective of many of these initiatives was that of creating the tallest building in the world or some other characteristic that would establish the host city as a place of importance in the global urban hierarchy. The Petronas Towers in Kuala Lumpur, Malaysia, surpassed the Willis (Sears) Tower of Chicago as the tallest building in the world in 1998. The objective of the government was to leapfrog ahead of other cities in Asia for the key place in their regional economy. Shanghai responded quickly with three buildings, the Jin Mao Tower, Shanghai World Financial Center and Shanghai Tower. While private companies were involved in the design and in the construction, the concept of the three super-tall buildings was that of the Shanghai government, the participation of which was the *sine qua non* of the initiative (Dupré, 2013).

The most notable example of this use of public enterprises to use architecture to put a city on the map, so to speak, is, of course, Dubai. The intent was clearly that of making Dubai the principal financial and tourism center of the Middle East. The first step was creation, in 2009, of the Palm Jumeirah, a residential-hotel development set on a structure of man-made islands out into the sea. Equally dramatic was the sail shaped Burj Al Arab that was intended to do for Dubai what the Opera House did for Sydney and functions as a hotel and retail center. It was opened in 1999. The final piece in Dubai's architectural call for attention was what in now the world's tallest building, the Burj Khalifa, completed in 2010. It is a financial and recreational center that is just over 2,700 feet in height. Not to be outdone, however, Saudi Arabia is planning its Kingdom Tower for completion in 2018. Its height will be 3,281 feet and, therefore, the world's tallest building, for now.

These architectural triumphs in Asia and the Middle East are the result of cooperation between the government, public enterprises and private sector firms. They demonstrate the dramatic results that can be achieved through this sort of initiative. The structures do not always make sense from the standpoint of economics narrowly perceived, but when linked with a desire to dramatically increase the international recognition and status of the place in which they are constructed, and hopefully to enhance the city's global competitiveness, the rationality is put in a different light.

The role of government in the support of research and new products in the US is shown clearly by the activities of the Department of Defense's Defense Advanced Research Projects Agency (DARPA), and the National Institutes of Health, or NIH. Founded in 1958 in response to the Sputnik initiative of the USSR, with a current annual budget of $2.8 billion DARPA functions similarly to a public enterprise but rather than doing research itself it issues contracts to universities, firms and research labs directly or through specific competitions. This is clearly the US approach to funding research as opposed to the state-centric model in which firms and universities are subsumed within government itself. For example, in 1982 it issued a contract to a professor at Carnegie-Mellon University, William Whittaker, to build a robot to work within the Three Mile Island nuclear facility after its 1979 meltdown. This established a "field robotics" program and a similar one in "space robotics". This has led to a series of devices for work with the space program and nuclear installations around the world, and other initiatives as well. This has led to Carnegie-Mellon being one of the premier universities in this area of research; it has also contributed importantly to enhancing the competitiveness of Pittsburgh in its post-steel rebirth as an important city. As noted above the other element in the rebirth of Pittsburgh has been regional health care, medical technology and medical research, based at the University of Pittsburgh, a state-related research university. This sector too is heavily dependent upon grants and

contracts from agencies such as the NIH and Commonwealth of Pennsylvania research agencies. NIH is the largest funder of biomedical research in the world. It's funding, about $30 billion, supports individual research projects as well as the operations of centers and programs. NIH grants to the University of Pittsburgh have averaged about $450 million in recent years. One of the most important consequences of this funding is the growth of start-up firms in the area of medical technology and health care.

Hence, it is clear that in both of the sectors that are sustaining the competitiveness of Pittsburgh's economy, government agencies, such as DARPA and the NIH, functioning as the equivalents of public enterprises have played crucial roles. DARPA holds regular conferences with researchers in universities, firms and laboratories to discuss what the most promising and important areas of research will be in the coming years. It then responds to this input in designing its competitions and contracts. Both entities are prime examples of the twist the US has given to the notion of public enterprises. State funding, state direction but with input from the research communities, grants issued to universities, firms and research laboratories that are usually completely separate from government. This model of quasi-public enterprises is relevant also to several other government departments, most notably Transportation and Agriculture. It maintains the US separation of the elements in the "triple helix" but imposes a close cooperation among them.

Education and knowledge generation are two other tightly linked aspects that public enterprises and quasi-public enterprises can work on that lead directly to a region's or to a city's competitiveness. We have just seen how agencies in the US, among others DARPA and the NIH, have supported university research programs and the furtherance of knowledge in general. But other agencies of the state and federal government give vital support to all universities through student grants and loan programs, such as Pell Grants and Title VI programs. Furthermore, most of the large research universities in the US are public, state-funded universities, such as the University of California campuses, the Big Ten (except for Northwestern University) universities, and major universities in virtually all other states. Undergraduate and graduate study programs are supported as they are the full array of research programs, centers, institutes, and so forth. They may be considered to be quasi-public enterprises. Highly regarded universities are seen by state and local leaders as essential elements in the development of the economy, in creation of a skilled labor force, in generation of tech-based start-up firms, and in attraction of firms, large and small, from outside the region to situate production and research facilities in the state. Hence, they are seen to be central to competitiveness enhancement of the city and state in which they are situated.

### *In Nigeria and in India*

This will in no way be a comprehensive treatment of the role of public enterprises in the developing world or even in these two countries but, rather, it will afford us a glimpse into the extent and nature of their role in the development of the economies and the competitiveness of these two classic cases. The reader is encouraged to explore this issue in greater detail in other and more authoritative sources.

In general, we can say that public enterprises in developing countries serve an extensive set of purposes. Their mandate is based on the experience these countries had with the earlier colonial system that was managed by European powers. These colonial powers established railroad, mining, harbor, and other government-chartered enterprises to accomplish the management of the economic management of the colony. Following the Second World War government involvement in the European economies was increased for introduction of the welfare state, to provide employment and to do economic activities that the private sector was not yet capable of doing, if only for shortage of capital for investment. In developing countries public enterprises used government funds for investment in facilities for transportation, mining and mineral extraction, manufacturing, education, and other services,

including those related to the welfare state. The enterprises were mandated to implement government policy objectives, provide basic goods and services to the public regardless of income, protect the consumer, provide infrastructure and public goods, and pursue national security.

In Nigeria after liberation from colonial status the government was reluctant to allow British or other foreign companies own and manage major infrastructure entities such as the national railway network that was needed, among other things, to link producers and harbors so goods could be exported. By the 1980s there were 275 public enterprises at the national level and additional 600 at the state level (Tsunabavyon & Orokpo, 2014). Prominent among these were Nigerian Telecommunication, National Electric Power Authority, Nigerian Railway Corporation, Nigerian Produce Board and Development Board, entities that were patterned on the British model. Public enterprises accounted for 22 per cent of total employment, and one-third of public sector employment and 35 per cent of GDP. They were involved in production ranging from agriculture and food processing to assembly of automobiles. They were charged with providing "goods and services for the cultural, social and economic upliftment (sic) of the citizen" (Ogohi, 2014). The oil boom of the 1970s gave the government the opportunity to become dominant in a new major economic activity and also access to the revenues it needed for support of the public enterprises, among other things.

The objectives of the public enterprises in Nigeria were specified in the national constitution. They were "to secure the maximum welfare freedom and happiness of every citizen on the basis of social justice and equality of status and opportunity." Furthermore, they should ensure: a planned and balanced economic development; that the material resources of the country should be distributed so as to serve the common good; that wealth is not concentrated; and "that suitable and adequate food, reasonable national minimum wage, old age care and pensions, and unemployment and sick benefits are provided for all" (Onyemenam, 2013).

Clearly, the objectives or tasks of public enterprises in Nigeria were those that could not be given to private sector actors. Either they lacked the capital to make the necessary investments, or their profit-maximizing goal was not in conformity with national objectives for economic actors. Public enterprises were developed in part because of the inability of private sector firms to meet the desired objectives of government or because of an ideological preference for state actors that were not governed by capitalist system goals. In any event, public enterprises were adopted with enthusiasm in Nigeria as was the case in many other African nations. Onyemenam tells us that public enterprises and the role of the state were pressed more aggressively in countries such as Algeria, Guinea, Malagasy and Tanzania but less so in others, Cameroon, Kenya, Gabon and Ivory Coast (Onyemenam, 2013).

However, in almost all of these countries public enterprises came under attack in the 1980s and 1990s. In Nigeria, the Structural Adjustment Program of 1986 sought to reform these institutions so as to improve their efficiency and to develop more effectively the growth potentials of the private sector (Tsunabavyon & Orokpo, 2014). The issue here, as in most other African countries, is the failure of public enterprises to achieve their objectives. A general critique is that they were inefficient, corrupt, mismanaged, overly bureaucratic, monopolistic, overstaffed, sink-holes for government revenues, subservient to political masters, and operating in opposition to national economic development. In many African countries there was a groundswell of rejection of public enterprises and an enthusiastic embrace of privatization and economic rationality. This process is not yet completed but public enterprises will now have to seek out a role they can play in national economic development.

In all of this there is virtually no discussion of what public enterprises can do to enhance national or regional or urban competitiveness. What they provide, in terms of infrastructure, education, and so forth, do however contribute powerfully to the ability of the nation to achieve objectives in international markets. This is not to say that they are always successful, but what they do is essential for the competitiveness of a developing economy. On the other

hand, the corruption and mismanagement of these entities has caused much negative impact on Nigeria's ability to competitive in international markets.

Our other case, India, follows much the same pattern but with a higher level to performance and competence. India's policy with regard to public enterprises and to the mix of public and private entities was clearly detailed in a series of Industrial Policy Statements, beginning in 1948, Five Year Plans, beginning in 1951-56, and the Industrial Policy Resolution of 1956. There were four broad categories of industries with three degrees of government and public enterprise involvement and one that was open to the private sector. This is far too detailed for exposition here but basic industries from iron and steel to military goods to essential infrastructure and public utilities were reserved for public enterprises of one sort or another, as were those requiring large scale investment. By 1991 there was growing frustration over the performance of public enterprises in industry. They were seen to be chronically sick and not able to be reformed. Many were characterized by over staffing, inadequate of monitoring of performance, under-utilization of capacity, poor labor management relations, lack of coordination with other enterprises, and so forth (Mishra, 2014). As a consequence, there began a process of government disinvesting in these public enterprises. As an alternative the government introduced a series of Special Economic Zones, a program of subsidies, and efforts to strengthen the private sector and entrepreneurship. Unfortunately, these initiatives have been less successful than was anticipated. One problem is the need for land by the zones and this can only be obtained from peasant farmers who have not been pleased by the experience. Another is that only a few of the many zones have actually been successful in generating substantial exports. The experience has been that both the public enterprises and the special export zones have, in anything, detracted from the competitiveness of India's regions and the national economy, with the exception of a few well run public enterprises and the provision of basic infrastructure and public goods. Most of the considerable growth and international success of India's information technology and high-technology sectors has occurred in the private part of the economy.

## Final Words

The objective of this paper was the exploration of the relationship between public enterprises and competitiveness. Specifically, what could public enterprises do to enhance competitiveness of firms, regions, and cities? The focus was on the situation in industrialized countries with analysis and experiences coming predominantly from the US. We briefly examined the situation in the established private sector firms and concluded that they were not a promising area of inquiry. It is true that quasi-public enterprises can have a very positive impact on start-ups of new firms in technology-based sectors through their support of education and research and the contracts they issue. Nevertheless, beyond this, there has not been done much in the US. The situation in Europe would probably be quite different given the different and closer structural relationships between the public and private sectors; but this would be the topic for another paper.

The situation has been shown to be quite different when it comes to public enterprises and the competitiveness of regions and cities. In our review of competitiveness and of the policies that regions and cities adopt with the objective of its enhancement we highlighted several specific ways in which public and quasi-public enterprises could assist regions and cities. There is not much that can be done with regard to two of the most important structures for cities: clusters and networks; perhaps some infrastructure, but not much else. However, the third structure, the "triple helix", is explicitly based on interaction between universities, private sector firms and government/public enterprises. This has been a very rich and productive interaction throughout the industrialized world. One of its features is that since the government/public enterprise does not dominate decisions and actual activities, what is done tends to be bottom-up and directly linked to economically rational, market-oriented, new product, and new firm activities. The alternative model was based on everything being subordinated to the

government and organized in accordance with the government political objectives and plans. Clearly, this approach had no necessary connection with competitiveness enhancement.

We also highlighted the positive consequences that public enterprises have through provision of infrastructure projects, such as high-speed rail, expressways for cars and trucks, and airports. These initiatives are typically a combination of public enterprises, and private sector firms. The infrastructure that is provided is a powerful contributor to regional and urban competitiveness. The same can be said of the impact on international reputation and recognition or branding of regions and cities of public art and architecture projects, such as the Guggenheim Museum in Bilbao, the Petronas Towers in Kuala Lumpar, and the structures that put Dubai on the map as a principal financial and tourist center in the Middle East. All of these were accomplished with the cooperation of private sector firms, government, and public enterprises.

The final area we explored was the impact of public enterprises on research, knowledge creation, and education. We used Pittsburgh as an example of how this worked. DARPA has had its impact on development of the internet and centers of robotics and computer science, on behavioral science, and on many areas of technology. The NIH has had a similar impact on biomedical research and production. One of the consequences of the competitions and contracts issued is on the development of new, technology-related small business and start-ups. This has had a powerful impact on many local economies throughout the country and has greatly enhanced their competiveness.

In some countries purely public enterprises are the principal feature, but in others in the industrial world in which government direct participation is not predominant, quasi-public enterprises are more common. Whichever form this takes it is clear that the participation of these enterprises in projects with private firms, universities and research laboratories is a powerful contributory factor in the ability of regions and cities to maintain their competitiveness or to become more competitive.

The experience of Nigeria and India is one of greater reliance on public enterprises as key engines of growth and competitiveness; however, beyond some initial positive impacts and the effects of provision of infrastructure and public goods the experience has been disappointing. A few enterprises have been well run and have contributed to the competitiveness of the national and regional economies but seemingly inevitably waste and inefficiency work against this enhancement of competitiveness.

## Conclusion

In conclusion, we find that public enterprises have been very useful in the development of the infrastructure and support of education and research that are required by successful private sector firms, the entities that contribute most directly to competitiveness. In the contemporary economy characterized by the rapid technological development of production, communication and transportation, the rise of new competitors somewhere in the world, and the importance of knowledge rather than manual labor: OMIT COMMA, government dominated enterprises lack the flexibility and adaptability to do much more to enhance competitiveness, as they are less central than they were at earlier stages of development.

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# Benchmarking the Efficiency of Public Water Companies in Peru: A Conditional DEA Approach

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## Abstract

Benchmarking has been suggested as a useful regulatory tool for water companies in both developed and developing countries, specially due to the predominance of public firms in these sectors. However, in order to be effective, the comparisons should reflect differences in the firms' performances, rather than capture differences in their operating contexts. In this paper I apply a conditional data envelopment analysis (DEA) benchmarking technique that specifically controls for this, i.e., the conditional DEA approach. As a result, I find that conditioning on the population density in each firm's area of operation affects the estimated efficiencies in a significant way. The results are consistent with previous findings in other countries (which use different methodologies), and are new in the case of Peru.

*Keywords*: Public enterprise, water, efficiency, DEA

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## Introduction

Providing incentives for the efficient performance of water companies in developing countries is a complex issue, not least because of the prevalence of state-owned companies in these sectors. While the theoretical

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incentive regulation literature has largely focused on profit-maximizing firms, empirical studies have simultaneously shown evidence that would contradict this behavioral paradigm in the case of government-owned firms.[1]

The empirical evidence in the water sector, however, points to a slow productivity growth in most instances, irrespectively of the ownership configuration. For example, Saal, Parker & Weyman-Jones (2007) found increased technical change in the UK in the years following the privatization, but, also, equally significant efficiency losses in the newly-privatized water and sewerage companies, summing up to a non-existent net effect.[2] In the case of Peru, where the companies have not been privatized, Lin & Berg (2008) did find some productivity growth in the period 1998-2002 (mostly from technical change, no efficiency gains), but very modest.[3]

Therefore, the question of how to provide incentives for efficiency to public companies remains open. One common approach taken by the regulatory agencies, as in Peru, has been the use of publicly benchmarking the companies in the sector, with the hope that the public pressure from stakeholders provide the incentives for efficient performance. In fact, in the case of Netherlands, De Witte & Saal (2010) found positive effects on prices and efficiency from this simple approach, named as "sunshine regulation" by the authors.

The objective of this study is to contribute to this literature by proposing a method, within the DEA framework, to benchmark the productive efficiency of the firms in the Peruvian water sector, but taking into account the heterogeneity in the operating context that the companies face. As suggested by Berg & Lin (2008), "to be of use to regulators (...), and to be accepted by other stakeholders, performance comparisons must be robust to promote confidence that the performance rankings do indeed reflect managerial skill rather than accidents of geography or history" (p.794). Although DEA as a benchmarking technique has been proposed and implemented in previous studies (Berg & Lin, 2008; Lin, 2005), these studies did not take into account the heterogeneity in the firms' operating contexts.

In the context of input-oriented efficiency analysis, this means that input usage requirements can be different in different operating contexts. For example, in cities with low population density, the amount of inputs (i.e., length of water network) required to reach a certain output level can be higher than in more highly densely populated areas. In this sense, the ideal would be to perform the comparison conditional on having relatively similar levels of population density. This is precisely the objective of the conditional DEA method, proposed in Daraio & Simar (2005). In order to keep the practical applicability at a simple level, this method is applied within a deterministic DEA approach.[4]

The previous literature in the Peruvian case suggest the importance of the contextual (also called "environmental") heterogeneity, beyond the control of the firms, to partially explain differences in performance. Corton (2003), for example, shows that the number of districts in the area of operation and the natural region where the firm is located are statistically significant to explain the variation in operating costs (controlling for length of mains).

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[1]For example, Dewenter & Malatesta (2001), studying a very heterogeneous sample of firms in several sectors, find that government-owned firms are significantly less profitable than private firms, and tend to be more labor intensive. On the other hand, Seim & Waldfogel (2013), in a study about of liquor retail stores, conclude that the behaviour of the public monopoly is best rationalized as "profit maximization with profit sharing".

[2]Portela, Thanassoulis, Horncastle & Maugg (2011) extended the analysis for the period 1993-2007, and even finds a *decline* in productivity starting in 2005.

[3]Also, Estache, Perelman & Trujillo (2005) concluded that there is scant evidence of any differential overall performance between public and private operators in the water sector, after surveying productivity studies in developing countries.

[4]Berg & Lin (2008) show that deterministic DEA can be considered a robust benchmarking technique in the Peruvian case, by showing that the performance rankings produced with this technique are not too dissimilar to those produced with stochastic DEA techniques, theoretically more robust to outlier observations.

*G. Diaz (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 18-34, 2016
https://doi.org/pehyj.2016.2201.02

International Center for Promotion of Enterprises
ICPE

The concern in controlling for the heterogeneity of the operating context is shared with studies about other countries. For example, Tupper & Resende (2004) proposed a regression-based method to clean the effect of contextual variables on the estimated efficiencies (they take away the variation explained by the contextual variables, using a Tobit regression model), and applied it to the water sector in Brazil. The main difference between their methods and the ones applied here is that the conditional DEA methodology does not impose parametric constraints on the relation between the contextual variable and the unconditional DEA estimated efficiencies.

In regards to the empirical evidence in developed countries, De Witte & Saal (2010) applied the method proposed in this study for the Dutch case, but under an stochastic DEA framework. They also found important to condition the DEA estimates on the population density. Similarly, Vidoli (2011) applied a novel nonparametric method to evaluate the dependency of the efficiency estimates on contextual variables in the Italian case, and finds a predominant role to the population density.

The remaining of the paper is organized as follow: Section 2 briefly describes the main institutional features of the water industry in Peru, Section 3 describes the benchmarking methodologies applied, Section 5 describes the details of the model specification, as well as the main features of the data at hand, Section 5 presents the main results, and Section 6 concludes.

## The Water Sector in Peru

The water and sewage sectors in Peru are a decentralized system, formed by the municipality-owned companies that are under the supervision of SUNASS (Superintendencia Nacional de Servicios de Saneamiento), the agency in charge of regulating the operation of the firms in the sector.

Starting in 1999, SUNASS established a benchmark system to evaluate the performance of the companies under its supervision. This system was based, originally, on nine indicators, grouped into four areas:[5] quality, coverage, management efficiency, and managerial finance efficiency. The indicators are expressed as a percentage, and averaged (with equal weight). Finally, the firms are ranked according to the score obtained within four groups, determined by the number of connections (small, with less than 10,000 connections; medium, with between 10,000 and 40,000 connections; and big, with more than 40,000 connections). See the results of the benchmarking for 2013 in Table 3, in the Appendix.

Berg & Lin (2008) evaluate the consistency of SUNASS's benchmarking method, in comparison to other frequently-used methodologies, such as regression, DEA (deterministic and stochastic), and stochastic frontier. The advantage of the alternative methodologies is that, generally, they consider the role of each indicator as either input, output, or "contextual" variable - that is, variables that characterize the operating environment of the firm, i.e., (1) they are outside the control of the firm; and (2) affect either input usage, or output production.[6]

Given the above discussion, unsurprisingly, the study found that the DEA and SFA-based methods generally produce consistent rankings, differently to those of the SUNASS and regression methods. In particular, the authors trace the major differences between methodologies that acknowledge input-output causality relations and SUNASS's simple benchmarking methodology in units that, although show low output levels, also show

[5]The number of indicators has risen in recent years, so that, for example, thirteen indicators were used in the 2013 benchmarking exercise.

[6]Besides the previously referenced studies, see also Thanassoulis (2000), for a review of the use of DEA techniques in the regulation of water companies in the UK.

*G. Diaz (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 18-34, 2016
https://doi.org/pehyj.2016.2201.02

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low input usage. These units would obtain low scores by definition under the simple average of SUNASS's indicators. The optimization-based techniques, on the other hand, would recognize that some of this output performance might be explained by the low availability of inputs.

I extend the deterministic DEA methodology used in the previous study, by incorporating the influence of the firms' context of operation. In particular, I consider the influence of the population density, given the extensively documented economies of density present in the sector - see De Witte & Saal (2010), Vidoli (2011).

## Methodology

Consider a vector of inputs, $X \in \mathbb{R}^p$, used to produce a vector of outputs, $Y \in \mathbb{R}^q$. Then, the production set is defined as: $\Psi = \{(x, y) | x \text{ can produce } y\}$. In this context, the Farrell's radial input efficiency measure for a DMU using input vector $x$ to produce output $y$ can be defined as:

$$\theta(x, y) \equiv \inf\{\theta | (\theta x, y) \in \Psi\} \tag{1}$$

This is an input-oriented efficiency measure: it calculates the maximum proportional (i.e., radial) decrease in input usage, $\theta$, that is technically feasible while keeping the production vector $y$ constant.

DEA is an empirical way to assess the Farrell input efficiency of a firm, relative to the observed performance of a group of comparable firms, or peers. That is, DEA takes all the units' input and output combinations and use them to form an empirical set of production possibilities, $\hat{\Psi}$. This set reveals what combinations of inputs and outputs are possible, *given the observed input-output combinations of the real units* (plus additional assumptions specified below). Given that it assess the unit's efficiency based on the observed performance the firm's peers, DEA can be seen as a benchmarking tool.

To be more concrete, consider the following typical assumptions for the empirical production possibilities set, $\hat{\Psi}$, under the DEA approach:

- Convexity: given two observed input-output configurations, any linear combination of them also belongs to $\hat{\Psi}$.
- Free disposal: given an input-output configuration in $\hat{\Psi}$, any other configuration with either lower output or higher input also belongs to $\hat{\Psi}$.
- Constant (CRS) or variable (VRS) returns to scale: under CRS any input-output configuration in $\hat{\Psi}$ is scalable, that is, it can be implemented any number of times. Under VRS, this is not the case.

Now consider a group of decision-making units (DMUs), $j = 1, ..., J$. Under the previous assumptions, the CRS and VRS empirical production possibilities can be determined in reference to the observed performance of all the units in the group, as follows:

$$\hat{\Psi}^{CRS} = \{(x, y) \in \mathbb{R}_+^{M+P} | \; x \leq \sum_{j \in J} \lambda_j x_j, \; y \geq \sum_{j \in J} \lambda_j y_j, \; \lambda_j \geq 0, \; \forall j \in J\} \tag{2}$$

$$\hat{\Psi}^{VRS} = \{(x, y) \in \mathbb{R}_+^{M+P} | \; x \leq \sum_{j \in J} \lambda_j x_j, \; y \geq \sum_{j \in J} \lambda_j y_j, \; \sum_{j \in J} \lambda_j = 1, \; \lambda_j \geq 0, \; \forall j \in J\} \tag{3}$$

*G. Diaz (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 18-34, 2016
https://doi.org/pehyj.2016.2201.02

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Then, the DEA input usage efficiency can be calculated by applying Farrell's efficiency definition to any of these production possibilities sets (under the CRS or VRS assumption, respectively). For example, under the VRS assumption, a firm $i$ with observed input-output configuration $(x_i, y_i)$ has an input usage efficiency of:

$$\theta_i^{VRS} \equiv \theta^{VRS}(x_i, y_i) = \inf\{\theta | (\theta x_i, y_i) \in \hat{\Psi}^{VRS}\} \tag{4}$$

For example, if $\theta_i^{VRS} = 0.7$, it would mean that DMU $i$ could reduce its inputs usage by up to 30% (in every input dimension), and still be able to produce the same output vector $y_i$. A fully input efficient unit would have $\theta^{VRS} = 1$ (no proportional input reduction is possible). This would mean that there is no other unit in the sample (or linear combination of them) that produces the same level of output, with a lower amount of inputs. As can be seen, this is a *relative* measure of efficiency because it defines efficient performance based on the observed performance of other units, not up to an ideal or absolute standard of efficiency.

Notice that the previous definition considers all the units as comparable. However, what if the contexts in which the units operate are *too* different? In the case of water distribution, it could be very different to provide the service in cities with different population densities. Arguably, it could be much less input-demanding to increase the coverage of the service in cities with higher population density. More generally, consider a *contextual* variable $Z$, that captures this diversity. One would want to compare cities with relatively similar values of this variable. Consider a firm $i$, with input-output configuration $(x_i, y_i)$ and contextual variable $z_i$. We can define a production possibilities set, conditional on the value of its contextual variable $z_i$ (I only present the CRS case for brevity):

$$\hat{\Psi}^{CRS}(z_i) = \{(x,y) |\ x \leq \sum_{j \in J} \lambda_j x_j,\ y \geq \sum_{j \in J} \lambda_j y_j,\ \lambda_j \geq 0, \\ \forall j \in J \text{ such that } z_i - h \leq z_j \leq z_i + h\} \tag{5}$$

In this definition, the comparison set for unit $i$ is formed following a similar procedure as before, but now considering only the units (indexed as $j$) that have a value $z_j$ within a distance $h$ of $z_i$. That is, the comparison group here considers units with a relatively similar value of $z$ (the similarity is controlled by appropriately choosing the bandwidth parameter, $h$). Following Daraio & Simar (2005), we denote this as a *conditional* DEA efficiency index.

## Model Specification and Data

The performance of 43 firms from 2006 to 2013 were studied, which is the full set of firms operating in the sector with the exception of the firm operating in the capital city, SEDAPAL, and a few small companies (due to missing data). This firm is excluded because its operating environment is radically different from the rest of the country: it serves almost 1.4 million active connections, compared to an average of 38 thousand for the firms in other cities. Given that having such a different observation in the sample may distort the performance comparisons, it is therefore excluded.

In order to deal with the panel data structure, the information for all the years was combined, and a single efficient frontier was calculated. In this way, the observed performance of every unit is compared to a single benchmark, which is intended to be formed by the best observed performances along all the years in the sample. Following this practice, Estache, Rossi & Ruzzier (2004) study of electric utilities in South America was followed, as well as previous studies about the Peruvian water sector specifically, such as Berg & Lin (2008).

*G. Diaz (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 18-34, 2016
https://doi.org/pehyj.2016.2201.02

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The last study was also followed, as well as the applied literature in the sector and in this industry in particular (Corton, 2003; Lin, 2005), to specify the inputs and outputs of the production model. The list of inputs includes the operating costs, the number of employees and the total length of the distribution network. The operating costs are used as a proxy for the use of intermediate inputs in the production and delivery process, while the number of employees measure the amount of labor (given the absence of more precise measures of labor input usage), and the length of the distribution network proxies the amount of the capital input utilized (given the usual problems in measuring capital).

Regarding the outputs, the list includes the total amount of water billed, the coverage ratio, and the degree of continuity of the service. This intends to capture not only output, but also quality dimensions (Lin, 2005; Picazo-Tadeo, Saez-Fernandez & Gonzalez-Gomez, 2008). For example, the amount of water billed indirectly measures a (negative) dimension of quality, such as the amount of water losses in the network. This problem is regarded as highly relevant in the Peruvian case (Berg & Lin, 2008) - e.g., by 2013 only around 65% of the water produced was actually billed, in average for all operators.

Table 1

*Summary Statistics*

| | Mean | St. Dev. | Min | Max |
|---|---|---|---|---|
| **Outputs** | | | | |
| Water Billed (m3) | 7'766,287 | 9'067,781 | 348,231 | 44'531,840 |
| Coverage (%) | 83 | 12 | 29 | 100 |
| Continuity (hs/day) | 15 | 6 | 0 | 24 |
| **Inputs** | | | | |
| Operating costs (S/.) | 11'275,086 | 16'503,797 | 260,677 | 92'253,000 |
| Workers | 132 | 144 | 2 | 740 |
| Total water network length (kms) | 336 | 388 | 28 | 2,044 |
| **Context** | | | | |
| Population density (habs/km) | 627 | 255 | 82 | 1,662 |

The other two variables included as outputs, the coverage and continuity of the service provision, can be seen as fully quality indicators. As shown in Lin (2005) (a benchmarking study, in the stochastic frontier analysis framework), these variables seem to have a significant incidence on the firms' operating cost efficiencies in this sector. Therefore, it is fruitful to include them also as determinants of productive efficiency. The coverage is calculated as the ratio between the estimated population served by the operator, and the total amount of population within the area of service. Continuity is measured as the average number of hours that the service is operating on a daily basis.

Table 1 shows the summary statistics of the aforementioned variables. Notice that there is still a considerable degree of heterogeneity left in the sample, in spite of having excluded the operator in Lima and those with a high degree of missing information (mostly very small networks). In particular, the population density (our proposed determinant of the operating context) has a big range of variation, from 82 to 1,662 inhabitants by kilometer of water network. Figure 1 shows an histogram for this variable, which illustrates the high heterogeneity present in the sample. This suggests that the differing contexts could be relevant to explain part of the observed operating performance.

*G. Diaz (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 18-34, 2016
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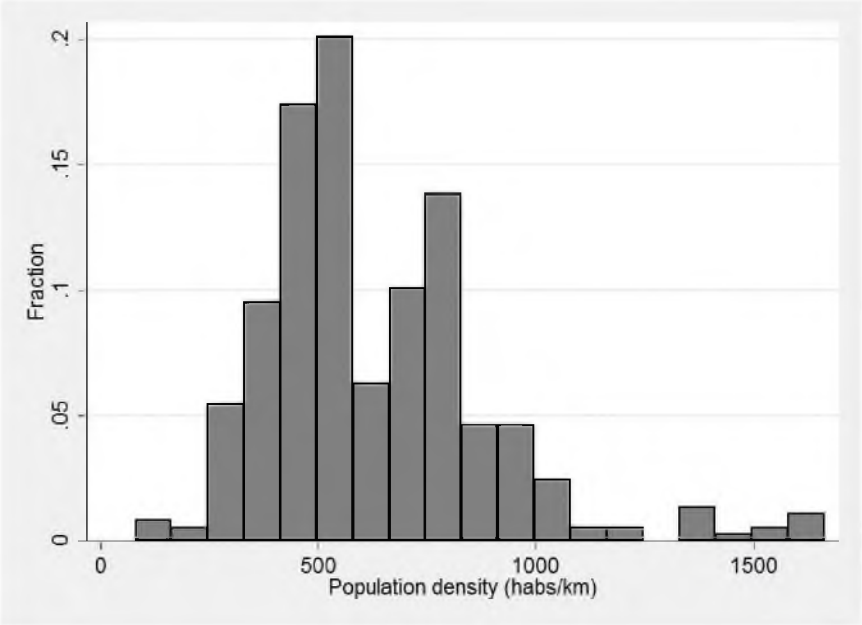


*Figure 1.* Histogram of population density

## Results

The Table 2, and Figures 2 and 3, show the statistics and histograms, respectively, of the DEA efficiency scores calculated under the VRS and CRS assumptions - the detailed results for every firm in every year are shown in Tables 4 and 6 in the Appendix. It is important to remember at this point that the efficiency assessments are *relative*: a fully efficient firm under this approach (i.e., with an efficiency score of 1) does not necessarily mean that the firm is technically fully efficient, but only than its performance is the best of the pool of firms under evaluation.

The distribution of the unconditional efficiency scores in both, the VRS and CRS cases, show an ample variability (particularly in the CRS case, as expected). Taken at face value, the VRS results imply that at the average observed performance (0.788), input usage could have been decreased by 21.2% in every dimension without affecting the output and quality produced, only taking as a reference the observed performance in the sample chosen. In the CRS case, given the more ample distribution, the average performance is of only 0.588.

Table 2

*Efficiency Scores Statistics*

| | Mean | St. Dev. | Min | p25 | p50 | p75 | Max |
|---|---|---|---|---|---|---|---|
| **Unconditional** | | | | | | | |
| CRS | 0.588 | 0.221 | 0.234 | 0.416 | 0.507 | 0.767 | 1.000 |
| VRS | 0.788 | 0.206 | 0.262 | 0.658 | 0.830 | 1.000 | 1.000 |
| **Conditional** | | | | | | | |
| CRS | 0.797 | 0.193 | 0.387 | 0.639 | 0.830 | 1.000 | 1.000 |
| VRS | 0.901 | 0.145 | 0.441 | 0.837 | 0.994 | 1.000 | 1.000 |

*G. Diaz (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 18-34, 2016
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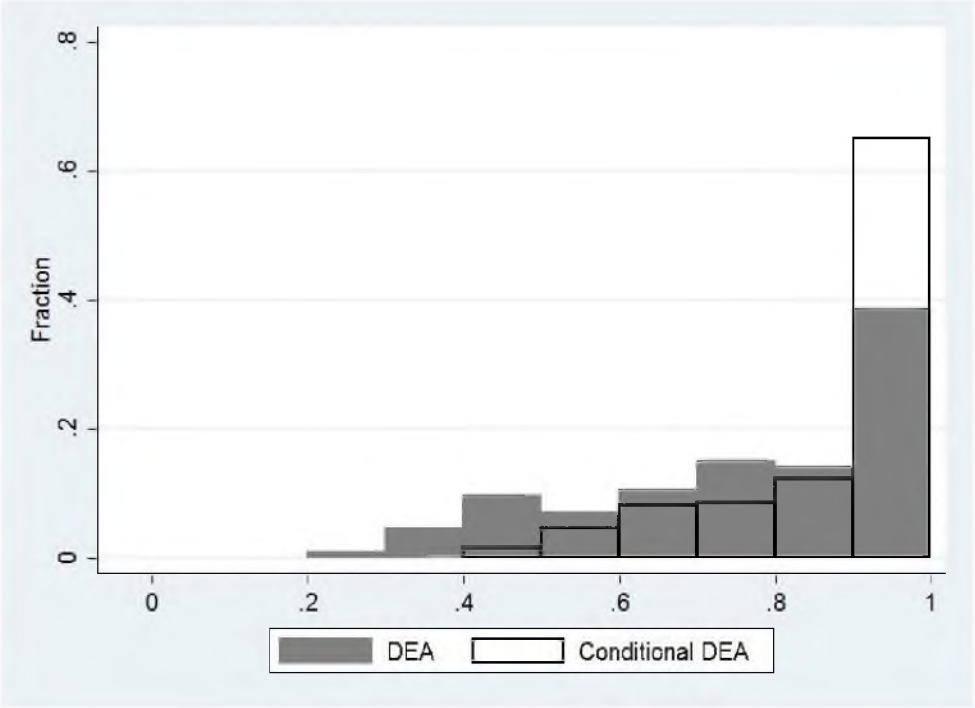


*Figure 2.* Histogram of DEA efficiency scores (VRS)

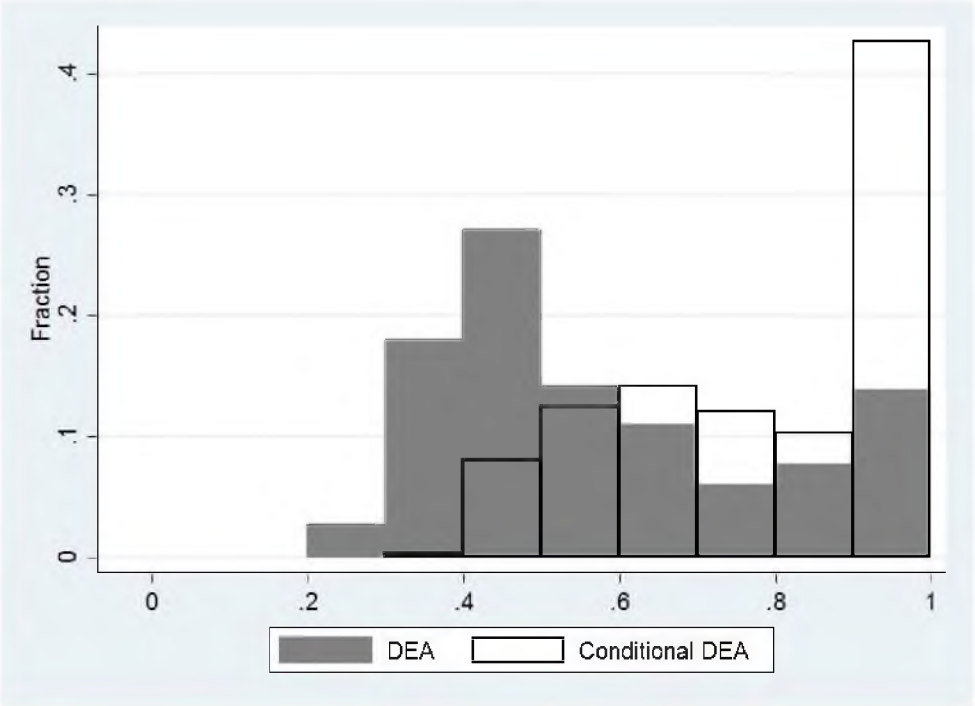


*Figure 3.* Histogram of DEA efficiency scores (CRS)

*G. Diaz (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 18-34, 2016
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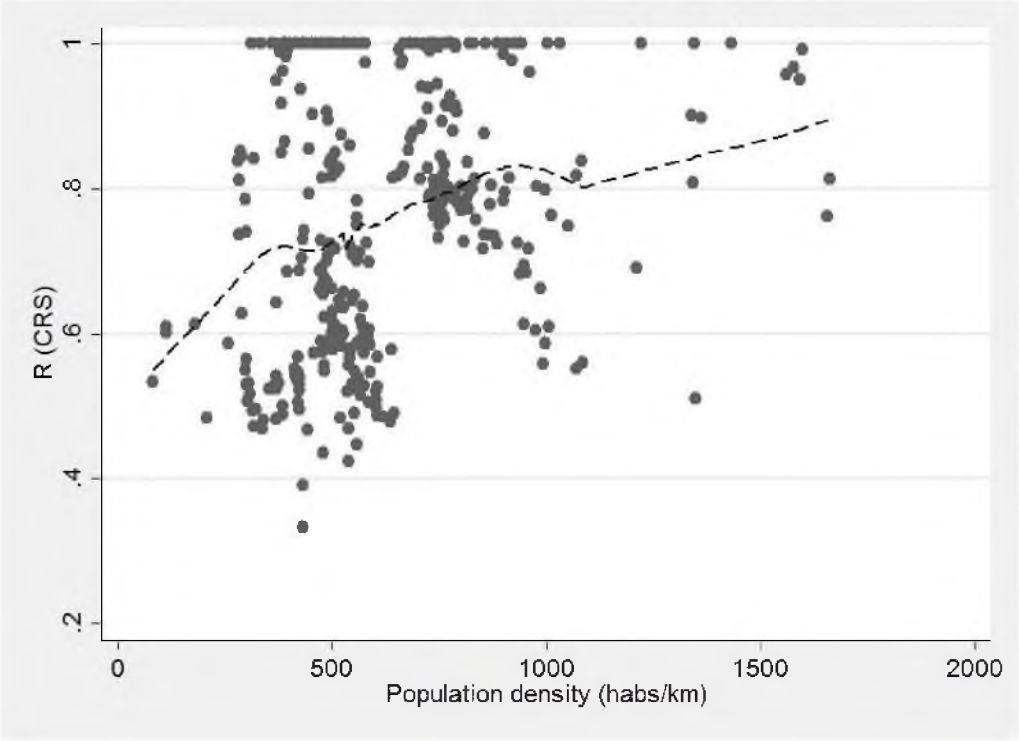


*Figure 4.* Ratio of unconditional over conditional DEA versus population density (CRS)

The distribution of the conditional DEA estimates are, naturally, less disperse - this is expected because with conditional DEA each performance is compared only to a subset of the sample, those observations with similar levels of population density. In both the CRS and VRS cases, the average efficiency increases substantially. In the CRS case it reaches 0.797 (up from 0.588 in the unconditional DEA), while in the VRS case is now 0.901 (up from 0.788). That is, the distance between the observed best and worst performances could be explained in a significant degree by different contexts in which the firms perform. The detailed calculated scores are presented in Tables 5 and 7 in the Appendix.

To get a sense of how much the context of operation could be affecting the production possibilities of the firms, I compare the ratio of the unconditional over the conditional DEA scores with the population density. Figures 4 and 5 plots these observations (denominated as $R$ in the figures), along with a non-parametric (lowess) regression estimate. The ratio of the DEA efficiency scores measures the distance between the unconditional and conditional production possibilities ($\hat{\Psi}$ and $\hat{\Psi}(z)$ in the methodological section). When the ratio is closer to one it means that the both estimates are exactly equal, so conditioning on the context would not affect the production possibilities of the firms. The farther the measure deviates from one, on the contrary, would mean that there is a significant effect. We can see that in both the CRS and VRS cases there seems to be positive relation between the ratios and population density, stronger in the CRS case. We can interpret this as saying that low population densities seem to affect the production possibilities of the firms.

*G. Diaz (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 18-34, 2016
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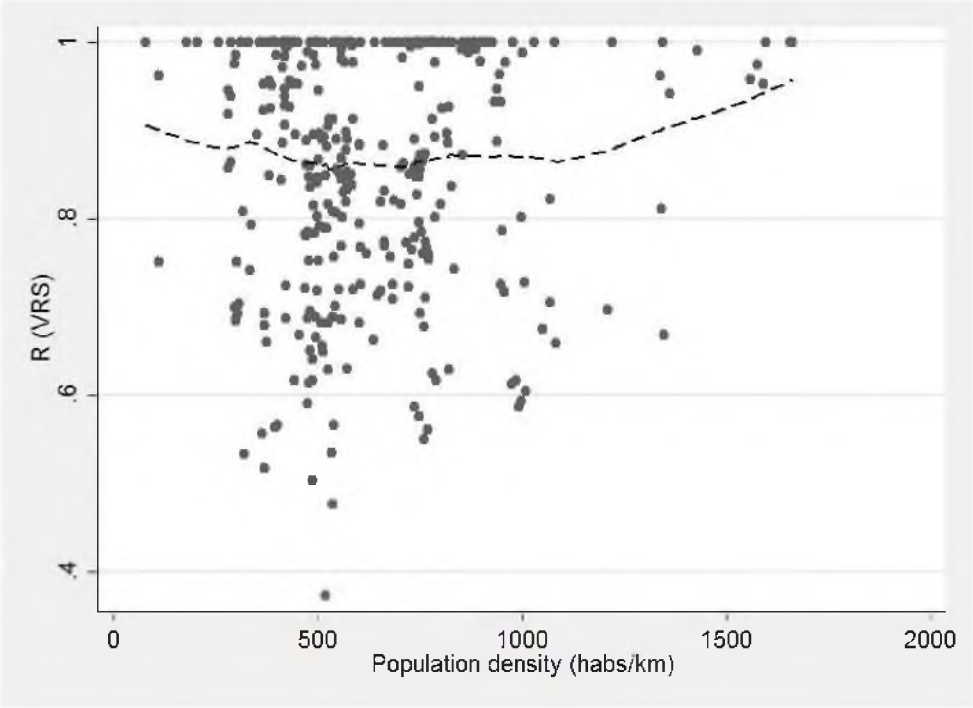


*Figure 5.* Ratio of unconditional over conditional DEA versus population density (VRS)

## Conclusions

In this study, production performance benchmarking techniques were applied, within the DEA framework, to compare the input usage efficiency of the water companies in Peru. The advantage of the DEA approach is that it does not only compares output and quality performance across companies, but also takes into consideration the input usage level. As noticed by Berg & Lin (2008), simple performance measures, like those used by SUNASS, mostly omit the input side of the production process.

On the other hand, in the DEA approach it could be complicated to account for the different contexts in which the companies operate, in comparison to regression methods, for example. At the same time, there is also the concern that the perceived differential performance could actually be explained in some degree by these differing contexts (Tupper & Resende, 2004). In this study I apply an extension of the usual input-oriented DEA benchmarking methodology to account for the possibly differential contexts. The conditional DEA method (Daraio & Simar, 2005) relies on comparing units with approximately similar contexts of operation, where this is quantified by a so-called "contextual variable".

Conditional DEA scores were calculated by conditioning on the population density in the area of operation of each company. I find that controlling for the context of operation in this way affects in an economically significant amount the calculated efficiencies, and therefore can affect the performance benchmarking of water companies in Peru.

*G. Diaz (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 18-34, 2016
https://doi.org/pehyj.2016.2201.02

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ICPE

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*G. Diaz (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 18-34, 2016
https://doi.org/pehyj.2016.2201.02

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## Author Note

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## Biographical Note

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## Appendix

### Efficiency Scores

In this section the efficiency scores calculated by SUNASS, as well as the scores calculated with the DEA methodologies proposed in this study are presented - the latter, both under the CRS and VRS assumptions.

*G. Diaz (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 18-34, 2016
https://doi.org/pehyj.2016.2201.02

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Table 3

*SUNASS's Efficiency Scores*

| Rank | Firm | Connections | Score | Grade 2013 | Grade 2012 |
|---|---|---|---|---|---|
| 1 | EPS MOQUEGUA | 20225 | 74.03 | B+ | B- |
| 2 | SEDAPAL | 1412305 | 73.16 | B+ | B+ |
| 3 | EPS ILO S | 24247 | 73.03 | B+ | C+ |
| 4 | EMUSAP SRL (Amazonas) | 6733 | 68.7 | B- | B- |
| 5 | EPS TACNA SA | 88836 | 68.15 | B- | B- |
| 6 | SEDACUSCO SA | 73850 | 66.49 | B- | B- |
| 7 | SEDAPAR S | 265264 | 65.16 | B- | B- |
| 8 | EPSASA | 52066 | 64.68 | B- | B- |
| 9 | SEDACAJ SA | 38854 | 60.46 | B- | C+ |
| 10 | SEDA HUÁNUCO SA | 41353 | 60.19 | B- | C+ |
| 11 | EPS NOR PUNO SA | 8653 | 58.56 | C+ | C+ |
| 12 | SEDACHIMBOTE SA | 84995 | 56.91 | C+ | C+ |
| 13 | EMUSAP ABANCAY SA | 12957 | 56.62 | C+ | B- |
| 14 | EMAPA Y SRL | 4768 | 56.31 | C+ | D+ |
| 15 | SEMAPACH SA | 44702 | 56 | C+ | C+ |
| 16 | EPS CHAVIN SA | 26280 | 55.99 | C+ | C+ |
| 17 | EMAPA HUANCAVELICA SA | 8024 | 55.88 | C+ | C+ |
| 18 | EPS MARAÑÓN SRL | 16494 | 55.83 | C+ | C- |
| 19 | SEDAPAR SRL (Rioja) | 5733 | 55.74 | C+ | C- |
| 20 | SEDALIB SA | 165558 | 55.66 | C+ | C+ |
| 21 | EPS SIERRA CENTRAL SRL | 9796 | 55.41 | C+ | C+ |
| 22 | EPS GRAU SA | 185947 | 54.89 | C+ | C+ |
| 23 | EMAPISCO SA | 24898 | 54.04 | C+ | C+ |
| 24 | EMAPA HUARAL SA | 15510 | 53.7 | C+ | C+ |
| 25 | EMAPICA SA | 50305 | 53.66 | C+ | C+ |
| 26 | EMAPA MOYOBAMBA SRL | 11689 | 53.15 | C+ | B- |
| 27 | EPS MANTARO SA | 17565 | 52.9 | C+ | C+ |
| 28 | EMSAP CHANKA SRL | 4436 | 52.81 | C+ | C+ |
| 29 | EMAPAT SRL | 15046 | 52.75 | C+ | C- |
| 30 | EMAPA SAN MARTIN SA | 39974 | 52.55 | C+ | C+ |
| 31 | EPSEL SA | 154748 | 52.42 | C+ | C+ |
| 32 | SEDAJULIACA SA | 48278 | 52.34 | C+ | C+ |
| 33 | EPS AGUAS DEL ALTIPLANO SRL | 6304 | 51.7 | C+ | C- |
| 34 | EMAPA HUACHO SA | 25755 | 51.68 | C+ | C+ |
| 35 | AGUAS DE TUMBES SA | 41392 | 51.58 | C+ | C- |
| 36 | EMAQ SRL | 6692 | 51.15 | C+ | C- |
| 37 | EMPSSAPAL SA | 13558 | 50.97 | C+ | C+ |
| 38 | EMSA PUNO SA | 42371 | 50.96 | C+ | C- |
| 39 | SEDAM HUANCAYO SAC | 67892 | 50.89 | C+ | C- |
| 40 | SEMAPA BARRANCA SA | 16297 | 48.74 | C- | C- |
| 41 | EMSAPA CALCA SRL | 3150 | 47.25 | C- | C- |
| 42 | EPSSMU SRL | 7578 | 46.51 | C- | C- |
| 43 | EMAPA CAÑETE SA | 31884 | 45.83 | C- | C- |
| 44 | EMAPAVIGS SAC | 8504 | 45.58 | C- | C- |
| 45 | EPS SEDALORETO SA | 88418 | 44.02 | C- | C- |
| 46 | EMSAPA YAULI SRL (La Oroya) | 3215 | 41.6 | C- | D+ |
| 47 | EMAPACOP SA | 24515 | 40.03 | C- | C- |
| 48 | EMAPA PASCO SA | 11343 | 39.93 | D+ | D+ |
| 49 | EPS SELVA CENTRAL SA | 22088 | 39.48 | D+ | D+ |
| 50 | EMAPAB SRL | 4759 | 39.32 | D+ | D+ |

Source: SUNASS (2013).

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Table 4

*Efficiency Scores: Unconditional DEA (CRS)*

| Code | Firm | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EMUSAP AMAZONAS | 1.000 | 1.000 | 1.000 | 0.961 | 1.000 | 1.000 | 0.981 | 0.893 | 0.824 |
| 2 | SEDA HUANUCO S.A. | | | 0.442 | 0.453 | 0.461 | 0.474 | 0.465 | 0.536 | 0.548 |
| 3 | EMAPACOP S.A. | 0.416 | 0.358 | 0.405 | 0.396 | 0.372 | 0.353 | | 0.442 | 0.416 |
| 4 | EPS SEDALORETO S.A. | 0.722 | 0.690 | 0.378 | 0.373 | 0.419 | 0.465 | 0.478 | | 0.319 |
| 5 | EMAPA CAÑETE S.A. | 0.575 | 0.548 | 0.591 | 0.595 | 0.563 | 0.688 | 0.529 | 0.581 | 0.641 |
| 6 | EMSA PUNO S.A. | 0.392 | 0.752 | 0.356 | 0.358 | 0.365 | 0.369 | 0.501 | 0.445 | 0.356 |
| 7 | EPSSMU S.R.LTDA | 0.821 | 0.824 | 0.884 | 0.903 | 0.683 | 0.695 | 0.733 | 0.794 | 0.832 |
| 8 | AGUAS DE TUMBES | 0.321 | 0.251 | 0.390 | 0.435 | 0.407 | 0.368 | 0.366 | 0.251 | |
| 9 | EMAPA PASCO S.A. | | 0.719 | | | 1.000 | 0.650 | | 0.914 | 1.000 |
| 10 | EMAPISCO S.A. | | 0.323 | 0.281 | 0.234 | 0.278 | 0.297 | 0.319 | 0.303 | 0.346 |
| 11 | SEDACAJ S.A. | 0.350 | 0.843 | 0.377 | 0.378 | 0.331 | 0.312 | 0.301 | 0.320 | 0.344 |
| 12 | EPS TACNA S.A. | 0.396 | 0.397 | 0.403 | 0.425 | 0.412 | 0.441 | 0.435 | 0.481 | 0.466 |
| 13 | EMAPAVIGSSA | 0.741 | 0.812 | 0.854 | | 0.950 | 1.000 | 0.798 | 0.836 | 0.936 |
| 14 | SEDACHIMBOTE S.A. | 0.444 | 0.467 | 0.431 | 0.491 | 0.453 | 0.423 | 0.386 | 0.367 | |
| 15 | EPSASA | 0.511 | 0.489 | 0.452 | 0.455 | 0.448 | 0.412 | 0.414 | 0.436 | 0.473 |
| 16 | EMAPA SAN MARTIN S.A. | 0.375 | 0.410 | 0.868 | 0.413 | 0.396 | 0.387 | 0.539 | 0.373 | 0.367 |
| 17 | EMAPAT S.R.LTDA. | 0.434 | 0.457 | 0.376 | 0.358 | 0.356 | 0.246 | 0.330 | 0.353 | 0.400 |
| 18 | SEMAPACH S.A. | 0.365 | 0.362 | 0.398 | | 0.353 | 0.436 | 0.456 | 0.474 | 0.492 |
| 19 | EPS SELVA CENTRAL S.A. | 0.705 | 0.503 | 0.724 | 0.740 | | 0.783 | 0.940 | 0.848 | 1.000 |
| 20 | EMAPA MOYOBAMBA S.R.LTDA. | 0.761 | | 0.774 | 1.000 | 0.985 | 0.783 | 1.000 | 0.805 | 0.812 |
| 21 | EMAPA HUANCAVELICA S.A.C | 0.960 | 1.000 | 0.848 | 0.614 | 0.668 | 0.763 | 1.000 | 0.611 | 0.620 |
| 22 | EPS MOQUEGUA S.R.LTDA. | 0.559 | 0.599 | 0.594 | 0.603 | 0.529 | 0.471 | 0.479 | 0.421 | 0.409 |
| 24 | EMAPA HUARAL S.A. | 0.919 | 1.000 | 0.979 | 0.956 | 0.879 | 0.875 | 0.829 | 1.000 | 0.924 |
| 25 | EMAPA HUACHO S.A. | 0.471 | 0.433 | | 0.440 | 0.433 | 0.425 | 0.432 | 0.451 | 0.488 |
| 27 | EPS ILO S.R.LTDA. | 0.268 | 0.274 | 0.275 | 0.280 | 0.278 | 0.292 | 1.000 | 0.294 | 0.298 |
| 28 | SEDALIB S.A. | 0.385 | 0.393 | 0.421 | 0.414 | 0.440 | 0.420 | 0.473 | 0.493 | 0.464 |
| 29 | EPSEL S.A. | 0.684 | 0.610 | 0.687 | | | 0.539 | | 0.545 | 0.868 |
| 30 | SEDAPAR S.A. | 0.416 | 0.413 | 0.434 | 0.913 | 0.377 | 0.363 | 0.359 | 0.423 | 0.438 |
| 31 | EPS - SEDACUSCO S.A. | 0.412 | 1.000 | 1.000 | 0.901 | 0.418 | 0.405 | 0.495 | 0.412 | 0.734 |
| 32 | EPS GRAU S.A. | 0.597 | 0.371 | 0.460 | 0.470 | 0.496 | 0.591 | 0.628 | 0.768 | 0.714 |
| 33 | EPS CHAVIN S.A. | 0.480 | 0.476 | 0.497 | 0.503 | 0.499 | 0.525 | | 0.805 | |
| 34 | EMAQ S.R.LTDA. | | 1.000 | 1.000 | 1.000 | | 1.000 | 0.957 | 1.000 | 1.000 |
| 35 | EMAPAB S.R.LTDA. | 0.712 | 0.751 | 0.787 | 0.801 | 0.644 | 0.677 | 0.777 | 0.742 | 0.758 |
| 36 | SEMAPA BARRANCA S.A. | 0.554 | 0.562 | 0.570 | 0.525 | 0.540 | 0.487 | 0.399 | 0.418 | 0.436 |
| 37 | EMAPICA S.A. | | | | | 0.456 | 0.503 | | 0.539 | 0.489 |
| 38 | EMPSSAPAL S.A. | 0.845 | 0.783 | 0.705 | 1.000 | 0.535 | 0.548 | 0.533 | 0.864 | 1.000 |
| 39 | EPS SIERRA CENTRAL S.A. | 0.695 | 0.658 | | 0.767 | 0.668 | 0.660 | 0.699 | 0.821 | 0.803 |
| 40 | NOR PUNO S.A. | 1.000 | 1.000 | 1.000 | 0.903 | 1.000 | 1.000 | 1.000 | 0.998 | 0.869 |
| 41 | SEDAJULIACA S.A. | 0.502 | 0.479 | 0.515 | 0.533 | 0.522 | 0.558 | 0.500 | 0.607 | 0.525 |
| 42 | EPS MANTARO S.A. | 1.000 | 0.406 | 0.538 | 0.550 | 0.472 | 0.513 | 0.489 | 0.491 | 0.489 |
| 43 | EMUSAP ABANCAY | 0.604 | 0.544 | 0.571 | 0.539 | 0.477 | | 0.468 | 0.469 | 0.468 |
| 45 | EPS MARAÑON | 0.579 | 0.565 | 0.579 | 0.567 | 0.818 | | 0.912 | | 0.504 |
| 46 | SEDAM HUANCAYO S.A.C | | 0.614 | 0.678 | | | 0.441 | 0.450 | 0.439 | 0.387 |

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Table 5

*Efficiency Scores: Conditional DEA (CRS)*

| Code | Firm | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EMUSAP AMAZONAS | 1.000 | 1.000 | 1.000 | 1.000 | | 1.000 | 0.988 | 1.000 | 0.969 |
| 2 | SEDA HUANUCO S.A. | | | 0.543 | 0.563 | 0.588 | 0.561 | 0.523 | 0.690 | 0.738 |
| 3 | EMAPACOP S.A. | 0.523 | 0.408 | 0.459 | 0.466 | 0.448 | 0.443 | 0.471 | 0.646 | 0.742 |
| 4 | EPS SEDALORETO S.A. | 1.000 | 0.705 | 0.468 | 0.514 | 0.525 | 0.622 | 0.656 | 0.581 | 0.391 |
| 5 | EMAPA CAÑETE S.A. | 0.779 | 0.901 | 1.000 | 1.000 | 0.712 | 1.000 | 0.699 | 0.750 | 0.822 |
| 6 | EMSA PUNO S.A. | 0.465 | 1.000 | 0.688 | 0.692 | 0.662 | 0.654 | 0.766 | 0.666 | 0.537 |
| 7 | EPSSMU S.R.LTDA | 0.982 | 1.000 | 0.988 | 1.000 | | 0.826 | 0.894 | 0.954 | 0.995 |
| 8 | AGUAS DE TUMBES | 0.448 | 0.447 | 0.609 | 0.685 | 0.538 | 0.474 | 0.482 | 0.387 | 0.702 |
| 9 | EMAPA PASCO S.A. | | 1.000 | | | 1.000 | 0.650 | | 0.914 | 1.000 |
| 10 | EMAPISCO S.A. | | 0.511 | 0.464 | 0.427 | 0.471 | 0.567 | 0.613 | 0.556 | 0.605 |
| 11 | SEDACAJ S.A. | 0.420 | 1.000 | 0.461 | 0.466 | 0.670 | 0.639 | 0.717 | 0.664 | 1.000 |
| 12 | EPS TACNA S.A. | 0.615 | 0.657 | 0.714 | 0.723 | 0.722 | 0.772 | 0.682 | 0.820 | 0.792 |
| 13 | EMAPAVIGSSA | 1.000 | 1.000 | 0.978 | 1.000 | 0.989 | 1.000 | 0.878 | 0.970 | 1.000 |
| 14 | SEDACHIMBOTE S.A. | 0.799 | 0.767 | 0.717 | 0.797 | 0.748 | 0.706 | 0.657 | 0.625 | 0.669 |
| 15 | EPSASA | 1.000 | 0.892 | 0.804 | 0.830 | 0.812 | 0.747 | 0.751 | 0.755 | 0.864 |
| 16 | EMAPA SAN MARTIN S.A. | 0.581 | 0.693 | 1.000 | 0.844 | 0.690 | 0.723 | 0.842 | 0.636 | 0.629 |
| 17 | EMAPAT S.R.LTDA. | 0.701 | 1.000 | 0.791 | 0.849 | 0.603 | 0.516 | 0.710 | 1.000 | 1.000 |
| 18 | SEMAPACH S.A. | 0.458 | 0.467 | 0.575 | 0.502 | 0.454 | 0.608 | 0.658 | 0.697 | 0.731 |
| 19 | EPS SELVA CENTRAL S.A. | 1.000 | 0.599 | 0.984 | 0.928 | | 1.000 | 1.000 | 1.000 | 1.000 |
| 20 | EMAPA MOYOBAMBA S.R.LTDA. | 0.879 | 1.000 | 0.972 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 21 | EMAPA HUANCAVELICA S.A.C | 1.000 | 1.000 | 1.000 | 1.000 | 0.954 | 0.914 | 1.000 | 1.000 | 0.967 |
| 22 | EPS MOQUEGUA S.R.LTDA. | 0.965 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 24 | EMAPA HUARAL S.A. | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | | 1.000 |
| 25 | EMAPA HUACHO S.A. | 0.535 | | 0.519 | 0.499 | | 0.498 | 0.501 | 0.605 | 0.603 |
| 27 | EPS ILO S.R.LTDA. | 0.521 | 0.544 | 0.560 | 0.573 | 0.566 | 0.593 | 1.000 | 0.650 | 0.679 |
| 28 | SEDALIB S.A. | 0.477 | 0.493 | 0.530 | 0.537 | 0.573 | 0.535 | | 0.664 | |
| 29 | EPSEL S.A. | 0.948 | 0.845 | 0.922 | 0.885 | 1.000 | 0.657 | 0.701 | 0.719 | 1.000 |
| 30 | SEDAPAR S.A. | 0.658 | 0.666 | 0.795 | 1.000 | 0.777 | 0.681 | 0.663 | 0.862 | 1.000 |
| 31 | EPS - SEDACUSCO S.A. | 0.525 | 1.000 | 1.000 | 0.912 | 0.538 | 0.520 | 0.641 | 0.577 | |
| 32 | EPS GRAU S.A. | 0.731 | 0.477 | 0.572 | 0.585 | 0.638 | 0.767 | 0.811 | 1.000 | 0.904 |
| 33 | EPS CHAVIN S.A. | 0.951 | 0.936 | 0.509 | 0.513 | 0.507 | 0.532 | | 1.000 | 0.575 |
| 34 | EMAQ S.R.LTDA. | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 35 | EMAPAB S.R.LTDA. | 0.842 | 0.895 | 1.000 | 0.966 | 0.919 | 0.816 | 1.000 | 0.988 | 1.000 |
| 36 | SEMAPA BARRANCA S.A. | 0.711 | 0.681 | 0.692 | 0.585 | 0.574 | | 0.697 | 0.673 | 0.754 |
| 37 | EMAPICA S.A. | | | | | 0.848 | 0.937 | | 1.000 | 0.920 |
| 38 | EMPSSAPAL S.A. | 0.979 | 0.915 | 0.868 | 1.000 | 0.649 | 0.665 | 0.690 | 0.881 | 1.000 |
| 39 | EPS SIERRA CENTRAL S.A. | 0.967 | 0.991 | 1.000 | 1.000 | 0.952 | 0.947 | 0.989 | 1.000 | 0.979 |
| 40 | NOR PUNO S.A. | 1.000 | 0.999 | 1.000 | 0.941 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 41 | SEDAJULIACA S.A. | 0.906 | 0.852 | | 0.995 | 0.975 | 1.000 | 0.906 | 0.882 | 0.909 |
| 42 | EPS MANTARO S.A. | 1.000 | 0.726 | 0.858 | 0.895 | 0.610 | 0.693 | 1.000 | 1.000 | 1.000 |
| 43 | EMUSAP ABANCAY | 1.000 | 0.902 | 0.942 | 0.801 | 0.815 | 0.805 | 0.808 | 0.858 | 0.876 |
| 45 | EPS MARAÑON | 1.000 | 1.000 | 1.000 | 1.000 | 0.999 | | 1.000 | | 0.675 |
| 46 | SEDAM HUANCAYO S.A.C | | 0.547 | 0.628 | | | 0.764 | 0.838 | 0.902 | 1.000 |

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Table 6

*Efficiency Scores: Unconditional DEA (VRS)*

| Code | Firm | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EMUSAP AMAZONAS | 1.000 | 1.000 | 1.000 | 1.000 | 0.958 | 1.000 | 1.000 | 1.000 | 0.933 |
| 2 | SEDA HUANUCO S.A. | | | 0.748 | 0.805 | 0.795 | 0.809 | 1.000 | 1.000 | 1.000 |
| 3 | EMAPACOP S.A. | 0.417 | 0.363 | 0.413 | 0.421 | 0.378 | 0.356 | 0.372 | 0.461 | 0.434 |
| 4 | EPS SEDALORETO S.A. | 1.000 | 1.000 | 0.572 | 0.598 | 0.677 | 0.706 | 0.732 | 0.731 | 0.585 |
| 5 | EMAPA CAÑETE S.A. | 0.728 | 0.552 | 0.596 | 0.598 | 0.605 | 0.699 | 0.537 | 0.596 | 0.670 |
| 6 | EMSA PUNO S.A. | 0.457 | 0.753 | 0.514 | 0.559 | 0.572 | 0.555 | 0.727 | 0.649 | 0.667 |
| 7 | EPSSMU S.R.LTDA | 0.875 | 0.888 | 0.892 | 1.000 | 0.807 | 0.801 | 0.755 | 0.801 | 0.874 |
| 8 | AGUAS DE TUMBES | | 0.262 | 0.391 | 0.460 | 0.427 | 0.424 | 0.407 | 0.349 | 0.486 |
| 9 | EMAPA PASCO S.A. | | 0.885 | | | | | | 0.924 | 1.000 |
| 10 | EMAPISCO S.A. | | 0.434 | 0.457 | 0.298 | 0.382 | 0.431 | 0.580 | 0.519 | 0.915 |
| 11 | SEDACAJ S.A. | 0.471 | 0.843 | 0.485 | 0.547 | 0.500 | 0.519 | 0.375 | 0.405 | 0.458 |
| 12 | EPS TACNA S.A. | 0.915 | 0.921 | 0.909 | 1.000 | 0.967 | 0.983 | 0.940 | 0.985 | 1.000 |
| 13 | EMAPAVIGSSA | 0.947 | 0.930 | 1.000 | 1.000 | 1.000 | 1.000 | 0.795 | 0.905 | 1.000 |
| 14 | SEDACHIMBOTE S.A. | 0.956 | 1.000 | 0.805 | 0.893 | 0.828 | 0.783 | 0.711 | 0.758 | 0.693 |
| 15 | EPSASA | 0.889 | 0.889 | 0.792 | 0.834 | 0.820 | 0.775 | 0.778 | 0.823 | 1.000 |
| 16 | EMAPA SAN MARTIN S.A. | 1.000 | 0.641 | 1.000 | 0.770 | 0.864 | 0.964 | 1.000 | 0.921 | 0.780 |
| 17 | EMAPAT S.R.LTDA. | 0.447 | 0.463 | 0.381 | 0.372 | 0.416 | 0.275 | 0.435 | 1.000 | |
| 18 | SEMAPACH S.A. | 0.377 | 0.377 | 0.408 | 0.387 | 0.520 | 0.677 | 0.681 | 0.744 | 0.648 |
| 19 | EPS SELVA CENTRAL S.A. | 0.785 | 0.510 | 0.728 | 0.741 | | 0.783 | 1.000 | 0.995 | 1.000 |
| 20 | EMAPA MOYOBAMBA S.R.LTDA. | 0.869 | 0.994 | 1.000 | 1.000 | 1.000 | | 1.000 | 0.822 | 0.933 |
| 21 | EMAPA HUANCAVELICA S.A.C | 1.000 | 1.000 | 0.871 | 0.624 | 0.689 | 0.769 | 1.000 | 0.673 | 0.751 |
| 22 | EPS MOQUEGUA S.R.LTDA. | 1.000 | 1.000 | 1.000 | 0.825 | 0.720 | 0.739 | 0.790 | 0.885 | 1.000 |
| 24 | EMAPA HUARAL S.A. | 0.940 | 1.000 | 0.979 | 0.957 | 0.999 | 0.923 | 0.829 | 1.000 | 0.982 |
| 25 | EMAPA HUACHO S.A. | 0.469 | 0.454 | 0.480 | 0.504 | | 0.554 | 0.590 | 0.670 | 0.729 |
| 27 | EPS ILO S.R.LTDA. | 0.395 | 0.441 | 0.450 | 0.432 | 0.423 | 0.425 | 1.000 | 1.000 | 0.695 |
| 28 | SEDALIB S.A. | 0.612 | 0.642 | 0.658 | 0.671 | 0.708 | 0.703 | 0.714 | 0.742 | 0.720 |
| 29 | EPSEL S.A. | 1.000 | 0.921 | 0.950 | 0.995 | 1.000 | 1.000 | 1.000 | 0.987 | 1.000 |
| 30 | SEDAPAR S.A. | | 0.948 | 1.000 | 1.000 | 1.000 | 0.964 | | 0.958 | 1.000 |
| 31 | EPS - SEDACUSCO S.A. | 0.757 | 1.000 | 1.000 | 0.914 | 0.867 | 1.000 | 0.753 | 0.721 | 1.000 |
| 32 | EPS GRAU S.A. | 0.753 | 0.661 | 0.701 | 0.714 | 0.744 | 0.859 | 0.897 | 1.000 | 1.000 |
| 33 | EPS CHAVIN S.A. | 0.679 | 0.688 | 0.750 | 0.749 | 0.853 | 1.000 | | 1.000 | 1.000 |
| 34 | EMAQ S.R.LTDA. | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.956 | 1.000 | 1.000 |
| 35 | EMAPAB S.R.LTDA. | 0.871 | 0.906 | 0.914 | 0.846 | 0.856 | 0.992 | 1.000 | 0.958 | 0.963 |
| 36 | SEMAPA BARRANCA S.A. | 0.734 | 0.789 | 0.963 | 0.867 | 0.947 | 0.863 | 0.511 | 0.585 | 0.536 |
| 37 | EMAPICA S.A. | | | | | 0.726 | 0.814 | 0.881 | 0.955 | 0.957 |
| 38 | EMPSSAPAL S.A. | 0.888 | 0.870 | 0.882 | 1.000 | 0.661 | 0.708 | 0.883 | 1.000 | 1.000 |
| 39 | EPS SIERRA CENTRAL S.A. | 0.724 | 0.759 | 0.919 | 1.000 | 0.809 | 0.811 | 0.930 | 1.000 | 1.000 |
| 40 | NOR PUNO S.A. | 1.000 | 0.960 | 1.000 | 0.938 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 41 | SEDAJULIACA S.A. | 0.599 | 0.632 | 0.775 | 0.771 | 0.804 | 0.843 | 0.754 | 0.856 | 0.803 |
| 42 | EPS MANTARO S.A. | 1.000 | 0.418 | 0.539 | 0.551 | 0.477 | 0.526 | 0.658 | 0.841 | 0.943 |
| 43 | EMUSAP ABANCAY | 1.000 | 0.943 | 1.000 | 0.840 | 0.830 | 0.859 | 1.000 | 0.993 | 1.000 |
| 45 | EPS MARAÑON | 0.760 | 0.712 | 0.684 | 0.642 | 0.828 | | 0.918 | | 0.523 |
| 46 | SEDAM HUANCAYO S.A.C | | 1.000 | 1.000 | | | 0.981 | 1.000 | 0.984 | 1.000 |

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Table 7

*Efficiency Scores: Conditional DEA (VRS)*

| Code | Firm | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EMUSAP AMAZONAS | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.999 |
| 2 | SEDA HUANUCO S.A. | | | | 0.854 | 0.878 | 0.878 | 1.000 | 1.000 | 1.000 |
| 3 | EMAPACOP S.A. | 0.610 | 0.547 | 0.633 | 0.662 | 0.624 | 0.581 | 0.603 | 0.660 | 0.731 |
| 4 | EPS SEDALORETO S.A. | 1.000 | 1.000 | 0.899 | 0.662 | | 0.756 | 0.762 | 0.755 | 0.781 |
| 5 | EMAPA CAÑETE S.A. | 0.957 | 0.893 | 0.987 | 1.000 | 0.830 | 1.000 | 0.763 | 0.798 | 0.891 |
| 6 | EMSA PUNO S.A. | 0.632 | 1.000 | 0.688 | 0.692 | 0.693 | 0.670 | 0.787 | 0.692 | 0.725 |
| 7 | EPSSMU S.R.LTDA | 1.000 | 1.000 | 1.000 | 1.000 | 0.818 | 0.825 | 0.896 | 0.958 | 1.000 |
| 8 | AGUAS DE TUMBES | 0.455 | 0.457 | 0.609 | 0.695 | 0.751 | 0.713 | 0.741 | 0.506 | 1.000 |
| 9 | EMAPA PASCO S.A. | | 1.000 | | | 1.000 | 0.670 | | 0.928 | 1.000 |
| 10 | EMAPISCO S.A. | | 0.517 | 0.475 | 0.441 | 0.475 | 0.581 | 0.753 | 0.715 | 1.000 |
| 11 | SEDACAJ S.A. | 0.640 | 1.000 | 0.692 | 0.715 | 0.675 | 1.000 | 0.775 | 0.664 | 1.000 |
| 12 | EPS TACNA S.A. | 0.959 | 0.959 | 0.948 | 1.000 | 0.960 | 0.972 | 0.963 | 1.000 | 1.000 |
| 13 | EMAPAVIGSSA | 0.772 | 0.856 | 0.927 | 1.000 | 0.968 | 1.000 | 0.943 | 1.000 | 1.000 |
| 14 | SEDACHIMBOTE S.A. | 1.000 | 1.000 | 0.935 | 1.000 | 0.959 | 0.892 | 0.837 | 0.837 | 0.857 |
| 15 | EPSASA | 1.000 | 1.000 | 0.955 | 1.000 | 0.984 | 0.972 | 0.951 | 0.992 | 1.000 |
| 16 | EMAPA SAN MARTIN S.A. | 1.000 | 0.799 | 1.000 | 0.887 | 0.887 | 1.000 | 1.000 | 0.977 | 0.878 |
| 17 | EMAPAT S.R.LTDA. | 1.000 | 1.000 | 0.812 | 1.000 | 0.603 | 0.521 | 0.573 | 1.000 | |
| 18 | SEMAPACH S.A. | 0.484 | 0.500 | 0.614 | 0.508 | 0.554 | 0.811 | 0.898 | 1.000 | 1.000 |
| 19 | EPS SELVA CENTRAL S.A. | 1.000 | 0.825 | 1.000 | 0.944 | | 1.000 | 1.000 | 1.000 | |
| 20 | EMAPA MOYOBAMBA S.R.LTDA. | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 21 | EMAPA HUANCAVELICA S.A.C | 1.000 | 1.000 | 0.897 | 1.000 | 0.956 | 0.928 | 1.000 | 1.000 | 0.966 |
| 22 | EPS MOQUEGUA S.R.LTDA. | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 24 | EMAPA HUARAL S.A. | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 25 | EMAPA HUACHO S.A. | 0.545 | 0.611 | 0.654 | 0.670 | 0.736 | 0.742 | 0.810 | 1.000 | 1.000 |
| 27 | EPS ILO S.R.LTDA. | 0.587 | 0.642 | 0.670 | 0.585 | 0.669 | 0.685 | 1.000 | 1.000 | 1.000 |
| 28 | SEDALIB S.A. | 0.725 | 0.783 | 0.788 | 0.938 | | 0.832 | 0.839 | 0.855 | 0.854 |
| 29 | EPSEL S.A. | 1.000 | 0.938 | 0.961 | 0.999 | 1.000 | 1.000 | 1.000 | 0.971 | 1.000 |
| 30 | SEDAPAR S.A. | 0.957 | 0.952 | 1.000 | | 1.000 | 0.975 | 0.945 | | 1.000 |
| 31 | EPS - SEDACUSCO S.A. | 0.920 | 1.000 | 1.000 | 0.919 | | 1.000 | 0.978 | 0.905 | 1.000 |
| 32 | EPS GRAU S.A. | 1.000 | 0.791 | 0.825 | 0.844 | 1.000 | 0.981 | 0.957 | 1.000 | 1.000 |
| 33 | EPS CHAVIN S.A. | 0.954 | 0.938 | 0.896 | 0.923 | 0.935 | 1.000 | | 1.000 | 1.000 |
| 34 | EMAQ S.R.LTDA. | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 35 | EMAPAB S.R.LTDA. | 1.000 | 0.981 | 1.000 | 1.000 | 0.960 | 1.000 | 1.000 | 1.000 | 1.000 |
| 36 | SEMAPA BARRANCA S.A. | 0.962 | 0.954 | 1.000 | 1.000 | 1.000 | 0.990 | 0.707 | 0.709 | 0.770 |
| 37 | EMAPICA S.A. | | | | | 0.917 | 0.948 | 1.000 | 1.000 | 1.000 |
| 38 | EMPSSAPAL S.A. | 1.000 | 0.957 | 0.907 | 1.000 | 0.671 | 0.721 | 0.883 | 1.000 | 1.000 |
| 39 | EPS SIERRA CENTRAL S.A. | 1.000 | 0.994 | 1.000 | 1.000 | 0.954 | 0.947 | 0.996 | 1.000 | 1.000 |
| 40 | NOR PUNO S.A. | 1.000 | 1.000 | 1.000 | 0.966 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 41 | SEDAJULIACA S.A. | | 0.864 | 0.973 | 1.000 | 1.000 | 1.000 | 0.907 | 1.000 | 0.944 |
| 42 | EPS MANTARO S.A. | 1.000 | | 0.860 | 0.898 | 0.618 | 0.859 | 1.000 | 1.000 | 1.000 |
| 43 | EMUSAP ABANCAY | 1.000 | 0.973 | 1.000 | 0.841 | 0.873 | 0.885 | | 0.993 | 1.000 |
| 45 | EPS MARAÑON | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | | 1.000 | | 0.675 |
| 46 | SEDAM HUANCAYO S.A.C | | 1.000 | 1.000 | | | 1.000 | 1.000 | 1.000 | 1.000 |

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# Measurement of Trade Costs, its Determinants and Trade Growth Accounting for India with its Asian Trading Partners

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## Abstract

Gravity model of international trade established a fact that international trade of an economy is highly affected by the trade costs incurred locally and across borders. These costs are the difference between production cost of a traded commodity and its price paid by the ultimate buyers. The present study calculates the trade costs of Indian economy with its Asian trading partners. The study is developed in three stages: It measures the trade costs for India with its trading partners from the Asian region; it also estimates the determinants of trade costs by using the data on the available trade cost proxies; and thereafter, it decomposes the growth of Indian trade into the contribution of growth in income, the contribution of the decline in bilateral trade costs, and the contribution of the decline in multilateral resistance. It is found that the trade costs of India with all its Asian partners have declined throughout the whole study period (1995-2013). The decline in Indian trade costs was the highest in West Asia followed by Southeast Asia, East Asia, South Asia, and Central Asia. The variables, used as determinants of trade costs, namely: contiguity, distance, tariffs, non-tariff barriers, exchange rate, and port infrastructure, behaved according to the theoretical expectations. Furthermore, the decomposition of the growth of Indian trade with Asian partners revealed that the decline in the relative bilateral trade costs was the driving force of growth of Indian trade with all the Asian regions.

*Keywords*: Trade costs, Novy, India, Asia

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## Introduction

The gravity model of international trade established a fact that international trade of an economy is highly affected by the trade costs incurred locally and across the borders. These costs are the difference between production cost of a traded commodity and its price paid by the ultimate buyers. To measure this price gap, between the supply price of a commodity and its final price, data on each and every variable that accumulates the price of a traded commodity from source to the ultimate destination is needed. But the paucity of data on directly observable variables – policy, geographical and environmental – forces to search for the other alternative measures of trade costs. These other alternative measures of trade costs are known as indirect measures of trade costs and surmise trade costs from trade flows by using the gravity model.

The presence of the gravity model in the international trade was first manifested by Tinbergen (1962). His gravity Equation imitates the Newton's gravity Equation and describes that international trade between two trading nations is directly linked with their economic sizes and inversely related with the distance between them, acting as a proxy for the trade costs. However, Tinbergen (1962) omitted many other trade affecting variables like tariff barriers, non-tariff barriers, contract enforcement costs, infrastructure costs, and distribution costs, among others. Thus, it triggered a debate among the economists to find out an appropriate gravity model of international trade which accounts for all of these omitted variables.

Anderson (1979) derived the gravity Equation from the systems' of expenditure Equations and provided a theoretical base to the gravity model of international trade. But McCallum (1995) again estimated the naive gravity Equation for the bilateral trade between the provinecs of Canada and states of America with distance and borderas proxies for the trade costs. He found that trade between two provinces have been more than 20 times larger than the trade between a state and a province. But Anderson and Wincoop (2003) challenged the estimated results of his study and proved that McCallum (1995) had used the wrong proxies to reflect the international trade costs. They emphasized that not only the bilateral trade barriers but multilateral trade barriers also affect the international trade and called these barriers as the multilateral resistance term, the resistance from the other trading partners.

Later on, Novy (2011) used the final gravity model of international trade by Anderson and Wincoop (2003) and after making some modifications into it, he derived a micro-founded measure for the international trade costs. His measure directly calculated the international trade costs from the observable international trade data. This bilateral measure of trade costs is comprehensive because it takes into consideration all kinds of costs involved in trading goods bilaterally relative to those involved in trading goods intranationally (Duval & Utoktham, 2011a).

The present study uses Novy's (2011) measure to calculate the trade costs of India with its trading partners from the Asian region. Then, to check the level of connectedness of this trade cost measure with the available proxies of trade costs, the study attempts to find out the determinants of these calculated bilateral trade costs for thirty one Asian economies, comprising India and its thirty partners, by using the data on the available proxies of trade costs. Furthermore, by applying Novy's (2011) trade growth decomposition , the study decomposes the growth of Indian trade into: contribution of growth in income; the contribution of the decline in bilateral trade costs; and the contribution of the decline in multilateral resistance. To present the aforementioned analysis in a sequential form, the present study is divided into seven sections, including the present introductory one. Section 2 puts some light on the place of Asian partners in the international trade of India. Section 3 discusses the database and methodology used. In the fourth section, the study calculates the trade costs for India with its Asian trading partners. The fifth section estimates the determinants of bilateral trade costs of Asia. The decomposition of growth of Indian bilateral trade with Asia is developed in sixth section and, finally, the last section includes the study conclusions.

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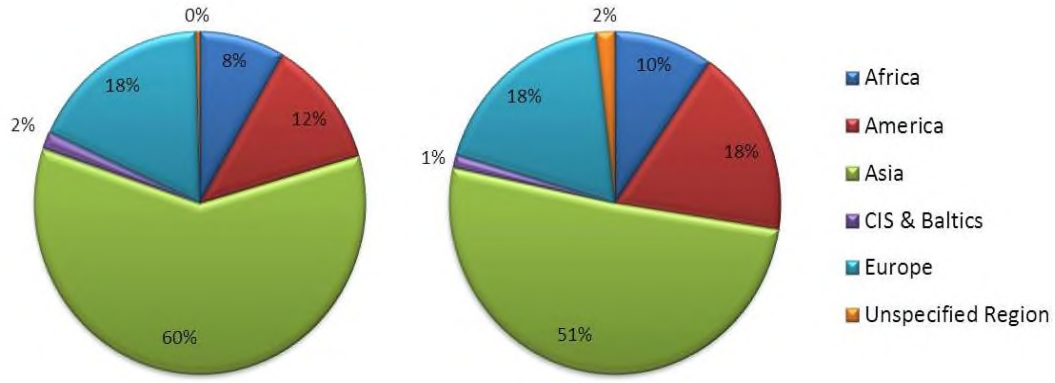
## Position of Asia in Indian Trade

Asia, the largest continent among the all seven continents of the world, is holding number one position in the category of region-wise trade (exports and imports) of India. It is apparently clear that in India's total imports (Figure 1, left panel), Asian countries have the maximum share (60%) followed by Europe (18%), America (12%), Africa (8%), CIS[1] and the Baltics (2%) and Unspecified Region (0.5%). On the exports side (Figure 1, right panel), about 51 percent share of India's total exports has gone to Asian countries followed by Europe (18%), America (18%), Africa (10%), Unspecified Region (2%) and CIS and the Baltics (1.23%).




*Note.* Compiled from Export-Import Data Bank (Ministry of Commerce and Industry, India).

*Figure 1.* Region-wise share of India's imports and exports (2013-2014).

Within the Asian region, GCC countries have maximum (38.64%) share in Asia's total exports to India (India's imports from Asian countries) followed by East Asia (32.01%), ASEAN members (15.74%), Other West Asian countries (12.40%), South Asian countries (0.94%) and Central Asian countries (0.27%). In the case of total exports to Asian countries, India's maximum exports have been to six GCC countries (31.47%), followed by East Asia (26.73%), ASEAN members (21.59%), South Asian countries (11.35%), other West Asian countries (8.51%) and least with Central Asian countries (0.35%).

## Methodology and Database

### *Methodology*

Obstfeld and Rogoff (2000) categorized measurement of trade costs as one of the major six puzzles in international macroeconomics. As discussed earlier, there is a lack of data on direct measures, thus, the present study uses an indirect measure of trade costs derived by Novy (2011). Novy assumed Anderson and Wincoop's (2003) final

[1]As per the data information provided by the Ministry of Commerce and Industry, CIS countries also includes all Central Asian countries and it has 0.16%and 0.17% share in total imports and exports of India respectively in 2013-14; therefore, it does not affect the total figure while explaining the required fact.

gravity model[2] as the starting point for the derivation of trade costs' measure, but ended up with totally different and more realistic findings. His measure of trade costs possesses some merits over the Anderson and Wincoop's trade cost function: it does not assume bilateral trade costs to be symmetric; trade costs do not depend only on the two variables distance and border; and also, these vary over time.
Anderson and Wincoop's (2003) framework:

$$x_{ij} = \frac{y_i y_j}{y^w}\left(\frac{t_{ij}}{\pi_i p_j}\right)^{1-\sigma} \quad (1)$$

$${\pi_i}^{1-\sigma} = \sum_j p_j^{1-\sigma}\theta_j t_{ij}^{1-\sigma}\ \forall_i \quad (2)$$

$${p_j}^{1-\sigma} = \sum_i \pi_i^{1-\sigma}\theta_i t_{ij}^{1-\sigma}\ \forall_j \quad (3)$$

where, $x_{ij}$ is the level of trade of country *i* to country *j*; $y_i, y_j$ and $y^w$ are the GDPs of country *i*, *j* and world respectively; $t_{ij}$ is the level of trade costs; $\pi_i$ is the outward multilateral resistance and $p_j$ is the inward multilateral resistance; and $\sigma > 1$ is the elasticity of substitution across the goods. In second and third Equations,$\theta_j$ and $\theta_i$ represents the income shares of country *i* and *j* in the world income, i.e., $\theta_j = \frac{y_j}{y^w}$ and $\theta_i = \frac{y_i}{y^w}$.

Equation (1) can be used to find an expression for country *i*'s intranational trade:

$$x_{ii} = \frac{y_i y_i}{y^w}\left(\frac{t_{ii}}{\pi_i p_i}\right)^{1-\sigma} \quad (4)$$

where $t_{ii}$ represents intranational (domestic) trade costs. Expressing Equation (4) in terms of the product of outward and inward multilateral resistance as:

$$\pi_i p_i = \left(\frac{x_{ii}/y_i}{y_i/y^w}\right)^{\frac{1}{(\sigma-1)}} t_{ii} \quad (5)$$

The gravity Equation (1) includes the product of multilateral resistance terms (inward and outward) of both the trading partners *i* and *j*. But Equation (5) provides a solution for $\pi_i p_i$, which is only for $i^{th}$ country. So to obtain a gravity Equation that contains both inward and outward resistance terms (for both *i* and *j* countries), it is wise to multiply the Equation (1) with the trade flows in the opposite direction $x_{ji}$.

$$x_{ij}x_{ji} = \left(\frac{y_i y_j}{y^w}\right)^2\left(\frac{t_{ij}t_{ji}}{\pi_i p_i \pi_j p_j}\right)^{1-\sigma} \quad (6)$$

By substituting the values of $\pi_i p_i$ and $\pi_j p_j$ (see Appendix A), Novy (2011) derived the following measure:

$$\tau_{ij} = \left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)^{\frac{1}{2}} - 1 = \left(\frac{x_{ii}x_{jj}}{x_{ij}x_{ji}}\right)^{\frac{1}{2(\sigma-1)}} - 1 \quad (7)$$

In the above measure, $\tau_{ij}$ represents the tariff equivalents of trade costs, $x_{ii}$ and $x_{jj}$are the intranational trade flows of country *i* and *j* respectively. $x_{ij}$is the bilateral trade flow from country *i* to *j* and $x_{ji}$ represents the bilateral trade flows from country *j* to *i*. σ is the elasticity of substitution across goods. Thus, trade costs ($\tau_{ij}$) depend upon the ratio

[2]See Equation (13) of Anderson and Wincoop (2003), p. 175.

of intranational trade ($x_{ii}x_{jj}$) to international trade ( $x_{ij}x_{ji}$). If this ratio declines, it means that bilateral trade flows in relation to domestic trade flows rises, which depicts the low level of trade costs between two trading partners and viceversa.

The above measure of trade costs is derived by using the demand side framework of Anderson and Wincoop (2003). But this is not the only gravity model available in the literature. There are other gravity models which have been derived from the producer's side. These models are of Eaton and Kortum (2002), Chaney (2008) and Melitz and Ottaviano (2008). Therefore, there is a need to verify the authenticity of trade costs' measure given in Equation (7). Novy (2011) proved that the measures of trade costs derived from the above-mentioned supply side models are isomorphic with the trade costs measure derived from the demand side model of Anderson and Wincoop (2003).

### *Database*

Domestic trade of county *i* ( $x_{ii}$ ) is the total income minus total exports, $x_{ii} = y_i - x_i$. Total exports $x_i$ are defined as the sum of all exports from country *i*, $x_i \equiv \sum_{j \neq i} x_{ij}$. As trade data are only for the merchandise goods, total GDP cannot be used to represent $y_i$, because it takes into account the data on all goods and services produced in a particular year. Therefore, the study took the sum of the GDP only from agricultural and manufacturing sectors to form $y_i$. The data on the GDP of agriculture and manufacturing, and trade (exports and imports) was taken from the World Development Indicators (WDI) and the World Integrated Trade Solutions (WITS), respectively. The study has assumed σ = 8, which is the middle range of 5 to 10, found by Anderson and Wincoop (2004)[3]. The study has also developed the sensitivity analysis by using the three different values of σ as 5, 8 and 10 respectively, but the trend line has depicted more or less the same behavior (see Appendix B). The study takes into account thirty trading partners of India within Asia and the rest was not included because of the limited data availability. The selected trading partners of India are categorized into five groups/regions: East Asia, West Asia, South Asia, Southeast Asia and Central Asia. The information about the number of countries and the names included in each group is given in Table 1.

Table 1
*Region-Wise Description of Asian Countries*

| East Asia | West Asia | South Asia | Southeast Asia | Central Asia |
|---|---|---|---|---|
| China | Armenia | Bangladesh | Brunei | Kazakhstan |
| Hong Kong | Azerbaijan | Maldives | Cambodia | Kyrgyzstan |
| Japan | Georgia | Nepal | Indonesia | Tajikistan |
| Republic of Korea | Jordan | Pakistan | Lao | |
| | Lebanon | Sri Lanka | Malaysia | |
| Macao | Saudi Arabia | | Philippines | |
| Mongolia | United Arab Emirates (U.A.E.) | | Singapore | |
| | | | Thailand | |
| | | | Vietnam | |

[3] Novy (2011) and Duval and Utoktham (2011a) also assumed the same elasticity.

## Measurement of Trade Costs

By using Novy's measurement (2011), trade costs have been calculated for India with each of the above mentioned regions: East Asia, West Asia, South Asia, Southeast Asia and Central Asia for the period of 1995 to 2013. The behavior of Indian trade costs with each of these Asian regions is shown in Figure 2. To make the comparison overtime, the trade costs for all countries, except Hong Kong, Georgia and Lao, are normalized to 1995. The trade costs for Georgia, Hong Kong and Lao are normalized to the initial years from which the data is available: these are 1999, 2000, and 2002, respectively.

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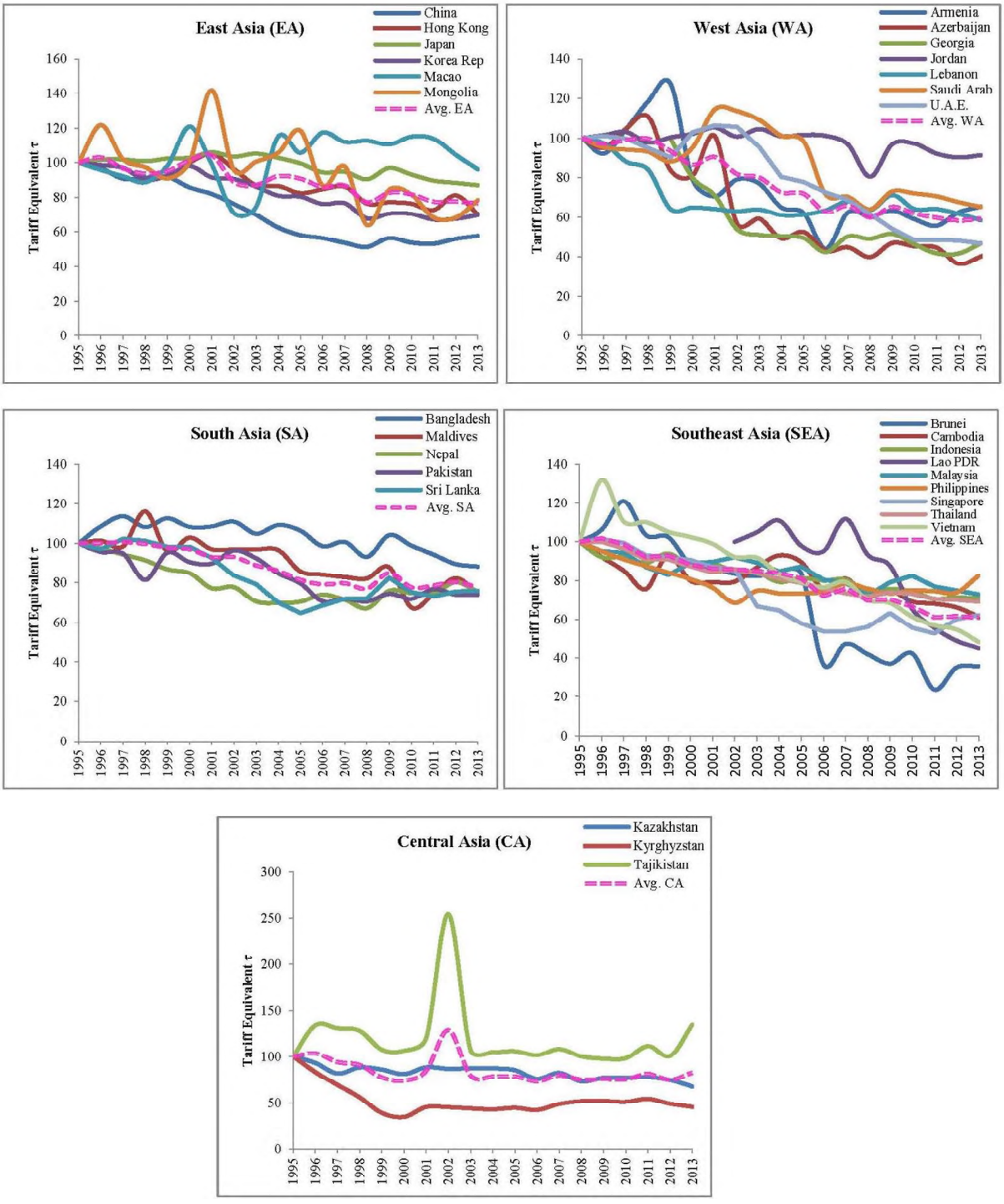


*Note.* Source: Authors' calculations.

*Figure 2.* Indian trade costs within Asia: Region-wise.

### *Trade Costs of India with East Asia*

The upper left panel of Figure 2 shows that Indian trade costs with East Asia have declined by almost 24 percent from the initial year (1995) to the ending year (2013). Decline in trade costs is the highest with China, which can be a reason of a very high level of trade of India with China, among others. After China, the decline in trade costs is further followed by Hong Kong, Republic of Korea, Mongolia, Japan, and Macao. Under the Look East Policy (LEP), India signed various trade agreements with China, Japan, and Republic of Korea, which are the dominant players in the East Asia. These agreements could be a reason of the decline in the Indian trade costs with East Asia.

### *Trade Costs of India with West Asia*

In Western Asia, most of the countries are the oil and gas producing countries, which are the basic needs of any economy. The top right panel of Figure 2 shows that trade costs of India with West Asia declined by 41 percentage points over the years 1995 to 2013. Here, decline in Indian trade costs was the highest (60%) with Azerbaijan and the lowest (9%) with Jordan. With Azerbaijan, Indian trade relations are improving day by day and the growth of bilateral trade of India with Azerbaijan is witnessing this[4]. In the present study, the West Asian region also includes two of the Gulf Cooperation Council (GCC) countries, namely: Saudi Arabia and United Arab Emirates. India's tie ups with the GCC and other oil exporting countries might have acted as a reason of the decline in trade costs of India with West Asia.

### *Trade Costs of India with South Asia*

The South Asian region includes the neighboring countries of India and the majority of them share a common border with India. As depicted in the middle left panel of Figure 2, Indian trade costs with the South Asian countries have declined by almost 22 percent on an average from 1995 to 2013. To promote the regional cooperation in South Asia, the South Asian Association of Regional Cooperation (SAARC) was created in 1985.The study covers six members of SAARC including India, and the remaining two – Afghanistan and Bhutan – have been left out due to data limitations. In 2004, India signed South Asian Free Trade Area (SAFTA) with other member countries and committed to promote the free trade area through the elimination of trade barriers, which might be the possible reason that caused Indian trade costs to decline.

### *Trade Costs of India with Southeast Asia*

Indian trade costs with the Southeast Asian countries have gone down over the whole study period as shown in the middle right panel of Figure 2. On an average, India's trade costs with Southeast Asia declined by 40 percent from 1995-2013. In Southeast Asian region, there exists an economic community called the Association of Southeast Asian Nations (ASEAN) and, except Myanmar, the study included all of them. Under the LEP, India has made many friendly connections with ASEAN members. The first phase of India's LEP was officially defined and articulated in September 1994 by Prime Minister Narasimha Rao in his Singapore lecture. He emphasized the development of a strong economic and security relationship between India and its eastern neighbors[5]. In the initial years, the emphasis was put on the economic tie ups and institutional partnership, particularly with ASEAN. In 2003, India's then foreign minister Yashwant Sinha announced the second phase of LEP by expanding the definition of East, extending from Australia to East Asia, with ASEAN at its core. Thus, Look East Policy was India's strategy

[4] See the change in RankingofAzerbaijan from 1995 to 2013 in Appendix C.
[5] Text of Prime Minister NarasimhaRao's speech, Institute of Southeast Asian Studies, Singapore, 1994.

to rebuild cooperative relations with its eastern neighbors in general and ASEAN in particular (Muni, 2011). Since 2002, India is having annual summits with ASEAN and signed the initials of ASEAN – India Free Trade Area (AIFTA) in 2003. In the 12th ASEAN-India summit – held at Nay Pyi Taw, Myanmar on12th November, 2014 – the prime minister of India, Narendra Modi, upgraded the "look east policy" to the "act east policy". This Look East Policy could be a reason of the decline in the trade costs of India with Southeast Asia and East Asia.

### *Trade Costs of India with Central Asia*

Due to the scarceness of the data, the present study incorporates only three countries from the Central Asia, namely: Kazakhstan, Kyrgyzstan, and Tajikistan. Except Kazakhstan, the rest of the two countries are having minimal amount of trade with India[6]. The bottom panel of Figure 2 depicts the trade cost of India with the Central Asian Countries. It is clear that Indian trade costs with Central Asia fell by 17 percent on average. In 2012, India joined its hands with Central Asia by the framework of "Connect Central Asia" policy, which may help in upcoming future to reduce the trade costs further.

It becomes clear from the above discussion that the trade costs of India have declined with almost all the trading partners from Asia. Region-wise, the decline in Indian trade costs was the highest with West Asia followed by Southeast Asia, East Asia, South Asia, and Central Asia. Among others, one reason of this decline could be the reduction in policy barriers (tariff and non-tariff) due to bilateral or multilateral trade agreements of India with its Asian trading partners and the study basically emphasized on the same.

## Determinants of Bilateral Trade Costs of Asia

Now, the question which comes into mind: Is there any connection between the trade costs inferred from the trade flows itself and the proxies generally used as measures of trade costs? The present section is devoted to answer this question by finding out the extent of the relationship between the observed values of bilateral trade costs and the proxies of trade costs for all the thirty-one (India plus thirty) economies of Asia. This task was carried forward by regressing the calculated trade costs on the list of available proxies, known as determinants of trade costs. The regression model has been used:

$$ln\,\tau_{ijt} = \alpha_{it} + \beta_1 Contig_{ij} + \beta_2\, ln\, Dist_{ij} + \beta_3 Land_{ij} + \beta_4 Comlang_{ij} + \beta_5\, ln\, Tariff_{ijt} + \beta_6 \ln NTB_{ijt} + \beta_7 \ln ER_{ijt} + \beta_8 \ln(PI_{it} * PI_{jt}) + \mathcal{E}_{ijt} \quad (8)$$

where, $\tau_{ijt}$ is the calculated trade costs, $Contig_{ij}$ is a dummy whether two countries are contagious to each other or not, $Dist_{ij}$ denotes distance between reporter and partner country, $Land_{ij}$ is a dummy variable equal to one if both $i$ and $j$ countries are landlocked, $Comlang_{ij}$ is also dummy variable having a value equal to one if both the reporter and partner countries have a common official language, $Tariff_{ijt}$ is the product of tariff rakings[7] of reporter and other trading partners, $NTB_{ijt}$is the product of non-tariff rankings of reporter and partner countries, $ER_{ijt}$ is the average official exchange rate with respect to reporter (in USD), $\left(PI_{it} * PI_{jt}\right)$ is the product of Port Infrastructures of reporter and partner country.

[6] See Appendix C for ranking of these countries as India's trading partners.
[7] Data on tariff and non-tariff barriers are difficult to obtain for many countries across the years (see Anderson and Wincoop, 2004)

The data for contiguity, distance, exchange rate, and port infrastructure are taken from CEPII[8] and World Development Indicators (WDI). Tariff and non-tariff rankings are taken from the Economic Freedom of the World 2014 (Gwartney, Lawson and Hall, 2014) Annual Report published by Fraser Institute. The components 4A and 4B of this report are used for the tariff and non-tariff rankings. The report gives a rating on a scale from 0 to 10, where 10 is given for the low tariff and non-tariff revenues. To make the coefficients in the regression more intuitive, the study follows Novy (2011) and multiplies the logarithmic values of tariff and non-tariff rankings by (-1) such that higher values indicate higher tariff and non-tariff barriers. For the estimation purpose, firstly, the OLS regressions have been run for the years 1995, 2000, 2005, 2010 and 2012 and then Pooled OLS was applied by combining all these years. The estimated results of these six models are given in the Table 2.

Table 2
*Determinants of Bilateral Trade Costs of Asia*

| **Model** | **(1) 1995** | **(2) 2000** | **(3) 2005** | **(4) 2010** | **(5) 2012** | **(6) Pooled** |
|---|---|---|---|---|---|---|
| Contiguity | 0.043 | 0.003 | -0.130** | -0.147** | -0.173** | -0.139** |
| Ln(Distance) | 0.067** | 0.108** | 0.256** | 0.185** | 0.188** | 0.196** |
| Landlocked | | | -0.498** | -0.629** | -0.346** | -0.524** |
| Common Language | 0.090** | -0.099** | -0.010 | -0.048 | -0.050 | -0.044** |
| Ln(Tariffs) | -0.034 | 20.79** | -20.88 | 50.61 | 104.30 | 0.128* |
| Ln(Non-Tariff Barriers) | 7.435** | -8.145 | 29.940** | -6.579 | -32.460 | 8.793* |
| Ln(Exchange Rate) | 0.0483** | -0.020 | -0.013 | -0.008 | -0.003 | -0.009 |
| Ln(Port Infrastructure) | | | | 0.834 | -3.127* | |
| Constant | 24.92 | 62.77 | 17.91 | 201.30 | 352.20 | 28.56 |
| **Observations** | **57** | **154** | **441** | **575** | **603** | **1,830** |
| **R-squared** | **0.95** | **0.90** | **0.86** | **0.82** | **0.81** | **0.83** |

*Note.* The dependent variable is logarithmic value of Trade Costs, robust OLS estimation. Country and time effects are included in the pooled regression but are not reported. ** $p < 0.01$, * $p < 0.05$. *Source:* Authors' calculations.

For discussion purposes, the study will concentrate only on the pooled Model (Model 6). The first variable (contiguity) is inversely and significantly affecting the trade costs of Asia, which has amply and clear intuition that in case of Asia, if the trading partners are sharing a common border, then the trade costs they are facing are low as compared with the courtiers that do not share common border with each other. The next variable is distance and it is significantly aggravating the trade costs of Asian trading partners with each other, meaning that the Asian countries are facing high trade costs from its far located trading partners within Asia. These two variables, contiguity and distance, come under the category of geographical/natural barriers which cannot be reduced through the policy reforms[9].

The third variable is the dummy variable having positive value if both the reporter and partner countries are landlocked countries. This variable is negatively and significantly affecting the bilateral trade costs in Asia. The fourth variable is the language spoken by the trading partners, and if the trading partners speak a common language then they are facing lower trade costs.

[8] CEPII data can be retrieved from: http://www.cepii.fr/cepii/en/bdd_modele/bdd.asp
[9] Anderson and Wincoop (2004); Chen and Novy (2009); Jacks, Meissner, and Novy (2008); Duval and Utoktham, (2011b); Khan and Kalirajan (2011).

The fifth and sixth determinants of trade costs are tariffs and non-tariff barriers. Both of these direct policy variables are affecting trade costs positively and significantly, by meaning that if the tariffs and non-tariff barriers are high then trade costs faced by trading partners will be high and vice versa. The next determinant of trade costs is the exchange rate. Here, the exchange rate is defined in terms of home currency of reporter country, so if the exchange rate rises it leads to the depreciation of home currency. Due to depreciation, home exports will increase and imports will go down, if Marshall Lerner Robinson conditions[10] are satisfied then the increase in exports outweighs the decline in imports. Hence, the total trade goes up, which also means that trade costs are declining because of inverse relationship between trade costs and trade. In the present study, the official exchange rate is inversely and insignificantly affecting the trade costs. Furthermore, the quality of port infrastructure also matters in the smooth movement of a tradable commodity (Abe & Wilson, 2011). But the data on quality of port Infrastructure is available only from the year 2007 and that is why coefficient of the same variable is present only in the two Models (4 and 5). Only in Model 5, its coefficient is significant and it is inversely affecting the trade costs of Asian countries which imply that if the level of port infrastructure is further improved, it will lower down the trade costs of Asia.

## Decomposition of Growth of Indian Trade within Asia

As the Indian trade is growing with its Asian partners, the present section is a step to decompose this growth into the three components given by Novy (2011): the economic growth proxied by growth in income; reduction in the trade barriers (trade costs); and the increase in the resistance from the rest of the trading partners. To start with, take logarithms and first differences of Equation (6).

$$\Delta ln(\, x_{ij}x_{ji}) = 2\Delta ln\left(\frac{y_i y_j}{y^w}\right) + (1-\sigma)\Delta ln(t_{ij}t_{ji}) - (1-\sigma)\Delta ln(\pi_i p_i \pi_j p_j) \quad (9)$$

Bilateral trade cost factors $\Delta ln(t_{ij}t_{ji})$ are unknown in the above Equation, but recalling Equation (7) of trade cost measure $\tau_{ij}$:

$$\tau_{ij} = \left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)^{\frac{1}{2}} - 1 \quad => \tau_{ij} + 1 = \left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)^{\frac{1}{2}}$$

$$(\tau_{ij}+1)^2 = \left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)$$

$$(t_{ij}t_{ji}) = (\tau_{ij}+1)^2(t_{ii}t_{jj})$$

Substitute $t_{ii}t_{jj}$ into Equation (9):

$$\Delta ln(\, x_{ij}x_{ji}) = 2\Delta ln\left(\frac{y_i y_j}{y^w}\right) + (1-\sigma)\Delta ln\left((\tau_{ij}+1)^2(t_{ii}t_{jj})\right) - (1-\sigma)\Delta ln(\pi_i p_i \pi_j p_j)$$

$$\Delta ln(\, x_{ij}x_{ji}) = 2\Delta ln\left(\frac{y_i y_j}{y^w}\right) + 2(1-\sigma)\Delta ln(\tau_{ij}+1) - 2(1-\sigma)\Delta ln(\Phi_i \Phi_j) \quad (10)$$

Where $\Phi_i$ and $\Phi_j$ stand for country *i* and *j*'s multilateral resistances in relation to their own domestic trade costs:

[10] See Kenen (2000), p. 323.

$$\Phi_{\mathrm{i}} = \left(\frac{\pi_i p_i}{t_{ii}}\right)^{\frac{1}{2}} \; and \; \Phi_{\mathrm{j}} = \left(\frac{\pi_j p_j}{t_{jj}}\right)^{\frac{1}{2}} \tag{11}$$

Finally, dividing by the left hand side:

$$100\% = \underbrace{\frac{2\Delta ln\left(\frac{y_i y_j}{y^w}\right)}{\Delta ln(\, x_{ij}x_{ji})}}_{(I)} + 2(1-\sigma)\underbrace{\frac{\Delta ln(\tau_{ij}+1)}{\Delta ln(\, x_{ij}x_{ji})}}_{(II)} - 2(1-\sigma)\underbrace{\frac{\Delta ln(\Phi_{\mathrm{i}}\Phi_{\mathrm{j}})}{\Delta ln(\, x_{ij}x_{ji})}}_{(III)} \tag{12}$$

In Equation (12), the growth of bilateral trade is bifurcated into three contributions: (I) the contribution of growth of income, (II) the contribution of the decline in relative bilateral trade costs, and (III) the contribution of the decline in relative multilateral resistance. Three kinds of possibilities are there: (a) If overtime, there is no change in trade barriers then contributions (II) and (III) will have zero value and growth of income solely drives the growth of bilateral trade overtime; (b) If bilateral trade costs fall$\left(i.e.,\ \Delta ln(\, \tau_{ij}+1) < 0\right)$, then contribution (II) enters positively in the model because $2(1-\sigma)$is already a negative value[11], and (c) If multilateral trade barriers/resistances fall $\left(i.e.,\ \Delta ln(\Phi_{\mathrm{i}}\Phi_{\mathrm{j}}) < 0\right)$, then it negatively contributes in the bilateral growth of trade, known as trade diversion effect.

The data on the contribution (I) $\left(\text{i.e.}\left(2\Delta ln\left(\frac{y_i y_j}{y^w}\right)/\Delta ln(\, x_{ij}x_{ji})\right)\right)$ is directly available. To calculate the contribution (II), recall Equation (7): this implies: $2(1-\sigma)\Delta ln(\tau_{ij}+1) = \Delta ln(x_{ij}x_{ji}) - \Delta ln(\, x_{ii}x_{jj})$. By using the data of $\Delta ln(x_{ij}x_{ji})$ and $\Delta ln(\, x_{ii}x_{jj})$, the contribution (II) can be calculated. For the calculation of contribution (III), use Equation (5): $2(1-\sigma)\Delta ln(\Phi_{\mathrm{i}}\Phi_{\mathrm{j}}) = \Delta ln\left(\frac{y_i/y^w}{x_{ii}/y_i}\right) + \Delta ln\left(\frac{y_j/y^w}{x_{jj}/y_j}\right)$. One thing that becomes apparently clear is that $\sigma$ does not have any role to play in the decomposition of the growth of bilateral trade.

Table 3 shows the results of decomposition of growth of Indian trade with Asia. Region wise, the first component, the contribution of growth in income, has played a positive role only in case of growth of Indian trade with South Asia (22%) and Southeast Asia (37%). The second component, the decline in the trade costs, has explained all the trade growth of India with West Asia (100% = 259 - (102+57)) and Central Asia (100% = 119 − (13+6)), and majority of growth of Indian trade with East Asia (95%) and South Asia (90%) and Southeast Asia (77%). The last component, the decline in the relative multilateral resistance term, has a positive effect on the Indian trade with East Asia (49.6%) only, meaning that on an average the relative multilateral trade barriers of East Asia had increased with their other trading partners except India and this resistance from the other world has made the Indian trade more attracted for this region. However, for the rest of the regions: West Asia (-57%), South Asia (-12%), Southeast Asia (-13%) and Central Asia (-6%), the decline in relative multilateral trade barriers with the other trading partners except India is diverting the trade of these regions from India to other countries and this diversion is the most in case of West Asia followed by South Asia, Southeast Asia, and Central Asia.

[11]As $\sigma > 1$, therefore $[2(1-\sigma)] < 0$.

Table 3
*Decomposition of Growth of Indian Trade within Asia*

| Partner | Average Change in Total Trade (USD M) | Contribution of the growth in income | Contribution of the decline in relative bilateral trade costs | Contribution of the decline in relative multilateral resistance | Total |
|---|---|---|---|---|---|
| | | | East Asia | | |
| China | 3,744.34 | -374.23 | 179.04 | 295.21 | 100 |
| Republic of Korea | 944.18 | 60.90 | 59.37 | -20.26 | 100 |
| Hong Kong | 929.54 | -43.19 | 59.56 | 83.64 | 100 |
| Japan | 676.45 | 111.75 | 13.49 | -25.23 | 100 |
| Mongolia | 1.25 | -26.97 | 126.22 | 0.75 | 100 |
| Macao | 0.28 | 3.70 | 132.59 | -36.29 | 100 |
| Avg. East Asia | 1,049.34 | -44.68 | 95.04 | 49.64 | 100 |
| | | | West Asia | | |
| United Arab Emirates | 3,570.77 | 87.95 | 75.29 | -63.24 | 100 |
| Saudi Arab | 2,516.18 | 57.43 | 65.24 | -22.66 | 100 |
| Kuwait | 989.02 | 55.53 | 74.95 | -30.47 | 100 |
| Jordan | 96.64 | -1091.14 | 1459.58 | -268.44 | 100 |
| Azerbaijan | 60.27 | 155.06 | -15.84 | -39.22 | 100 |
| Lebanon | 18.26 | 24.80 | 79.25 | -4.05 | 100 |
| Georgia | 5.50 | 31.54 | 71.51 | -3.06 | 100 |
| Armenia | 4.00 | 18.56 | 82.09 | -0.65 | 100 |
| Avg. West Asia | 895.95 | -102.26 | 259.59 | -57.33 | 100 |
| | | | South Asia | | |
| Bangladesh | 299.62 | -69.73 | 111.13 | 58.60 | 100 |
| Sri Lanka | 268.48 | -23.29 | 96.42 | 26.87 | 100 |
| Nepal | 185.80 | 35.34 | 77.73 | -13.07 | 100 |
| Pakistan | 135.22 | 72.47 | 119.70 | -92.17 | 100 |
| Maldives | 7.05 | 96.79 | 47.07 | -43.86 | 100 |
| Avg. South Asia | 179.23 | 22.32 | 90.41 | -12.73 | 100 |
| | | | Southeast Asia | | |
| Indonesia | 1,000.51 | 118.38 | -112.53 | 94.15 | 100 |
| Singapore | 798.56 | 18.85 | 391.25 | -310.10 | 100 |
| Malaysia | 726.25 | -349.65 | 243.20 | 206.45 | 100 |
| Vietnam | 481.94 | 68.62 | 66.75 | -35.38 | 100 |

| Partner | Average Change in Total Trade (USD M) | Contribution of the growth in income | Contribution of the decline in relative bilateral trade costs | Contribution of the decline in relative multilateral resistance | Total |
|---|---|---|---|---|---|
| Thailand | 454.44 | -107.28 | 149.12 | 58.16 | 100 |
| Philippines | 53.16 | 746.57 | -393.24 | -253.33 | 100 |
| Brunei | 44.39 | -14.76 | 113.82 | 0.94 | 100 |
| Lao | 15.50 | -16.04 | 121.83 | -5.79 | 100 |
| Cambodia | 9.07 | -132.86 | 110.79 | 122.06 | 100 |
| Avg. Southeast Asia | 398.20 | 36.87 | 76.78 | -13.65 | 100 |
| | | | Central Asia | | |
| Kazakhstan | 42.49 | -18.34 | 106.73 | 11.61 | 100 |
| Tajikistan | 2.41 | 107.62 | 32.00 | -39.62 | 100 |
| Kyrgyzstan | 1.69 | -127.47 | 219.22 | 8.25 | 100 |
| Avg. Central Asia | 15.53 | -12.73 | 119.32 | -6.59 | 100 |

*Note*. Source: Author's calculations.

In a nutshell, Table 3 is putting forward the evidence that the decline in the relative bilateral trade costs is a major factor in explaining the growth of Indian trade with its Asian partners. The decline in Indian trade costs had been the highest with West Asia and in the present section, the decline in trade costs is explaining all the growth of Indian trade with the same region. The second highest decline in trade costs had been with Southeast Asia and this decline has explained 76 percent growth of Indian trade with this region and rest (24%) has been explained by the growth of income. The decline in Indian trade costs was the third highest with East Asia and here also, the same factor is explaining the growth of Indian trade with East Asia. Moving to the South Asia, the decline in the Indian trade costs was second lowest with this region and this decline in trade costs explains the 90 percent growth of Indian trade with the same region. The decline in the Indian trade costs was the lowest with the Central Asian economies and this decline explains all the growth of Indian trade with Central Asia. Hence, trade costs play a major role in explaining the growth of Indian trade with its Asian trading partners over the study period.

## Conclusions

Trade costs are the costs that are incurred to move a good from the production site to the site of final consumer. Due the paucity of data on the direct measures of trade costs, the present study infers trade costs from the available trade data. Basically, the study has three main objectives: to measure the trade costs for India with its trading partners from the Asian region; to find out the determinants of these calculated trade costs by using the data on the available trade cost proxies; and to decompose the growth of Indian trade with Asian partners into the contribution of growth in income, the contribution of the decline in bilateral trade costs and the contribution of the decline in multilateral resistance.

It is found that trade costs of India with its all Asian partners have declined across the whole the study period (1995-2013). The decline in Indian trade costs was the highest with West Asia followed by Southeast Asia, East Asia, South Asia and Central Asia. Then, the study has found that the variables, used as determinants of trade costs – namely: contiguity, distance, tariffs, non-tariff barriers, exchange rate and port infrastructure – behaved in the proper

way as predicted by theory. Furthermore, the decomposition of the growth of Indian trade with the Asian regions reveals that the decline in the relative bilateral trade costs has been the driving force of growth of Indian trade with all the regions of Asia.

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# Appendix A

## Derivation of Trade Costs from Anderson and Wincoop (2003)

Anderson and Wincoop (2003)'s framework

$$x_{ij} = \frac{y_i y_j}{y^w}\left(\frac{t_{ij}}{\pi_i p_j}\right)^{1-\sigma} \tag{1}$$

and

$$\pi_i{}^{1-\sigma} = \sum_j p_j^{1-\sigma}\theta_j t_{ij}^{1-\sigma}\ \forall_i \tag{1.A}$$

$$p_j{}^{1-\sigma} = \sum_i \pi_i^{1-\sigma}\theta_i t_{ij}^{1-\sigma}\ \forall_j \tag{1.B}$$

By using gravity Equation (1) to find the expression for country *i*'s intranational trade:

$$x_{ii} = \frac{y_i y_i}{y^w}\left(\frac{t_{ii}}{\pi_i p_i}\right)^{1-\sigma} \tag{2}$$

Equation (4) can be solved for the product of outward and inward multilateral resistance as:

$$\pi_i p_i = \left(\frac{x_{ii}/y_i}{y_i/y^w}\right)^{\frac{1}{(\sigma-1)}} t_{ii} \tag{3}$$

Multiply Equation (1) with$x_{ji}$, to obtain a bidirectional gravity Equation that contains both countries' outward and inward multilateral resistance variables:

$$x_{ij}x_{ji} = \left(\frac{y_i y_j}{y^w}\right)^2\left(\frac{t_{ij}t_{ji}}{\pi_i p_i \pi_j p_j}\right)^{1-\sigma} \tag{4}$$

Substituting the solution from Equation (5) yields:

$$x_{ij}x_{ji} = \left(\frac{y_i y_j}{y^w}\right)^2\left(\frac{t_{ij}t_{ji}}{\left(\frac{x_{ii}/y_i}{y_i/y^w}\right)^{\frac{1}{(\sigma-1)}} t_{ii}\left(\frac{x_{jj}/y_j}{y_j/y^w}\right)^{\frac{1}{(\sigma-1)}} t_{jj}}\right)^{1-\sigma} \tag{5}$$

$$x_{ij}x_{ji} = \left(\frac{y_i y_j}{y^w}\right)^2\left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\left(\frac{x_{ii}/y_i}{y_i/y^w}\right)^{\frac{1}{(1-\sigma)}}\left(\frac{x_{jj}/y_j}{y_j/y^w}\right)^{\frac{1}{(1-\sigma)}}\right)^{1-\sigma}$$

$$x_{ij}x_{ji} = \left(\frac{y_i y_j}{y^w}\right)^2\left(\frac{x_{ii}/y_i}{y_i/y^w}\right)^{\frac{1-\sigma}{(1-\sigma)}}\left(\frac{x_{jj}/y_j}{y_j/y^w}\right)^{\frac{1-\sigma}{(1-\sigma)}}\left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)^{1-\sigma}$$

$$x_{ij}x_{ji} = \left(\frac{y_i y_j}{y^w}\right)^2 \left(\frac{x_{ii}}{y_i}\frac{y^w}{y_i}\right)\left(\frac{x_{jj}}{y_j}\frac{y^w}{y_j}\right)\left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)^{1-\sigma}$$

$$x_{ij}x_{ji} = \left(\frac{y_i y_j}{y^w}\right)^2 \left(\frac{y^w}{{y_i}^2}\right)\left(\frac{y^w}{{y_j}^2}\right)(x_{ii}x_{jj})\left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)^{1-\sigma}$$

$$x_{ij}x_{ji} = \left(\frac{y_i y_j}{y^w}\right)^2 \left(\frac{y^w}{y_i y_j}\right)^2 (x_{ii}x_{jj})\left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)^{1-\sigma}$$

$$x_{ij}x_{ji} = (x_{ii}x_{jj})\left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)^{1-\sigma}$$

$$x_{ij}x_{ji} = (x_{ii}x_{jj})\left(\frac{t_{ii}t_{jj}}{t_{ij}t_{ji}}\right)^{\sigma-1}$$

$$\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}} = \left(\frac{x_{ii}x_{jj}}{x_{ij}x_{ji}}\right)^{\frac{1}{\sigma-1}} \quad (6)$$

As $(t_{ij} \neq t_{ji})$ and $(t_{ii} \neq t_{jj})$, so it is useful to take the geometric mean of the barriers in both directions. To make it tariff equivalent deduct one from the final measure.

$$\tau_{ij} = \left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)^{\frac{1}{2}} - 1 = \left(\frac{x_{ii}x_{jj}}{x_{ij}x_{ji}}\right)^{\frac{1}{2(\sigma-1)}} - 1 \quad (7)$$

$\tau_{ij}$ measures bilateral trade costs $t_{ij}t_{ji}$ relative to domestic trade costs $t_{ii}t_{jj}$.

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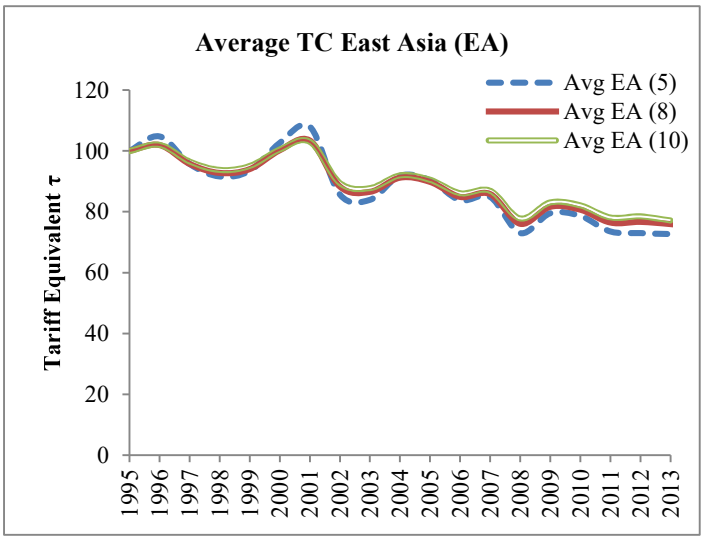
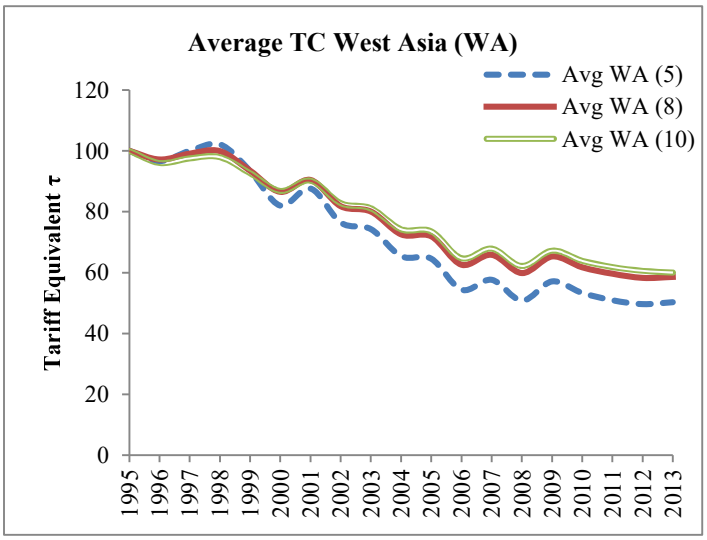
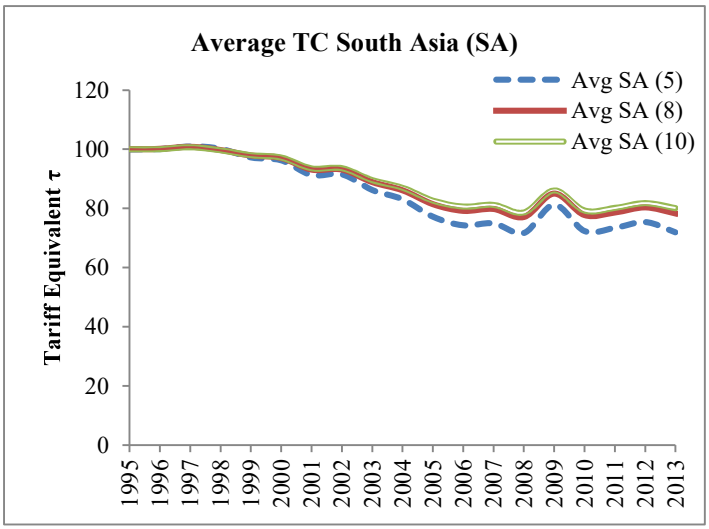
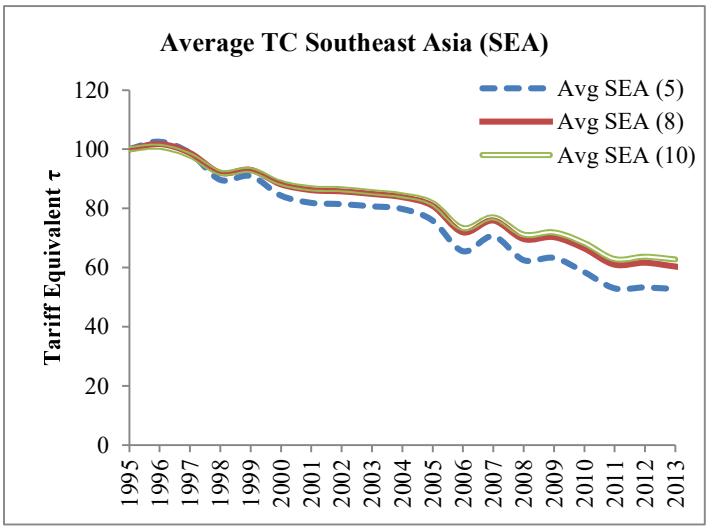
## Appendix B

### Sensitivity Analysis of Trade Costs (TC) for each Region with Sigma 5, 8, and 10



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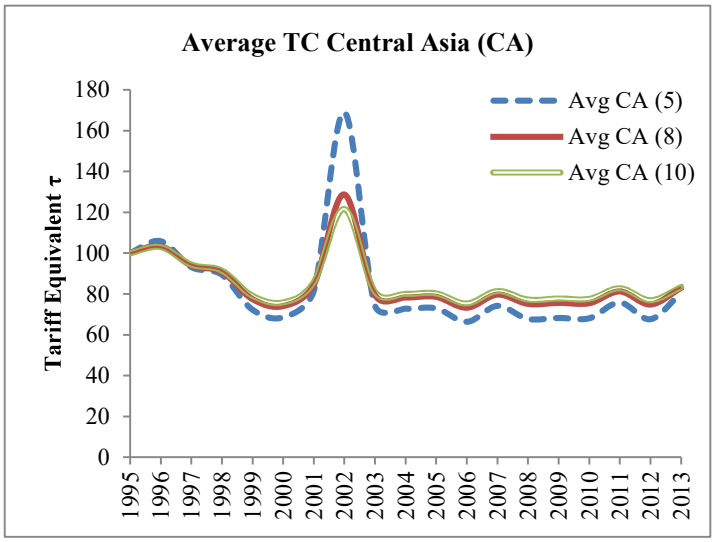


*Note*. Source: Authors' calculations.

## Appendix C

| Region | Reporter | Trade Costs | | Percentage decline in Trade Costs | Partner Rankings | |
|---|---|---|---|---|---|---|
| | | 1995 | 2013 | | 1997 | 2013 |
| **East Asia** | China | 146 | 84 | 42 | 13 | 1 |
| | Hong Kong | 78 | 54 | 31 | 10 | 7 |
| | Japan | 116 | 101 | 13 | 4 | 16 |
| | Republic of Korea | 124 | 86 | 30 | 18 | 14 |
| | Macao | 355 | 334 | 6 | 206 | 188 |
| | Mongolia | 327 | 257 | 22 | 145 | 171 |
| | Avg EA | 214 | 142 | 33 | -- | -- |
| **West Asia** | Armenia | 445 | 291 | 35 | 168 | 145 |
| | Azerbaijan | 423 | 171 | 60 | 128 | 61 |
| | Georgia | 450 | 211 | 53 | 182 | 131 |
| | Jordan | 120 | 110 | 9 | 42 | 50 |
| | Lebanon | 322 | 185 | 43 | 94 | 95 |
| | Saudi Arab | 100 | 62 | 38 | 9 | 4 |
| | United Arab Emirates | 77 | 36 | 53 | 7 | 3 |
| | Avg WA | 248 | 152 | 39 | -- | -- |
| **South Asia** | Bangladesh | 117 | 103 | 12 | 26 | 30 |
| | Maldives | 218 | 170 | 22 | 114 | 135 |
| | Nepal | 127 | 96 | 24 | 38 | 44 |
| | Pakistan | 182 | 134 | 26 | 49 | 47 |
| | Sri Lanka | 129 | 98 | 24 | 31 | 38 |
| | Avg SA | 155 | 120 | 22 | -- | -- |
| | Brunei | 358 | 128 | 64 | 133 | 77 |
| | Cambodia | 329 | 203 | 38 | 124 | 123 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Southeast Asia** | Indonesia | 128 | 91 | 29 | 21 | 8 |
| | Lao | 366 | 149 | 59 | 157 | 139 |
| | Malaysia | 104 | 76 | 27 | 15 | 21 |
| | Philippines | 201 | 166 | 18 | 39 | 55 |
| | Singapore | 92 | 57 | 38 | 14 | 10 |
| | Thailand | 138 | 95 | 31 | 30 | 27 |
| | Vietnam | 176 | 85 | 52 | 59 | 29 |
| | Avg SEA | 191 | 117 | 39 | -- | -- |
| **Central Asia** | Kazakhstan | 223 | 151 | 32 | 77 | 73 |
| | Kyrghyzstan | 549 | 255 | 54 | 109 | 163 |
| | Tajikistan | 222 | 299 | -35 | 212 | 153 |
| | Avg CA | 331 | 225 | 32 | -- | -- |

*Note.* Source: Authors' calculations.

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# Drivers of Growth in the Travel and Tourism Industry in Thailand and Singapore: A Geweke Causality Analysis

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## Abstract

Tourism is one of the fastest growing economic sectors in Southeast Asian countries, especially in countries such as Thailand and Singapore. The tourism and travel industry has been promoted as an integral part of the national development strategies for decades in these two countries. In this light, the paper identifies the causal determinants of the growth of the tourism and travel industry in Thailand and Singapore, using quarterly data from 2000-2012, under a Geweke causality framework. The empirical results suggest that for Thailand specifically, religious unrest, capturing an element of domestic instability and turbulence seems to affect international tourist arrivals significantly. In the case of Singapore, international tourist arrivals are driven by infrastructural variables covering airport facilities as well as policy variables, such as government expenditures on the tourism industry.

*Keywords*: Geweke Causality, economic growth, travel and tourism, Thailand, competitiveness

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## Introduction

The significance of the travel and tourism industry as a driver of economic growth and development has long been established in the economic literature. Several countries globally have seen their domestic travel and tourism industries flourish which has contributed significantly to their socio-economic development, mainly through generating employment opportunities and denting poverty rates. Boosting the local economy through the development of domestic travel and tourism industry generates both direct and indirect employment as well as

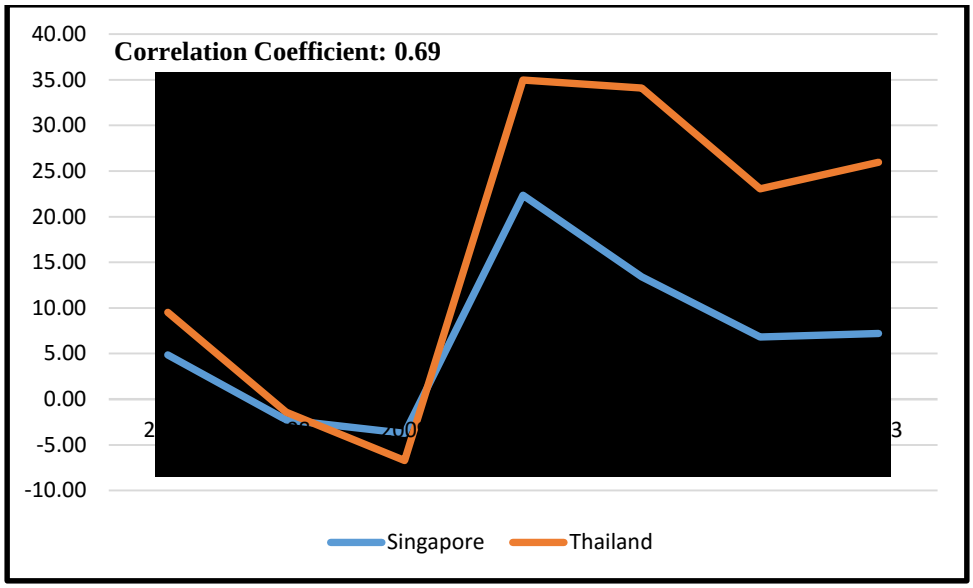
facilitates backward and forward linkages with other allied industries. This not only helps in terms of achieving greater economic growth, but also enhances a country to scale up its competitiveness in the global markets. Thus, investment in the development and promotion of tourism and travel industry remains a policy priority globally (Gopalan, 2013).

The travel and tourism industry globally in 2014 represented about 10 percent of the global output and a staggering 280 million jobs (1 in 11 jobs) for the global economy in 2014 (UNWTO, 2015). In addition, the total number of international tourist arrivals globally was over 1 billion and tourists from emerging economies represented almost half of these international arrivals. International tourism receipts crossed US$ 1 trillion worldwide in 2014, registering an increase of over 3.5 percent in real terms from 2013.

Among the various regions in the world, Europe and the Asia-Pacific regions have consistently stood out as the world's most preferred destinations, with both regions constituting 60 percent (on average) of global tourist arrivals during the last decade or so. Within the Asia and Pacific region, the Southeast Asian region spearheaded the growth in international tourist arrivals with an annual average growth of about 10 percent or so over the last decade, although it slowed down after 2013, mainly driven by the political crisis in Thailand. In terms of tourism receipts from international visitor expenditures on accommodation, food and drink, shopping and entertainment, Europe accounted for over 40 percent of worldwide international tourism receipts and also witnessed the largest increase from 2013. Consistent with the trends on international tourist arrivals, the Asia and the Pacific region cornered a 30 percent share in global tourism receipts which crossed US$ 1 trillion in 2014. Southeast Asian countries represented a third of this share within the Asia-Pacific region in 2014, in terms of international tourism receipts.

While the tourism and travel industry on the whole matters for several countries within the Southeast Asian region, two countries – Thailand and Singapore – stand out in terms of their share of international tourism receipts in the region. Both countries represent over half of the international tourism receipts generated by the Southeast Asian region on average for the last decade or so. Specifically, in the last five years after the global financial crisis, the Southeast Asian region broadly has seen a resurgence in international tourism receipts, growing from about US$ 68 billion to nearly US$ 110 billion in 2014, which translates into a jump from about 25 to 30 percent of international tourism receipts in less than five years. This growth was spearheaded by Singapore and Thailand, with the sum of international tourism receipts rising from US$ 34 billion to about US$ 58 billion during 2010 and 2014, which represented an average share of over 50 percent of receipts generated by Southeast Asia (UNWTO, 2015).

Although Thailand's tourism industry has been recognized for its resilience even during difficult times like the global financial crisis, the 2014 political turmoil in Thailand appeared to have caused a severe setback to its domestic tourism industry (Credit Suisse, 2014). This is likely to pose some macroeconomic challenges to Thailand's economy, considering that the economy is heavily reliant on the tourism industry for both as a source of exports and economic growth. Further, it is also interesting and important to note that relative tourism growth in Singapore tends to exhibit a highly positive correlation with that of Thailand. This implies that the growth of tourism industry, proxied by international tourist arrivals in Thailand, tends to co-move with that of Singapore, underlining the need to examine the drivers of tourism in both countries together (Figure 1; Credit Suisse, 2014). Further, we believe that this strong correlation, exhibited by both the countries for a sustained period of time, is another reason to believe that the causal factors determining the growth of tourism industry in both Thailand and Singapore could perhaps be similar. Finally, it is also worth emphasizing that given the significant share of tourism revenues that these two countries together represent in the Southeast Asian region, understanding the causal determinants of tourism growth in these economies will prove vital for policy makers to ensure that the industry continues to remain robust, moving forward.




*Note.* Source: World Bank.

*Figure 1*. Growth of visitor arrivals in Singapore and Thailand.

In this light, the paper is interested in empirically understanding the causal factors that drive the growth of the tourism industry. Specifically, the paper attempts to provide an empirical explanation for the sources of international tourist arrivals in Thailand and Singapore. To do this, the paper employs a novel empirical approach: the Geweke causality analysis, which helps us understand and measure the linear dependence and feedback between multiple time series variables. To that effect, we performed both a bi-variate as well as multi-variate causality analysis. The unidirectional causality analysis that is popularly employed in the literature does not investigate the degree of dependence or the extent of various kinds of feedback between different time series variables (Calderón & Liu, 2003). However, the method suggested by Geweke (1982) overcomes this problem and helps measure the linear dependence and feedback between multiple time series variables. In essence, the linear dependence is defined as "the sum of the measure of linear feedback from the first series to the second, linear feedback from the second to the first, and instantaneous linear feedback" (Geweke, 1982). The direction of causality and the interplay of the variables can be examined in a more detailed manner with a reduced form quantitative framework under the Geweke causality analysis.[1]

The next section provides a brief background of the importance and significance of the travel and tourism industry in Thailand and Singapore along with an overview of the related literature which form the basis for developing empirically testable hypotheses. Then, the empirical methodology and data employed in the paper is presented, followed by the discussion of the empirical findings. Finally, the paper concludes with a discussion of the policy implications for Malaysia.

[1] For a more detailed treatment and discussion of causality analysis, see Geweke (1982) and Granger (1988).

*K. G. Tan et al. (2016)*
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## Background, Literature, and Hypothesis

### *Background*

Tourism is one of the world's largest industries and one of its fastest growing economic sectors in Southeast Asian countries, especially Thailand and Singapore. In many countries, tourism and travel has been promoted as an integral part of the national development strategies for decades (Mazumder, Sultana, & Al-Mamun, 2013).
Given the high degree of regional integration among the Southeast Asian countries in terms of trade and investment, the region on the whole could also benefit from the various inter-linkages and spillover effects from the national strategies that are taken by various countries to boost their domestic tourism and travel industry. With the recent establishment of the Association of Southeast Asian Nations (ASEAN) Economic Community (AEC) in December 2015, it is imperative that countries in the region continue to focus and develop plans to bolster their travel and tourism industry that will distribute the benefits of economic growth to the region.

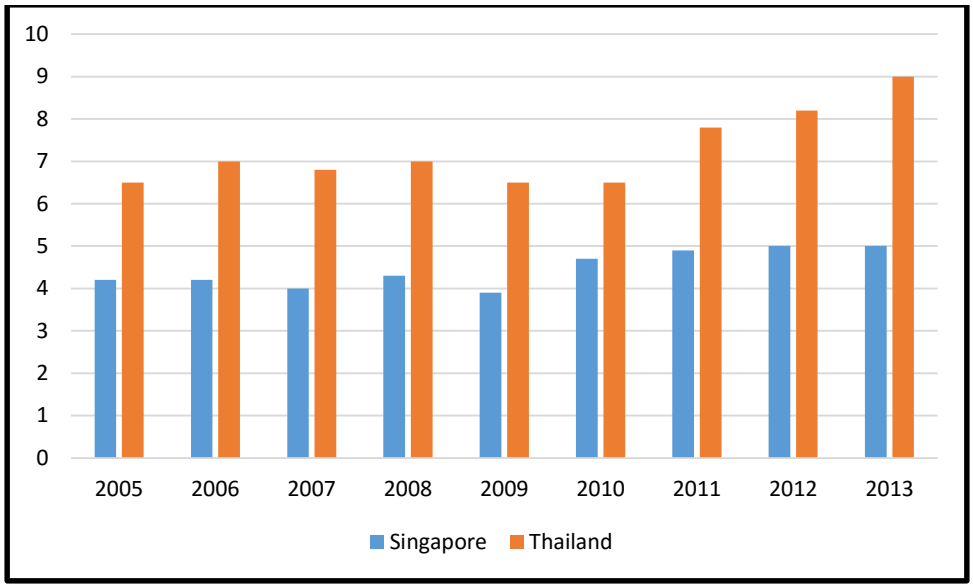
The importance of tourism to both these economies is widely recognized. As per the statistics produced by the World Travel and Tourism Council (WTTC) in 2013, Thailand was ranked No. 17 out of the 184 countries in the world in terms of the absolute size and no. 35 in terms of relative size measured by contribution of the tourism and travel industry to the country's output in 2013 (WTTC, 2015). On a similar note, Singapore was ranked No. 35 out of the 184 countries in the world in terms of the absolute size and no. 83 in terms of relative size measured by the industry's contribution to the country's output during the same period.

Both the countries have registered impressive growth rates in terms of the direct contribution of their respective travel and tourism industry to the output of these countries. As Figure 2 shows, Singapore's direct contribution of its travel and tourism industry to the country's output has been consistently hovering around 5 percent on average between 2005 and 2013. For Thailand, it is even more significant, with the average contribution around 7.5 percent or so during the same period, with the share peaking at 9 percent or so in 2013, on par with the world average. In 2013, the total contribution (direct and indirect put together) of the tourism and travel industry to the output of Thailand and Singapore were much higher at 20 percent and 10 percent respectively.

In terms of employment, Thailand and Singapore saw the travel and tourism industry generate direct and indirect employment. In 2013, the contribution of the industry to direct employment was around 7 percent and the total contribution to include indirect and ancillary jobs springing from the industry was about 16 percent of total employment, underlining the importance of the industry as a crucial engine and source of growth for the country (WTTC, 2014).

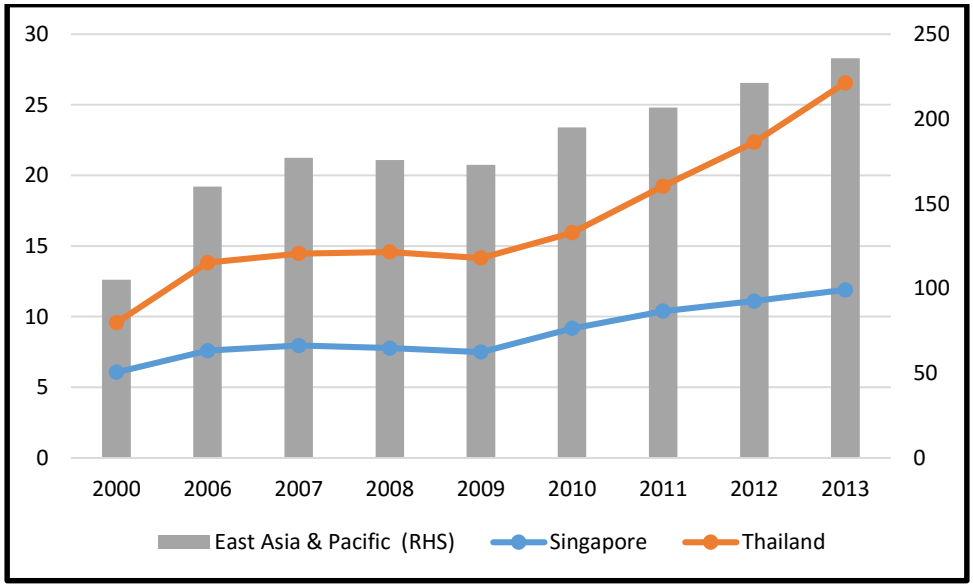
The importance of the tourism industry to both Singapore and Thailand has been a direct consequence of flurry of international tourist arrivals that both countries have seen over the last decade or so, as shown in Figure 3. This has consequently led to a significant rise in tourism receipts both as a share of total exports (Figure 4) and in in absolute terms (Figure 5). Thus, inbound tourism as a service traded across borders has emerged as one of the world's important trading categories, with tourism receipts accounting for as much as 16 percent of the total exports for Thailand and averaged about 12 percent or so between 2006 and 2013. The corresponding figures for Singapore were about 4 percent in 2013 and on average tourism receipts as a share of exports were about 3 percent (Figure 5).[2]

[2] Visitor exports refer to expenditures by foreign visitors which remains an important and growing share of direct contribution of the travel and tourism industry. The ability of the tourism industry to address current account imbalances of a country is also widely recognized in the literature, and there are a number of studies that examine




*Note.* Source: WTTC Reports, various years.

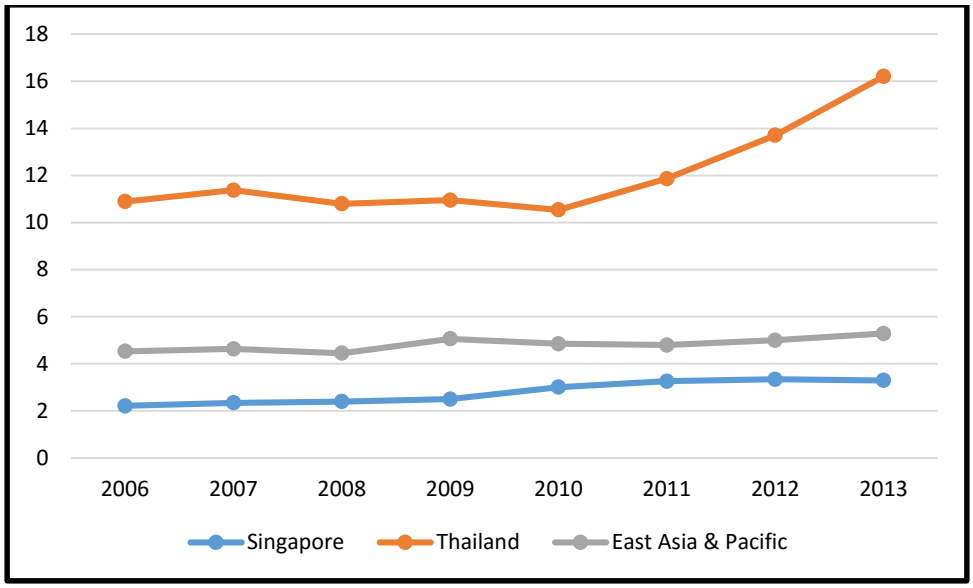
*Figure 2.* Direct contribution of tourism and travel to output (% of GDP).




*Note.* Source: World Bank.

*Figure 3.* Number of international tourist arrivals (millions).

the importance of tourism through its implications for the balance of payments, especially in developing countries (Malik, Chaudhry, & Sheikh, 2010; Thano, 2015).




*Note.* Source: World Bank.

*Figure 4*. International tourism receipts (% of total exports).

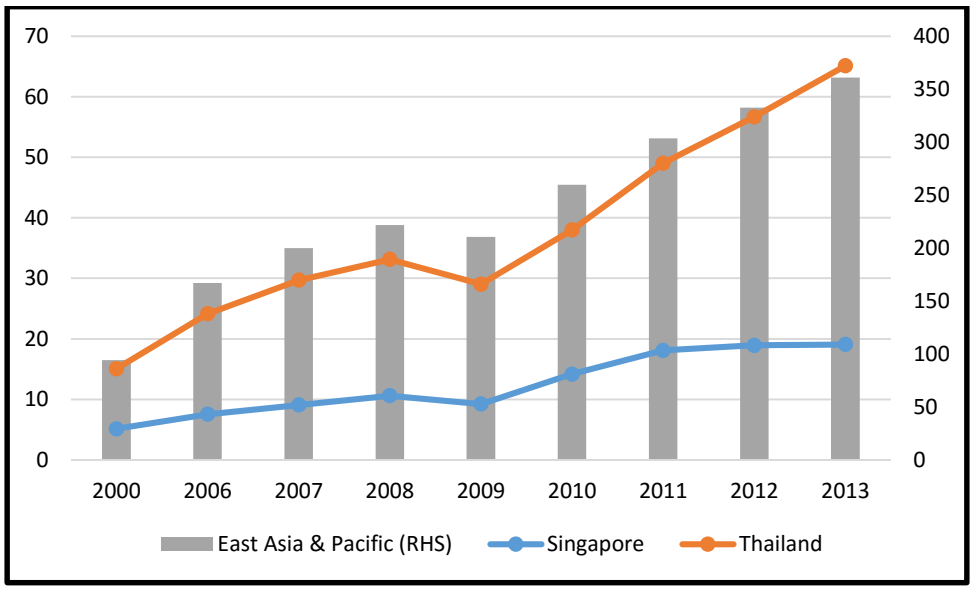



*Figure 5*. International tourism receipts (current US$ billion).

The development of the domestic tourism and travel industry has always been a prominent feature of the policy agenda of both the countries. The most recent and significant policy initiatives taken by Thailand for instance were the tenth economic and social development plan, covering the period 2007-2011, which included a masterplan to jump start the economy through the active promotion of domestic and international tourism, more specifically to enhance the attractiveness of the country as a preferred destination for international tourists. Yet another policy initiative comes from the national tourism development plan covering the subsequent period of 2012-2016, which

has an explicit focus of turning Thailand into one of the top five destinations in Asia (Board of Investments Thailand, 2011). In addition, several tourism promotional campaigns have been launched with the most recent one being the plan by the Tourism Authority of Thailand (TAT) to promote the country as a "Quality Leisure Destination through Thainess" which apparently marks a new era for Thai tourism. As noted by the acting Governor of TAT:

> This plan marks the opening of a new chapter for Thai tourism. It is based on the fact that there is more than adequate accessibility to Thailand via excellent air, road and sea connections, as well as smooth facilitation that allows visa-free or visa-on-arrival access for citizens from 68 countries and territories…. we can confidently say that the era of promoting "quantity" is over. The era of promoting "quality" has begun. (TAT, 2015)

Similar initiatives have been taken by Singapore all the way from the 1970s in order to make it a top touristy destination in the region. Considering especially the fact that Singapore is a small city state with relatively few natural resources compared to other countries in the region, the Singapore government duly recognized the potential that the travel and tourism industry can offer to the Singapore economy. The Singapore Tourism Board (STB) has been playing an instrumental role in promoting tourism through a combination of developing "garden attractions and modern hotels" and marketing the city state as "Instant Asia" (Meng, Siriwardana, & Pham, 2013).

Since the 1990s, the STB had elevated its tourism strategies to the next level by coming up with a master-plan which had a plan to accord primacy to tourism in the 21st century. The objectives included multiplying the tourism receipts, doubling visitor arrivals as well as creating significant employment opportunities through the industry. Marking Singapore's 50th anniversary after independence, the Singapore government announced a host of policy initiatives to be undertaken by the STB, with the most prominent one being to ramp up global marketing efforts to boost Singapore's image as a slowing tourism industry. At the annual Tourism Industry Conference in 2015, the Singapore Minister for Trade and Industry Mr. S. Iswaran was quoted saying:

> Outbound travel to the Asia-Pacific is expected to continue to grow, so too intra-Asia travel, as Asian economies and disposable incomes rise. We must be ready to seize our share of this growth and, I would like highlight three ways we can do so: Deepening innovation, boosting promotion and marketing and enhancing capabilities. (Channel News Asia, 2015).

It is clear from the foregoing discussion that both Thailand and Singapore, having well recognized the significance of the contribution of the tourism and travel industry to their respective economies, are putting in place a host of policy initiatives to boost the industry.

## *Literature and Hypotheses*

Most of the related literature explaining the economic significance of the T&T industry examines its potential impact on poverty alleviation, especially in emerging and developing countries. For instance, a comprehensive survey study by the Overseas Development Institute (ODI, 2007) offers a useful conceptual framework to illustrate this link between tourism and poverty alleviation. As noted by ODI (2007), there are three major "pathways"—"direct", "indirect", and "dynamic"—through which tourism can impact poverty reduction.

The direct effects pertain to the incomes that are generated from tourism jobs. The indirect channel relates to the "tourism value chain" where the earnings are generated from allied sectors such as food or transportation industries. Studies suggest that inter-sectoral impacts are substantial and make up about 60 to 70 percent of earnings in the

industry in developing economies, in addition to the direct effects of tourism (Ashley, Brine, Lehr, & Wilde, 2007). Finally, the dynamic channel spans a wide spectrum as the development of the tourism industry in an economy can enhance the livelihoods of local households, improve the business environment for small enterprises and also ease the infrastructural bottlenecks in an economy, all of which can contribute to poverty reduction through growth (Gopalan, 2013).

There is also a related and extensive literature dating back to the 1990s which has investigated the determinants of tourism demand (see Tan, Gopalan, & Ye (2016) and the references cited within for a more comprehensive discussion of the related literature). The literature points out that the specific variables that have been identified as plausible determinants of tourism demand in any country are real per capita income of the host countries, the (effective) exchange rate, and relative prices prevailing in the host country as well as the quality of tourism infrastructure. It is interesting how there is a clear convergence of the choice of explanatory variables and the results in various country studies trying to investigate the drivers of tourism demand are quite similar.

In a more recent paper, Culiuc (2014) estimated the impact of both supply and demand side determinants of tourism to find that tourism flows respond strongly to changes in the destination country's real exchange rate. The paper also finds that tourism in smaller island countries is less sensitive to changes in the country's real exchange rate, although more sensitive to the quality of infrastructure and connectivity, specifically the introduction and removal of direct flights.

Beyond economics, tourism policy that is designed to market the distinctiveness of local traditions and culture can pave the way for better cultural exchanges between countries which can foster bilateral relations between countries. The literature also points out that, since tourism by its very nature involves and requires inter-country cooperation on many fronts, tourism policy assumes significance in order to shaping a country's engagement with the rest of the world (Prideaux, 2005).

The foregoing discussion leaves us with a broad idea about the variables highlighted in the literature as determinants of tourism demand. However, we go beyond just the related literature and also complement it with the thrust of the various national policy initiatives the governments of Singapore and Thailand have taken in order to identify the growth drivers of the travel and tourism industry. To that end, we empirically try to understand the casual factors that affect the growth of travel and tourism industry in Thailand and Singapore, moving forward. We do this by employing a novel empirical methodology—the Geweke causality analysis—to specifically analyze what factors, ranging from economic to infrastructure to environmental indicators, have a significant causal impact on the growth of the industry.

This paper sets international tourism arrivals as the dependent variable which has been identified by the relevant literature as one of the most appropriate for analyzing the industry. The following hypotheses will be tested: government policy, increased purchasing power for international tourists, improvements in the environment and infrastructure, and safety and security measures are the causal factors driving the growth of international tourist arrivals into Singapore and Thailand.

The independent and control variables that we propose to include in the model can be divided into several categories. First, government policy, which includes government expenditure as well as capital investments on the travel and tourism industry. Second, purchasing power indicators specifically refer to the prevailing cost dynamics in the countries by focusing on the consumer price index (CPI). Third, environmental and infrastructure indicators, which include airport facilities, air quality, and internet users. Fourth, safety and security measures, which include

public security and safety, and religious unrest indicators. In the next section we discuss the methodology employed and the data sources for the variables used in the paper.

## Methodology and Data

This section discusses the methodology employed in the paper. We utilized a stepwise regression in the selection of the "best" set of explanatory variables before we identify the variables that need to be tested for causal relationships.

As the first step, the stepwise regression (forward selection) helps us choose the "best" set of explanatory variables by introducing one explanatory variable one at a time. The decision to keep or drop a variable will be based on their contribution to the variance due to regression, based on the F test (Gujarati, 2004).

Further to this, we also employ a factor analysis in the construction of a policy environment comprising several plausible independent variables that could possess significant causal power in explaining the growth of tourist arrivals. Factor analysis consists of an "array of structure-analyzing procedures used to identify the interrelationships among a large set of observed variables and then, through data reduction, to group a smaller set of these variables into dimensions or *factors* that have common characteristics" (Pett, Lackey, & Sullivan, 2003, p. 4). In this paper we adopt a principle component analysis method for factor analysis.

Once the variables are identified, we employ the Geweke causality method to assess the causal factors determining the growth of the tourism industry in Thailand and Singapore. Geweke causality analysis is used as a tool to identify causal relationships in the field of economics and neuroscience. Some recent and prominent applications of Geweke causality to macroeconomic issues include Tan and Cheng (1995), Calderón and Liu (2003) and Aizenman and Noy (2006). While Tan and Cheng (1995) employed Geweke's approach to examine the causal nexus of money, output and prices in Malaysia, Calderón and Liu (2003) explored the direction of causality between financial development and ecnomic growth. Aizenman and Noy (2006) investigated the two-way linkages between foreign direct investment (FDI) and trade.

The causality and linear feedback between two linear systems were defined in Granger (1963; 1969) and Sims (1972) provides complementary tests for the existence of unidirectional causality. Although the determinants of single economic variable are likely to be multidimensional, most applications found in the literature are focused on the bivariate cases. Geweke (1982) developed the concept further by including the instantaneous (two-way) linear feedback between multiple time series, i.e., $F_{X,Y} = F_{X\to Y} + F_{Y\to X} + F_{X\cdot Y}$, which indicates that the measure of linear dependence, $F_{X,Y}$ is the sum of the measure of linear feedback from the first series to the second, $F_{X\to Y}$, linear feedback from the second to the first, $F_{Y\to X}$ and instantaneous linear feedback, $F_{X\cdot Y}$. The measures are non-negative, and zero only when feedback (causality) of the relevant type is absent.

The multivariate causality test proposed by Geweke (1982) is a test between two vectors of the variables. The equivalence of linear dependence measures as proved in one of the theorems in Geweke (1982) provides us with an elegant way to conduct the multivariate test, which is as convenient as bivariate tests. Like Granger (1969), Sims (1972) and Geweke (1982), we focus on wide-sense stationary and purely nondeterministic time series $X = \{x_t, t\ real\}$. By wide-sense stationary, we infer that the mean of $x_t$ exists and is independent of $t$, and for all $t$ and $s$ $cov(x_t, x_{t+s})$ exists and depends on $s$ but not on $t$. By purely nondeterministic, it presumes that the correlation of $x_{t+p}$ and $x_t$ vanishes as $p$ increases.

*K. G. Tan et al. (2016)*
*Public Enterprise*
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The idea of causality between multiple time series $X$ and $Y$ can be summarized as follows:

$$F_{X,Y} = F_{X\to Y} + F_{Y\to X} + F_{X\cdot Y} \tag{1.1}$$

A non-deterministic and stationary multiple time series can be considered as follows:

$$\boldsymbol{Z}_t = \sum_{s=1}^{\infty} \boldsymbol{B_S Z_{t-s}} + \boldsymbol{\varepsilon_t} \tag{1.2}$$

where $\mathcal{E}_t$ is white noise and $\mathbf{z}_t$ can be partitioned into $k \times 1$ and $l \times 1$ subvectors $X_t$ and $Y_t$.

Geweke (1982) showed a canonical form for the wide sense stationary time series $Z_t = (X_t, Y_t)$ is of the form:

$$x_t = \sum_{s=1}^{\infty} E_{1s} x_{t-s} + u_{1t} \qquad var(u_{1t}) = \Sigma_1 \tag{1.3}$$

$$x_t = \sum_{s=1}^{\infty} E_{2s} x_{t-s} + \sum_{s=1}^{\infty} F_{2s} y_{t-s} + u_{2t} \qquad var(u_{2t}) = \Sigma_2 \tag{1.4}$$

$$x_t = \sum_{s=1}^{\infty} E_{3s} x_{t-s} + \sum_{s=0}^{\infty} F_{3s} y_{t-s} + u_{3t} \qquad var(u_{3t}) = \Sigma_3 \tag{1.5}$$

$$x_t = \sum_{s=1}^{\infty} E_{4s} x_{t-s} + \sum_{s=-\infty}^{\infty} F_{4s} y_{t-s} + u_{4t} \qquad var(u_{4t}) = \Sigma_4 \tag{1.6}$$

$$y_t = \sum_{s=1}^{\infty} G_{1s} y_{t-s} + v_{1t} \qquad var(v_{1t}) = \mathrm{T}_1 \tag{1.7}$$

$$y_t = \sum_{s=1}^{\infty} G_{2s} y_{t-s} + \sum_{s=1}^{\infty} H_{2s} x_{t-s} + v_{2t} \qquad var(v_{2t}) = \mathrm{T}_2 \tag{1.8}$$

$$y_t = \sum_{s=1}^{\infty} G_{3s} y_{t-s} + \sum_{s=0}^{\infty} H_{3s} x_{t-s} + v_{3t} \qquad var(v_{3t}) = \mathrm{T}_3 \tag{1.9}$$

$$y_t = \sum_{s=1}^{\infty} G_{4s} y_{t-s} + \sum_{s=-\infty}^{\infty} H_{4s} x_{t-s} + v_{4t} \qquad var(v_{4t}) = \mathrm{T}_4 \tag{1.10}$$

Geweke (1982) defined the measure of linear feedback from $y$ to $x$ as:

$$F_{Y\to X} = \ln(|\boldsymbol{\Sigma}_1| / |\boldsymbol{\Sigma}_2|) \tag{1.11}$$

The measure $F_{Y\to X}$ is always non-negative and takes the value of zero only if the linear feedback running from $y$ to $x$ is absent. Symmetrically, the measure of linear feedback from $x$ to $y$ is:

$$F_{X\to Y} = \ln(|\mathbf{T}_1| / |\mathbf{T}_2|) \tag{1.12}$$

and the measure of instantaneous feedback is:

$$F_{X\cdot Y} = \ln(|\mathbf{T}_1| * |\boldsymbol{\Sigma}_2|) / |\Upsilon|) \tag{1.13}$$

where:

$$\Upsilon = \text{var}\begin{pmatrix} u_{2t} \\ v_{2t} \end{pmatrix} = \begin{bmatrix} \Sigma_2 & C \\ C' & \mathrm{T}_2 \end{bmatrix}.$$

We can decompose the measure of linear dependence between any two groups of time series $X$ and $Y$, $F_{X,Y}$, as the sum of the measure of linear feedback from the $X$ to $Y$, $F_{X\to Y}$, linear feedback from the $Y$ to $X$, $F_{X\to Y}$, and instantaneous linear feedback between the two series, $F_{X\cdot Y}$, as shown in equation (1.1). Geweke (1982) also proved that the following set of equations are equivalent:

$$F_{X,Y} = \ln(|\mathbf{\Sigma}_1|/|\mathbf{\Sigma}_4|) = \ln(|\mathbf{T}_1|/|\mathbf{T}_2|) \tag{1.14}$$

$$F_{X\to Y} = \ln(|\mathbf{\Sigma}_3|/|\mathbf{\Sigma}_4|) = \ln(|\mathbf{T}_1|/|\mathbf{T}_2|) \tag{1.15}$$

$$F_{Y\to X} = \ln(|\mathbf{\Sigma}_1|/|\mathbf{\Sigma}_2|) = \ln(|\mathbf{T}_3|/|\mathbf{T}_4|) F_{X\cdot Y} = \ln(|\mathbf{\Sigma}_2|/|\mathbf{\Sigma}_3|) = \ln(|\mathbf{T}_2|/|\mathbf{T}_3|) \tag{1.16}$$

### *Data Selection and Sources*

The dependent variable we use is the number of international tourist arrivals that have been recognized as the best proxy capturing the growth of tourism industry in a country. The data comes from The World Bank database and captures the total amount of international inbound visitors into Singapore and Thailand between 2000 and 2012.

As far as the independent variables are concerned, we relied on the stepwise regression and a factor analysis approach to identify the appropriate variables for causality testing for both countries. From a master set of independent variables comprising several macroeconomic and institutional variables, we find that only two variables emerge to be significant for Thailand, while we have three in the case of Singapore. However, we conduct a factor analysis as well to construct four different environments capturing the various dimensions of the economy that could affect the growth of tourism in these two countries and assess their relevance in causally explaining the tourism industry's growth. In what follows, we will explain the master set of independent variables that we have considered for our study, although the final choices of the variables used for Geweke causality analysis will be a function of the results from the stepwise regressions.

For both Thailand and Singapore, we used the prevailing inflation levels in the economies, proxied by the consumer price index, as one of the key determinants of growth of tourism industry. The consumer price index data was collected from The World Bank's data set and the indicator describes the changes in the cost to the average consumer of purchasing a specific basket of goods and services on a yearly basis.

As far as the other independent variables are concerned, we examine broadly a set of explanatory factors capturing the government and institutional environment. We consider several relevant measures such as government expenditures on tourism as a share of GDP and the capital investments on tourism as a percentage of GDP, which were collected from the World Travel and Tourism Council (WTTC). The government expenditures on tourism captures the spending of the government on travel and tourism industry related services linked to the tourists, expressed as a percentage share of total GDP. Capital investments on tourism include spending by all sectors involved in the tourism industry (WTTC, 2014).

In addition to these variables, we also tested the relevance of several other variables capturing environment and infrastructure such as airport facilities, air quality and internet users. The explanatory variable on airport facilities was obtained from the World Economic Forum's Global Competitiveness Index's survey data which asked the respondents to rate the quality of the country's air transportation infrastructure with 1: extremely underdeveloped, and 7: extensive and efficient by international standards and was utilized to examine the quality of travel infrastructure. The data on air quality was obtained from the Global Market Information Database and examines the amount of fine particulates, micrograms per cubic meter, that are in the air which are capable of causing health damage. The other relevant infrastructure environment captures the amount of Internet users, measuring individuals with access to the Internet per 100 people, and it was collected from the World Bank's data set.

Finally, we also emphasize the importance of a volatile and unstable security environment in understanding the growth in tourist arrivals. As we discussed earlier, this issue has been a major concern for Thailand and given that the fortunes of Thailand and Singapore are tied together when it comes to political and security related instability affecting their respective tourism industry, we use the public security and safety and religious unrest as broad proxies compiled from the WEF's Global Competitiveness Index survey data to represent the security related explanatory variables. The public safety and security indicator is a composite of two survey questions combined to assess the state of security and safety in the country; the first question asked to what extent does organized crime imposes costs on businesses in the country with 1: to a great extent and 7: not at all, and the second question asked to what extent can police services be relied upon to enforce law and order with 1: cannot be relied upon and 7: can be completely relied upon (World Economic Forum, 2014). The indicator religious unrest asked the respondents to what extent does the threat of terrorism impose costs on businesses in the country with 1: to a great extent, and 7: not at all (World Economic Forum, 2014).

All variables used in empirical estimations were subjected to stationary tests and those that were found to have unit roots were transformed to a stationary series before using it in the causality analysis. The sample of our study spans from 2000 to 2012, and due to limited observations for the period of 2000–2012, we converted the yearly data into quarterly data using quadratic-sum/average method.

## Empirical Results

### *Geweke Causality Analysis for Thailand*

As discussed in the previous section, we employed a Geweke causality analysis in this paper to identify the causal determinants of the growth of tourism and travel in Thailand and Singapore. This section will furnish the results of the Geweke analysis in Thailand.

In order to select the "best" set of explanatory variables among the nine variables (Table 1), we adopted a stepwise forward selection. As Table 2 shows, among the nine aforementioned candidates, only consumer price index and religious unrest are the two variables that turn out to be the most significant variables used for Geweke analysis.

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Table 1
*Master Set of Variables Considered for Empirical Analysis*

| Environment | Indicator |
|---|---|
| Environmental and infrastructure environment | Airport facilities; air quality; internet users |
| Purchasing power environment | Consumer price index |
| Government policy environment | Government expenditure on tourism (% of GDP); Capital investment on tourism (% of GDP) |
| Safety and security environment | Public security and safety; religious unrest |

Table 2
*Summary of Linear Stepwise Regression Analysis on Tourism Development in Thailand*

| Dependent variable: International tourism arrivals | $y_i = \partial_i + \sum_{k=1}^{K} \beta_k x_{ik} + \epsilon_i$ | | | Number of obs = 51<br>$F$=19.71<br>Prob > $F$ = 0.0000<br>Adjusted $R^2$ = 0.4280 |
|---|---|---|---|---|
| Independent variables | β | Standard error | $t$ statistics | $p$-value |
| CPI | 81656.53*** | 19811 | 4.12 | 0.000 |
| Religious unrest | -702575.7*** | 131989.1 | -5.32 | 0.000 |
| *Constant* | 11890.11 | 16561.69 | 0.72 | 0.476 |

*Note*. *** Represents the 1% level of significance.

Table 3 provides the first set of results for bi-directional causality for Thailand. For the subsequent Geweke causality tables, figures of $F_{x,y}$ may not be equal to the sum of figures of $F_{x\to y}$, $F_{y\to x}$ and $F_{x\cdot y}$ due to round-up. As can be inferred from the bidirectional causality results we do not find any significant unidirectional association between international tourist arrivals and consumer price index on either direction. However, we find that there is an instantaneous causal relationship between the two variables that is significant at the 5 percent level, which cannot be ignored. Further, it is useful to note that this instantaneous causation does not translate into total causality between the two variables, in either direction. Considering the bidirectional causality results between international tourist arrivals and religious unrest, we find that the causality again is bidirectional, although the association between the dependent and explanatory variable at the 1 percent level of significance is being driven by instantaneous feedback.

Table 3
*Estimated Measures of Bidirectional Feedbacks between International Tourism Arrivals (ITA), Consumer Price Index (CPI), and Religious Unrest (RU) for Thailand, 2000-2012*[ab]

| Economic aggregates | | $\boldsymbol{H_0(F_{x,y} = F_{x\to y} + F_{y\to x} + F_{x\cdot y})}$ | | | |
|---|---|---|---|---|---|
| $\boldsymbol{x}$ | $y$ | $F_{x,y}$ | $F_{x\to y}$ | $F_{y\to x}$ | $F_{x\cdot y}$ |
| ITA | CPI | 0.0886<br>(0.2268) | 0.0019<br>(0.7619) | 0.0008<br>(0.8450) | 0.0860**<br>(0.0401) |
| CPI | ITA | 0.0936<br>(0.2047) | 0.0002<br>(0.9242) | 0.0075<br>(0.5457) | 0.0860**<br>(0.0401) |

| Economic aggregates | | $H_0(F_{x,y} = F_{x\to y} + F_{y\to x} + F_{x\cdot y})$ | | | |
|---|---|---|---|---|---|
| ITA | RU | 0.8041***<br>(0.0000) | 0.0008<br>(0.8413) | 0.0505<br>(0.1156) | 0.7528***<br>(0.0000) |
| RU | ITA | 0.7774***<br>(0.0000) | 0.0155<br>(0.3830) | 0.0091<br>(0.5049) | 0.7528***<br>(0.0000) |

*Note*. [a] *, ** and *** denote 10%, 5% and 1% level of significance, respectively. [b] Confidence interval would be provided upon request.

Table 4 reports the multi-directional causality between international tourist arrivals on the *X* vector which comprises consumer price index and religious unrest. The results are consistent with what we found earlier in the bilateral case, and there is a strong overall causal relationship between the vector of explanatory variables and tourism growth, although the feedback is instantaneous and ($F_{x\cdot y}$) accounts for almost all the variation in total multi-directional linear dependence. These results indicate that while consumer price index and social stability in Thailand could simultaneously influence international tourism arrivals, the direction of causality individually is difficult to ascertain from the results.

Table 4
*Estimated Measures of Multi-Directional Feedbacks between ITA, CPI, and RU for Thailand, 2000-2012*[ab]

| Economic aggregates | | $H_0(F_{x,y} = F_{x\to y} + F_{y\to x} + F_{x\cdot y})$ | | | |
|---|---|---|---|---|---|
| $x$ | $y$ | $F_{x,y}$ | $F_{x\to y}$ | $F_{y\to x}$ | $F_{x\cdot y}$ |
| ITA | CPI | 1.6695***<br>(0.0000) | 0.0027<br>(0.9355) | 0.0581<br>(0.2410) | 1.6087***<br>(0.0000) |
| | RU | | | | |

*Note*. [a] *, ** and *** denote 10%, 5% and 1% level of significance, respectively. [b] Confidence interval would be provided upon request.

The final bit of analysis for Thailand is to examine the bi-directional and multi-dimensional causality of international tourist arrivals with the various explanatory variables lumped into factors through a principle component analysis. We construct different environments which proxy the different determinants of tourism. They can be grouped into environmental and infrastructure; purchasing power; government policy; and safety and security as mentioned earlier. The intuition is to tease out the causal relationships that could exist between these set of variables and tourism growth.

Table 5 furnishes the estimated bidirectional feedbacks between international tourism arrivals and the four environments mentioned above. Consistent with the bidirectional and multi-directional results we found earlier, we find only a strong instantaneous association between the different variables. With the exception of the total causality for international tourist arrivals and environment and infrastructure environment, almost every other environment has a strong and statistically significant relationship with international tourist arrivals. However, as noted before, the

direction of causality cannot be ascertained because we find only a simultaneous or instantaneous feedback. The multi-dimensional counterpart of the same set of regressions is shown in Table 6 and we find that the results broadly concur with the results shown in Table 5. We find evidence only for an instantaneous feedback.

Table 5
*Estimated Measures of Bidirectional Feedbacks between ITA, Purchasing Power Environment (PPE), Government Policy Environment (GPE), Safety and Security Environment (SSE), and Environmental and Infrastructure Environment (EIE) for Thailand, 2000-2012*[ab]

| Economic aggregates | | $\boldsymbol{H_0(F_{x,y} = F_{x\to y} + F_{y\to x} + F_{x\cdot y})}$ | | | |
|---|---|---|---|---|---|
| $\boldsymbol{x}$ | $y$ | $F_{x,y}$ | $F_{x\to y}$ | $F_{y\to x}$ | $F_{x\cdot y}$ |
| ITA | PPE | 0.0962<br>(0.1940) | 0.0000<br>(0.9704) | 0.0013<br>(0.7997) | 0.0949**<br>(0.0311) |
| PPE | ITA | 0.1034<br>(0.1670) | 0.0021<br>(0.7501) | 0.0065<br>(0.5738) | 0.0949**<br>(0.0311) |
| ITA | GPE | 0.1106<br>(0.1437) | 0.0009<br>(0.8381) | 0.0020<br>(0.7520) | 0.1077**<br>(0.0216) |
| GPE | ITA | 0.0594<br>(0.1036) | 0.0002<br>(0.9131) | 0.0004<br>(0.3471) | 0.0587**<br>(0.0216) |
| ITA | SSE | 0.6568***<br>(0.0000) | 0.0013<br>(0.7985) | 0.0466<br>(0.1308) | 0.6089***<br>(0.0000) |
| SSE | ITA | 0.6358***<br>(0.0000) | 0.0155<br>(0.3840) | 0.0115<br>(0.4528) | 0.6089***<br>(0.0000) |
| ITA | EIE | 0.1238<br>(0.1085) | 0.0292<br>(0.2319) | 0.0054<br>(0.6085) | 0.0893**<br>(0.0365) |
| EIE | ITA | 0.1304*<br>(0.0942) | 0.0061<br>(0.5837) | 0.0350<br>(0.1904) | 0.0893**<br>(0.0365) |

*Note*. [a] *, ** and *** denote 10%, 5% and 1% level of significance, respectively. [b] Confidence interval would be provided upon request.

Table 6
*Estimated Measures of Multi-Directional Feedbacks between ITA, PPE, GPE, SSE, and EIE for Thailand, 2000-2012*[ab]

| Economic aggregates | | $H_0(F_{x,y} = F_{x\to y} + F_{y\to x} + F_{x\cdot y})$ | | | |
|---|---|---|---|---|---|
| $x$ | $y$ | $F_{x,y}$ | $F_{x\to y}$ | $F_{y\to x}$ | $F_{x\cdot y}$ |
| ITA | PPE<br>GPE<br>SSE<br>EIE | 1.4171***<br>(0.0000) | 0.0282<br>(0.8477) | 0.0865<br>(0.3744) | 1.3024***<br>(0.0000) |

*Note.* [a] *, ** and *** denote 10%, 5% and 1% level of significance, respectively. [b] Confidence interval would be provided upon request.

In summary, the empirical results point out a couple of interesting results. One, we do not find an explicit uni-directional feedback in either direction for the variables considered. Two, however, there is a joint or simultaneous causation that can be observed between inflation and tourist arrivals as well as between religious unrest and tourism growth. These results point out the need for the policy makers to be sensitive to the macroeconomic shocks as well as domestic political conditions which could adversely affect tourism growth that in turn is likely to have a spillover effect on overall economic growth.

### *Geweke Causality Analysis for Singapore*

We followed a similar template for Singapore, as we did for Thailand, and tried and ascertained the direction of causality between the concerned variables. One notable exception from the Thailand results is that, using our stepwise forward selection, we find more relevant variables to be included in our causality analysis. Specifically, we find that government expenditure on tourism, the capital investments on tourism, consumer price index, airport facilities as well as the indicator capturing religious unrest appear to become the most significant variables to be used for Geweke causality analysis (Table 7).

Table 7
*Summary of Linear Stepwise Regression Analysis on Tourism Development in Singapore*

| Dependent Variable: International tourism arrivals | $y_i = \partial_i + \sum_{k=1}^{K} \beta_k x_{ik} + \epsilon_i$ | | | Number of obs = 51<br>$F$ = 44.54<br>Prob > $F$ = 0.0000<br>Adjusted $R^2$ = 0.8132 |
|---|---|---|---|---|
| Independent variables | β | Standard error | $t$ statistics | $p$-value |
| Government expenditure on tourism (% of GDP) | 3253069.00*** | 358715.80 | 9.07 | 0.000 |
| Capital investment on tourism (% of GDP) | -50283.18*** | 10181.20 | -4.94 | 0.000 |
| CPI | 20341.80*** | 7154.60 | 2.84 | 0.007 |
| Airport facilities | -351607.80** | 170567.20 | -2.06 | 0.045 |
| Religious unrest | -46283.62** | 22789.90 | -2.03 | 0.048 |

| | | | | |
|---|---|---|---|---|
| *Constant* | 8506.50 | 6361.20 | 1.34 | 0.188 |

*Note*. ** and *** represent the 5% and 1% level of significance, respectively.

Table 8 starts with bidirectional causality results. With the exception of a weak unidirectional causality between international tourist arrivals and airport facilities, there is no other set of variables that exhibit strong causality in either direction. However, there are two interesting results that come out of this analysis. One, consistent with the results for Thailand, we find that there is evidence only for an instantaneous feedback between the variables and no evidence whatsoever for unidirectional causal associations individually. Two, however, unlike Thailand, the variables for which we find a significant instantaneous feedback, are exactly those variables that were not part of the Thailand estimation, namely, we find that inflation and religious unrest to be insignificant whereas all the other variables were significant in the case of Singapore.

Table 8

*Estimated Measures of Bidirectional Feedbacks between ITA, Government Expenditure on Tourism (% of GDP) (GET), and Capital Investment on Tourism (% of GDP) (CI), CPI, Airport Facilities (AF), and RU for Singapore, 2000-2012*[ab]

| Economic aggregates | | $\boldsymbol{H_0(F_{x,y} = F_{x\to y} + F_{y\to x} + F_{x\cdot y})}$ | | | |
|---|---|---|---|---|---|
| $\boldsymbol{x}$ | $y$ | $F_{x,y}$ | $F_{x\to y}$ | $F_{y\to x}$ | $F_{x\cdot y}$ |
| ITA | GET | 1.2279***<br>(0.0000) | 0.0010<br>(0.8274) | 0.0025<br>(0.7270) | 1.2245***<br>(0.0000) |
| GET | ITA | 1.2553***<br>(0.0000) | 0.0002<br>(0.9185) | 0.0306<br>(0.2209) | 1.2245***<br>(0.0000) |
| ITA | CI | 0.4247***<br>(0.0001) | 0.0014<br>(0.7950) | 0.0035<br>(0.6804) | 0.4198***<br>(0.0000) |
| CI | ITA | 0.4216***<br>(0.0001) | 0.0006<br>(0.8674) | 0.0013<br>(0.8041) | 0.4198***<br>(0.0000) |
| ITA | CPI | 0.0503<br>(0.4818) | 0.0010<br>(0.8259) | 0.0002<br>(0.9295) | 0.0491<br>(0.1207) |
| CPI | ITA | 0.0551<br>(0.4406) | 0.0001<br>(0.9675) | 0.0059<br>(0.5915) | 0.0491<br>(0.1207) |
| ITA | AF | 0.8076***<br>(0.0000) | 0.0038<br>(0.6663) | 0.0662*<br>(0.0718) | 0.7377***<br>(0.0000) |
| AF | ITA | 0.7642***<br>(0.0000) | 0.0212<br>(0.3078) | 0.0053<br>(0.6088) | 0.7377***<br>(0.0000) |

| | | | | | |
|---|---|---|---|---|---|
| ITA | RU | 0.0257<br>(0.7384) | 0.0002<br>(0.9222) | 0.0020<br>(0.7558) | 0.0236<br>(0.2825) |
| RU | ITA | 0.0252<br>(0.7447) | 0.0005<br>(0.8812) | 0.0012<br>(0.8103) | 0.0236<br>(0.2825) |

*Note*. [a] *, ** and *** denote 10%, 5% and 1% level of significance, respectively. [b] Confidence interval would be provided upon request.

Table 9 shows the multi-directional causality results between international tourist arrivals on the $X$ vector and the $Y$ vector of variables comprising government expenditures on tourism, consumer price index, capital investments on tourism, airport facilities and religious unrest. We find that that there is strong causality between $X$ and $Y$ ($F_{x,y}$) at the 1 percent level of significance. Although there is no significant linear feedback running from $X$ to $Y$ or $Y$ to $X$ ($F_{x\to y}$; $F_{y\to x}$) , the instantaneous association between $X$ and $Y$ ($F_{x\cdot y}$) is strongly significant at 1 percent level and contributes 96 percent of total multi-directional linear dependence. These results indicate that the government policies on tourism, inflation rates, airport construction and social stability in Singapore could effectively and simultaneously affect international tourism arrivals.

Table 9
*Estimated Measures of Multi-Directional Feedbacks between ITA, GE (% of GDP), CI (% of GDP), CPI, AF, and RU for Singapore, 2000-2012*[ab]

| Economic aggregates | | $\boldsymbol{H_0(F_{x,y} = F_{x\to y} + F_{y\to x} + F_{x\cdot y})}$ | | | |
|---|---|---|---|---|---|
| $\boldsymbol{x}$ | $y$ | $F_{x,y}$ | $F_{x\to y}$ | $F_{y\to x}$ | $F_{x\cdot y}$ |
| ITA | GET<br>CI<br>CPI<br>AF<br>RU | 2.4647***<br>(0.0000) | 0.0063<br>(0.9975) | 0.0923<br>(0.4768) | 2.3661***<br>(0.0000) |

*Note*. [a] *, ** and *** denote 10%, 5% and 1% level of significance, respectively. [b] Confidence interval would be provided upon request.

Table 10
*Estimated Measures of Bidirectional Feedbacks between ITA), Purchasing Power Environment (PPE), GPE, Environmental and Infrastructure Environment (EIE) and SSE for Singapore, 2000-2012*[ab]

| Economic aggregates | | $\boldsymbol{H_0(F_{x,y} = F_{x\to y} + F_{y\to x} + F_{x\cdot y})}$ | | | |
|---|---|---|---|---|---|
| $\boldsymbol{x}$ | $y$ | $F_{x,y}$ | $F_{x\to y}$ | $F_{y\to x}$ | $F_{x\cdot y}$ |
| ITA | PPE | 0.0723 | 0.0015 | 0.0085 | 0.0623* |

| | | | | | |
|---|---|---|---|---|---|
| | | (0.3150) | (0.7874) | (0.5182) | (0.0805) |
| PPE | ITA | 0.0761<br>(0.2925) | 0.0001<br>(0.9486) | 0.0136<br>(0.4138) | 0.0623*<br>(0.0805) |
| ITA | GPE | 1.6515***<br>(0.0000) | 0.0053<br>(0.6115) | 0.0102<br>(0.4786) | 1.6360***<br>(0.0000) |
| GPE | ITA | 1.6679***<br>(0.0000) | 0.0001<br>(0.9786) | 0.0318<br>(0.2117) | 1.6360***<br>(0.0000) |
| ITA | EIE | 0.5322***<br>(0.0000) | 0.0093<br>(0.5000) | 0.0526<br>(0.1084) | 0.4703***<br>(0.0000) |
| EIE | ITA | 0.5132***<br>(0.0000) | 0.0200<br>(0.3220) | 0.0229<br>(0.2895) | 0.4703***<br>(0.0000) |
| ITA | SSE | 0.2283**<br>(0.0108) | 0.0130<br>(0.4251) | 0.1985***<br>(0.0018) | 0.0168<br>(0.3646) |
| SSE | ITA | 0.1155<br>(0.1294) | 0.0543<br>(0.1029) | 0.0444<br>(0.1400) | 0.0168<br>(0.3646) |

*Note*. [a] *, ** and *** denote 10%, 5% and 1% level of significance, respectively. [b] Confidence interval would be provided upon request.

Following what we did for Thailand, we next consider the causality results for the different environments and tourism growth. It is important to highlight that the environment capturing environment and infrastructure as well as government policies have a strong instantaneous causal feedback with growth in international tourist arrivals, while there is no significant association between the other two environments comprising of purchasing power and security (Table 10).

The multi-directional counterpart is shown in Table 11 and the results appear to be consistent with what we discussed earlier in that the there is a strong and significant linear feedback running from $Y$ to $X$ ($F_{y\to x}$), which perhaps is being driven by the significance of the government policy and environmental and infrastructure environment. The instantaneous association ($F_{x\cdot y}$) is also highly significant at the 1 percent level, contributing to over 90 percent of the total multi-directional linear dependence.

Table 11
*Estimated Measures of Multi-Directional Feedbacks between ITA, PPE, GPE, EIE, and SSE for Singapore, 2000-2012*[ab]

| Economic aggregates | | $H_0(F_{x,y} = F_{x\to y} + F_{y\to x} + F_{x\cdot y})$ | | | |
|---|---|---|---|---|---|
| $x$ | $y$ | $F_{x,y}$ | $F_{x\to y}$ | $F_{y\to x}$ | $F_{x\cdot y}$ |
| ITA | PPE<br>GPE<br>EIE<br>SSE | 2.6134***<br>(0.0000) | 0.0263<br>(0.8634) | 0.2300**<br>(0.0237) | 2.3571***<br>(0.0000) |

*Note*. [a] *, ** and *** denote 10%, 5% and 1% level of significance, respectively. [b] Confidence interval would be provided upon request.

To summarize the results, our causality analysis shows two interesting trends: The first pertains to the consistency with that of Thailand, where we find evidence only for an instantaneous feedback between the explanatory variables considered and international tourist arrival. This implies that there is no unidirectional causal association individually that we could establish. The second conclusion to come out of this analysis is that we find the quality of infrastructure as proxied by airport facilities causes tourism growth, which is consistent with the story of Singapore's investments in its airport infrastructure. Further, we also find that the lists of variables which exhibit significant instantaneous feedback are those that were not significant for Thailand.

## Conclusions

Tourism is one of the vibrant economic sectors in Southeast Asian countries, being spurred by the growth of this industry in Thailand and Singapore. These two economies stand out from the rest of Southeast Asia in terms of their significance of domestic tourism and travel industry, as measured by growth in tourist arrivals, the consequent revenues generated, as well as employment opportunities.

These countries have also promoted several national development strategies for decades in these two countries. In this light, the paper identifies the causal determinants of the growth of the travel and tourism industry in Thailand and Singapore, using quarterly data from 2000–2012, under a Geweke causality framework.

The findings of the paper leave us with useful policy insights that could serve as a useful guidance to policymakers to boost the capacity and enhance the quality of the domestic travel and tourism industry in both the countries.

While overall our results are stronger for Singapore than Thailand, we still find that there is a strong linear instantaneous feedback between international tourist arrivals and the different policy environments we chose for the respective countries. For Thailand specifically, we find that religious unrest, capturing an element of domestic instability and turbulence seems to affect international tourist arrivals significantly. This appears to be consistent with what happened to Thailand after 2013, where the political turmoil caused a severe setback to the growth of the tourism industry and also halted the country's economic growth. This is also likely suggestive that the policy makers must pay attention to the economic damage that such instability can bring about to the tourism industry in particular but the economy more generally. In the case of Singapore, we find that international tourist arrivals are driven by

infrastructural variables covering airport facilities as well as government policy variables such as government expenditures on the tourism industry.

The strong causal relationship we find between these variables is consistent with the national tourism policies of Thailand and Singapore although our causality results are indicative of an instantaneous feedback rather than a strong unidirectional feedback in either direction. The only exception being the weak unidirectional relationship that we find in the case of Singapore where the causality runs from quality of airports to international tourist arrivals, which again stands testimony to the efforts taken by the Singapore government in maintain a world-class airport like the Changi airport. In fact, Changi airport is an example of an aviation hub that has played an instrumental role in the transformation of economy into an important destination by leveraging the tourism-transport policy complementarities.

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# On Discerning the Implications of Operating and Financial Leverage Ratios on the Systematic Risk of Enterprises: Evidence from Sensex Firms in India

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## Abstract

With the proliferation of advancements surrounding the investment analysis, an area that has received only token attention from the practitioners and academicians pertains to the factors (beyond the market) implicating the systematic risk of securities. It is surprising that, even while there is an overwhelming consumption of the notion surrounding the critical role rendered by the security beta in bearing the corporate valuation process to fruition, there is almost an implied incongruity towards establishing the implications of fundamental business variables bearing an influence on the beta value of securities. The seminal studies conducted by Hamada (1972); Mandelker & Rhee (1984); Huffman (1989); Duett, et al., (1996); Ryan (1997); Faff, et al., (2002); Bernardo, et al., (2007); Alaghi (2011); and Ozdagli (2012) have attempted to discern the implication of fundamental business variables represented by operating and financial leverage on the systematic risk of enterprises that bear as significant additions to the literature in this area. However, the paucity of such studies particularly in respect of the emerging markets like India, serves as a significant contributor towards deciphering the interrelationship between systematic risks and fundamental business variables of enterprises thereby enriching the existing expanse of literature. In this paper, we seek to re-examine the hypothesis surrounding the implications of the fundamental business variables: Operating Leverage (OL) and Financial Leverage (FL) on the enterprise-wide systematic risk represented by security beta. On identifying OL and FL independently, we found a statistically significant relationship that FL bears on security beta. However, when we considered the Combined Leverage (CL), we observed a statistically significant relationship with security beta. Our sample consists of all the firms forming part of India's benchmark capital market (SENSEX).

*Keywords*: Systematic risk, operating, financial, combined leverage, econometric approach, multiple regressions, BSE, SENSEX

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## Introduction

Enormous emphasis has been laid upon the critical input concerning the beta value of security, which together with the risk-free rate and risk premium, has a bearing on the cost of equity. All cash flows almost ubiquitously employ the cost of equity as at least one of the components for determining the discount rate when arriving at the intrinsic value for a corporate firm. The origin of security beta is best traced to the seminal work carried out by William Sharpe, which eventually earned him a Nobel Prize for proposing a highly influential work in the form of capital market hypothesis. The idea was conceived by Sharpe (1964) and later expanded by Solink (1974), Ross (1976), and Merton (1987).

Security beta, also known as the systematic risk in its simplest form, represents the sensitivity of security's return with that of the market. It is computed as the coefficient of the independent variable represented by the market's return when regressed over the security returns represented as a dependent variable. Alternatively, beta may also be computed using the covariance approach.

$$\frac{Co\,\mathrm{var}(R_i, R_m)}{\sigma_m^2}$$

where:

β = Beta of security i in relation with market,
Covar = Covariance between security returns ($R_i$) and the market returns ($R_m$),
$\sigma^2$ = Variance of market returns.

With beta of a market always given as 1, the value of beta reflected by a firm determines the magnitude of systematic risk. For instance, a firm with a security beta of 1.5 is expected to have sensitivity to the tune of 150% making investment in the firm, a highly risky proposition. In contrast, a firm with a beta value of 0.2 is perceived as having a lower systematic risk. As an example, the firms representing the manufacturing and health-care sectors normally report high and low values of beta, respectively.

Taking the case of a plain-vanilla dividend discount model (DDM) as applied to a stable-firm, the influence rendered by security beta may be gauged from the equation delineated below.

$$P_0 = \left( \frac{D_1}{K_e - g_n} \right)$$

where:

$$K_e = R_f + \left[ (R_m - R_f)\beta_i \right]$$

As is evident from the above equation, the value assigned to the beta of a security has a direct bearing on the computed intrinsic value of a firm. It is worth mentioning that the value assigned to the beta while determining the discount rate at the terminal stage renders a significant role in influencing the corporate value of a firm. Financial theorists would argue that, with the ageing process of the firm accelerating at an increasing rate, it would be prudent to allow the beta of the firm at the terminal stage to converge with the market beta. Analysts building their "black-

*N. R. Parasuraman and U. Rao (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 79-91, 2016
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box" models would invariably factor this value with perhaps scant regard to the factors played out by fundamental business variables in influencing the terminal beta value. The last point needs some more elaboration. Here, we defined fundamental business variables as represented by the two ratios: OL and FL. Postponing the discussion in respect of OL for a later section, corporate finance has clearly established an inextricable influence of FL in determining the beta value. This may be appreciated by glancing at the mathematical equation represented below (Damodaran, 2006).

$$\beta_L = \beta_U \left[ 1 + (1 - t) \left( \frac{D}{E} \right) \right] \quad (1)$$

where:

$\beta_L$ = Levered beta of a security,

$\beta_U$ = Unlevered beta of a security,

t = corporate tax rate.

$\left( \frac{D}{E} \right)$ = Debt-to-Equity ratio

It is easy to gauge from the above equation that FL represented by $\left( \frac{D}{E} \right)$ will have the direct implication of increasing the beta value. The significance rendered by leverage in influencing the beta value is worth examining. Even while the norm among the early-stage or growing firms is invariably centered upon embracing an equity-dominated capital structure—as the firms mature—and with every additional penny of equity for capital expansion coming with "strings attached", corporations find it much easier to opt for debt capital. The tax advantage apart, debt capital also serves the interests of management by preventing further dilution of control. However, an environment dominated by slowing or stagnant earnings in the wake of heightened competition among the industry players tends to exert significant pressure on the cash flows towards achieving the objective of debt-servicing. With free cash flows coming under pressure, the risk-propensity of the equity shareholders tends to rise, which is eventually reflected in an increased systematic risk led by higher beta value.

A pertinent issue to be pondered from the above discussion relates to the heightened influence of leverage or financial risks over business risks. In fact, corporate India in recent times has witnessed limited number of firms being nudged almost into extinction not due to enhanced business risks, but more owing to a flawed capital structure by embracing disproportionately high debt capital[1].

Unlike the mathematical expression rendered by FL in influencing the beta value, unfortunately, there is no mathematical expression to decipher the linkage OL bears on the beta value. At best, the influence of OL may be represented by building an econometric model based on multiple regressions approach. The model and the

[1]As an example, Suzlon, India's leading manufacturer of wind-turbines, went through a very tumultuous phase primarily driven by its debt woes. While Suzlon managed to embrace a sound business model, yet the firm driven by its insatiable desire to purse international growth went for acquisitions supported by borrowed funds. With most of the acquisitions failing to yield the desired synergy, Suzlon had to ultimately witness a default on account of Foreign Currency Convertible Bonds (FCCBs) resulting in an instantaneous erosion of shareholders' wealth.

subsequent treatment are dealt elaborately in the subsequent section. At this stage, there are some more pertinent points in respect of OL that deserve greater attention.

Corporate financial theory posits an inverse relationship between the discount rate ($K_e$ or WACC, as the case may be) and the value of the firm, implying a higher discount rate that would lower the intrinsic value and vice versa. It is interesting to observe the plausible implications of assigning a theoretical beta value of "1" for a corporate enterprise that chooses to be an all-equity firm right until "eternity". In this case, the convergence of the existing lower or higher beta value to 1 gradually would be best explained by the application of business risk, as measured by OL. This is particularly true as decisions pertaining to capital structure (whether to lever the balance sheet) are best taken by the management of corporations. Zero-debt companies, therefore, have an implied obligation to generate higher returns as investors are inherently exposed to a greater degree of operating risks.

In the Indian context, in a study conducted by ET Intelligence, 52 corporations among Bombay Stock Exchange (BSE) 500 were found to be totally debt-free in the three years to 2014-15. Of the 52 corporations, 17 firms reported a double-digit three-year compounded annual growth rate (CAGR) in sales and net profits (ET Intelligence, 2015).

## Objectives and Scope of the Study

In this paper, our primary objective is to discern the influence of business risk and financial risk on the systematic risk of a firm. In order to achieve the aforesaid objective, we developed a multiple regression model isolating extraneous variables bearing an influence on beta by relying upon financial measures represented by operating leverage (business risk) and financial leverage ratios operating as explanatory variables to capture the influence on systematic risk of a firm.

An implied rationale following the above is that business and financial risks surrounding a firm render a pre-eminent role in influencing the beta of a security. As ultimately, it is the systematic factors that lend an influence on a cross-section of securities as against unsystematic factors—as they are essentially diversifiable and therefore insignificant—our research endeavor rests upon providing an empirical support to the view delineated above.

## Theoretical Postulates Surrounding Implications of the Beta on Corporate Valuation, Particularly at the Terminal Stage

It is interesting to observe the ramifications of the assigned beta value at the terminal stage. As stated above, analysts would prefer to assign a beta value of 1 (usually a range of 0.8 to 1.2) implying that the security risk will converge with the market risk with the gradual decline in the competitive advantages and the growth rates settling to a stable rate at the terminal stage. There are two preeminent factors bearing a significant impression on the assigned beta value, in particular, at the terminal stage.

### *Financial Leverage*

With the maturing process of the firm setting in, corporate financial theory would posit that mature firms would find it much harder to raise additional layers of capital by equity than by debt. The argument towards this postulate flows from the fact that investment in a maturing firm (with its waning influence in dictating the industry and customers) would be deemed as much riskier and consequently less profitable by equity investors as against a young firm that holds out plenty of promising opportunities at least for investors like venture capitalists, private equity, and angel investors, who are cuddled with the prospects of earning an attractive IRR on their initial investment.

*N. R. Parasuraman and U. Rao (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 79-91, 2016
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With such a possibility, it is fair to expect the capital structure to have some traces of debt for a firm at the maturity stage that chooses to retain its 'all-equity characteristic' all along the growth phase[2]. With leverage coming into fruition, ceteris paribus, the beta value is influenced by the degree of financial leverage as given in Equation 1. That is, for an all-equity firm, the transition takes place from a previously unlevered beta value to a levered beta value.

### *Operating Leverage*

Yet another significant aspect of a firm's business bearing an influence on the beta value pertains to the operating leverage. Operating leverage represents the business risk measured by the volatility in earnings and is influenced by the ability of a firm to derive the benefits of the "economies of scale" by virtue of the presence of "fixed costs." Consider again a firm that gradually matures over its life-cycle with the prospects of diminishing the economies of scale due to the limitations imposed on the productive capacity of the firm. In such a scenario, the volatility in earnings as a consequent impact of enhanced business risk is expected to have a discernible influence on the beta value. It is not unreasonable to expect firms (which are virtually debt-free) to witness an increased equity risk primarily owing to an upward revision of its beta value. A more pertinent issue would relate to the underlying mechanism towards capturing the impact of the operating leverage on the beta value of a firm.

There is one significant caution that must be exercised by researchers when working with operating leverage. In his paper on operating leverage, Novy-Marx (2010) made the following observation. "A more sophisticated analysis must recognize that higher operating costs may influence firms to reduce productions sooner in the face of falling demand, resulting in higher cost betas for highly geared firms. Moreover, the true level of gearing, which depends on capitalized value of all future costs and revenues, is not truly observable. While market values provide a good proxy for the difference in the capitalized values of costs and revenues, it is difficult to find good proxies for these individually. Cross-industry differences in accounting practices, and the prevalence of leases, add further noise to accounting variables that might conceivably be related to the operating leverage".

An interesting corollary flowing from the above discussions pertain to the degrees of influence borne by operating and financial leverage on the systematic risk as measured by the beta value. With the lens of investors consistently placed on the management of a firm, corporate executives have an implied responsibility towards continuously enhancing the shareholders' wealth as measured by the intrinsic value on per-share basis. Given that there is an inverse relationship between the intrinsic value of a firm and its corresponding discounting rate, the influence permitted by beta of a security bears significance. That is a firm that does not wish to seek raise additional capital by debt must have the inherent responsibility to control business risks in order to keep the influence of operating leverage on the beta value under check. Otherwise, in the fall-out of increased business risks, the management will be pressured to assume financial leverage (with its soothing influence on WACC arising out of tax-shield) in order to maximize the intrinsic value.

The above delineated points clearly demonstrate the inexorable influence remitted by the fundamental business variables on the systematic risk of a firm.

[2] Schmid and Gomes (2010) in their study found that, in the presence of financial market imperfections, leverage and investments appear to be highly correlated so that highly levered firms are also mature firms with relative more (safe) book assets and fewer (risky) growth opportunities.

*N. R. Parasuraman and U. Rao (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 79-91, 2016
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## Literature Review

A popular model that has witnessed a heightened degree of attention from the scholastic community relates to the one propagated by Hamada (1972). The model seeks to decipher the underlying relationship between systematic risk and the leverage ratios represented by OL and FL as depicted below.

$$\beta = \beta^* + \beta^*(1-\tau)\left(\frac{D}{E}\right)$$

The model served as a seminal contribution for spearheading research relating to the empirical examination of the relationship between the leverage ratios (operating and financial) and the systematic risk. The model was however criticized by Mandelker and Rhee (1984) who pointed out the following:

1. Equation does not explicitly introduce the degrees of two types of leverage in its expression.
2. The model suffers from various econometric problems caused by a nonlinear multiplicative effect of financial structure on operating risk as measured by $\beta^*$.
3. Equation assumes corporate debt is risk-free.

In their paper, Stone and Hill (1980) pointed towards the need for improved methods of estimating operating risk including its decomposition into more primitive components. They observed that both financial structure and systematic operating risks led a significant influence on market beta values. On the basis of this observation, they hold that forecasts of financial structure and operating risks are necessary towards accurately estimating beta values. They further found evidence to the effect that accounting betas do a better job towards capturing systematic risks as opposed to covariance-based measure.

In their own work, Mandelker and Rhee (1984) carried out a study with the objective to capture the underlying relationship between the systematic risk and the operating and financial leverage ratios. While their findings suggest that the degrees of operating leverage (DOL) and financial leverage (DFL) explain a large portion of the variation in beta; the inherent weakness reflected by the DOL, when used as an independent variable in the regression equation suggesting a smaller explanatory power, points out to the potential challenges posed in isolating DOL towards explaining the systematic risk. Besides, the observance of poor $R^2$ further exacerbates the robustness of the proposed model.

The study conducted by Huffman (1989) pointed out to the typical deficiencies confronted while transforming the earnings variable into their logarithmic equivalents. A major source of irritation flows from the logarithmic transformation of firms with negative earnings. The study found a positive relationship between systematic risk and financial leverage, and a negative relationship between systematic risk and operating leverage. The study also did not find any support for the conjecture that there is a trade-off between operating leverage and financial leverage.

The study conducted by Duett, Merikas, and Tsiritakis (1996) sought to enhance the understanding of the linkage between product markets and financial markets. The study proposed formulation of demand beta that is described as an important source of uncertainty in a security's return. The introduction of demand elasticity serves as an alternative formulation of inherent risk to that delineated by Mandelker and Rhee (1984).

The study conducted by Ryan (1997) related to a survey of research with regard to accounting numbers to systematic equity risk. The study points out to the deficiencies arising out of employment of traditional accounting earnings numbers as reflected in historical financial statements to represent operating risk. It argues for employment

*N. R. Parasuraman and U. Rao (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 79-91, 2016
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of fair-value accounting and well considered disaggregation of balance sheet accounts and major accrual estimates. The study consequently points out to the blurring of the sources of risk as operating and financing and criticizes the limited focus accorded by the financial reports towards providing direction only in respect of information concerning financial leverage, often at the cost of operating risk.

The study conducted by Bernardo, Chowdhry, and Goyal (2007) related to the decomposition of a firm's beta into beta of assets-in-place and beta-of-growth opportunities. The study empirically observed the beta of growth opportunities to be greater than the beta of assets-in-place for virtually all the industries over all periods of time dating back to 1977. In this paper, the authors posit that growth beta firms have a greater bearing on the project's cost of capital. They opine that assuming a 6% equity risk premium accounting for growth has the potential to alter cost of capital by as much as 2% to 3%.

Yet most studies pointed out to the significant relationship held by financial leverage towards explaining the systematic risk of firms. The evidence is found in notable studies including Faff, Brooks, and Kee (2002), Alaghi (2011) and more recently by Ozdagli (2012).

## Conceptual Framework Surrounding Operating and Financial Leverage

Before proceeding with the presentation of the empirical model, it is useful to define the fundamental business variables, OL and FL, along with the depiction of the underlying computational procedures.

OL represents the business risk of a firm as measured by the volatility in earnings. Simply put, it may be defined as a ratio of percentage change in operating income (ΔEBIT) over percentage change in sales (ΔSales). In other words, we say a proportionate change in operating income brought about by an incremental change in sales due to the presence of OL.

That is:

$$\Delta\text{Sales} \times \text{OL} = \Delta\text{EBIT} \tag{2}$$

Putting it differently,

$$\text{OL} = \left( \frac{\Delta\text{EBIT}}{\Delta\text{Sales}} \right)$$

Also, OL may be computed alternatively as a ratio of Contribution over Operating Profit (EBIT). That is:

$$\text{OL} = \left( \frac{\text{Contribution}}{\text{EBIT}} \right)$$

where:

Contribution = Sales – Variable Costs,
EBIT = Contribution – Fixed Costs.

FL is expressed as a ratio over percentage in earnings-after-taxes (ΔEAT) over percentage change in operating income (ΔEBIT). In simple sense, FL represents the impact on earnings-after-taxes (EAT) owing to the presence of

fixed costs in the form of interest expenses. Conventionally, an incremental change in EBIT leads to a more than proportionate change in EAT due to the influence of FL. That is:

$$FL = \left( \frac{\Delta EAT}{\Delta EBIT} \right) \quad (3)$$

Also, it may be represented as a ratio of operating profit (EBIT) over pre-tax income (EBT).

That is:

$$FL = \left( \frac{EBIT}{EBT} \right)$$

## The Empirical Model

Our empirical model seeks to examine the null hypothesis surrounding no significant impact borne by the leverage ratios, OL and FL, on the systematic risk of firms as represented by their beta values. Consequently, we formulate a linear econometric model based on multiples regressions as depicted below.

$$\beta_i = \gamma_1 OL + \gamma_2 FL \quad \text{(Model I)}$$

where:

$\beta_i$ = Beta value of a firm,

$\gamma_1$ = Coefficient of OL,

$\gamma_2$ = Coefficient of FL.

The mutual interplay of the variables representing OL and FL leads to combined leverage (CL), which is computed as a product of OL and FL. Symbolically, it may be represented as:

$$CL = OL \text{ x } FL \quad (4)$$

That is:

$$CL = \left( \frac{\Delta EBIT}{\Delta Sales} \right) \text{ x } \left( \frac{\Delta EAT}{\Delta EBIT} \right)$$
$$= \left( \frac{\Delta EAT}{\Delta Sales} \right)$$

By its derivation, CL seeks to capture the combined effect of OL and FL. Consequently, we derive a modified version of the model depicted above to capture the impact of CL on the systematic risk of firms as represented by their beta values.

$$\beta_i = \gamma_1 CL \quad \text{(Model II)}$$

where:

$\beta_i$ = Beta value of a firm,

$\gamma_1$ = Coefficient of CL.

Our study endeavors to seminally contribute to the practitioner and the academia by proposing a robust model that seeks to explain the implications of corporate decisions surrounding operating and financial risk on the systematic risk of firms in India. As posited by corporate valuation theory, every firm seeks to maximize the corporate value by maximizing growth, cash flows, and minimizing (or at least controlling) the risks. Typical valuation models, including the popularly employed Discounted Cash-Flow (DCF) models, present varied frameworks enabling corporate managers to appreciate the mutual interconnectedness between the financial variables in determining the corporate value.

In keeping with the abovementioned objective, we selected a sample that is representative of growth firms as represented by their market capitalization and commanding a similar risk profile. Imposition of these parameters leads us to select all the firms constituting India's oldest and most tracked benchmark capital market index led by SENSEX. SENSEX represents a diversified portfolio of top 30 companies that are selected predominantly using the criteria of market capitalization. The performance of these blue-chip companies virtually represents the state-of-the-economy.

Our initial sample included all the 30 firms. Given the unavailability of the most recent financial data in respect of one firm along with the observation of negatives values of OL and FL (as there is not much meaning attached for negative OL and FL values) for the other seven firms, the final sample consisted of 22 firms. The data in respect of beta values, operating income, and earnings-after-tax were retrieved as on March 31st, 2015. OL and FL values were computed using the Equation 2 and Equation 3 depicted earlier. The data including the beta values was retrieved from Capitaline databases.

## Empirical Results and Inferences

The empirical results flowing from the above delineated models are discussed below.

Table 1
*Regression Results Derived from Model I*

| Regression Statistics | |
|---|---|
| $R^2$ | 0.6609 |
| Standard error | 0.6203 |
| F-statistic | 17.5411 |

*Note*. Source: Excel analysis.

Table 2
*Regression Parameters Derived from Model I*

| Dependent variable | Statistical parameters | Regression coefficients | |
|---|---|---|---|
| | | $\gamma_1$ | $\gamma_2$ |
| $\beta_i$ | Coefficient | 0.0091 | 0.5236 |
| | Standard error | 0.0494 | 0.1282 |

| | | | |
|---|---|---|---|
| | t-value | 0.1846 | 4.0854 |
| | p-value | 0.8556 | 0.0007 |
| | Confidence Interval (lower) | -0.0946 | 0.2543 |
| | Confidence Interval (upper) | 0.1128 | 0.7929 |

*Note.* Source: Excel analysis.

Table 3
*Regression Results Derived from Model II*

| Regression Statistics | |
|---|---|
| $R^2$ | 0.2327 |
| Standard error | 0.9082 |
| F-statistic | 5.7637 |

*Note.* Source: Excel analysis.

Table 4
*Regression Parameters Derived from Model II*

| Dependent variable | Statistical parameters | Regression coefficients |
|---|---|---|
| | | $\gamma_1$ |
| $\beta_i$ | Coefficient | 0.0516 |
| | Standard error | 0.0215 |
| | t-value | 2.4007 |
| | p-value | 0.0268 |
| | Confidence Interval (lower) | 0.0066 |
| | Confidence Interval (upper) | 0.0966 |

*Note.* Source: Excel analysis.

From the above results, we infer that while FL as a variable is statistically significant at 5% level of significance bearing a clear implication on the systematic risk of a firm, the results in respect of OL appear mixed. The observed results are consistent with those observed by Alaghi (2011) and Ozdagli (2012).

When the OL's impact is captured independently, we failed to observe an evidence of statistically significant impact; however, when observed along with FL in the form of CL, we observe a statistically significant relationship held by OL and FL together as in CL at 5% level of significance thereby rejecting the null underlying no impact of OL and FL on the systematic risk of firms. The results are consistent with those observed by Huffman (1989).

The above results clearly show that the systematic risk, as reflected by the beta value, is better reflected by OL and FL together. This is cognizable from the fact that corporate managers seek to control both operating and financial risks at the same time implying an equal-weighted attention accorded by the top management led by its shareholders towards managing and mitigating these risks.

In recent times, we have witnessed the cases of Suzlon Ltd. and Wockhardt Ltd. that were once revered as darlings of the stock market exemplifying an excellent business model with virtually negligible operating risks. However, the quest of the management to expand their business drove these corporations to assume substantial amounts of debt exacerbating their levered position. In the following years, with the interest burden only expanding, the management at these firms faced the prospect of pushing their businesses to almost extinction. Lately though, these firms learned

the lessons of the perils of excessive leverage and have subsequently taken measures to gradually offload debt by engaging in divestitures and other measures of corporate restructuring. The cash realized have been utilized for shelving debt from their balance sheet with a consequent favorable impact on the stock prices commanded by these firms (Balasubramanyam, 2013). These instances point to the significant influence commanded by capital structure on firms at least among the corporations in India.

Having posited the significance underlined by operating and financial risks together, it is ubiquitously accepted by both theoreticians and practitioners alike about the critical role rendered by financial leverage in influencing the equity risk of enterprises. After-all a few of the well-managed corporations with virtually negligible operating risks have been almost driven to "extinction" due to the unbridled desire of the management to assume higher debt in order to drive expansive capital investment proposals often at the detriment of the interests of the larger shareholders.

**Conclusions**

In this paper, whilst we seek to empirically examine the influence borne by the fundamental business variables towards explaining the systematic risks encountered by corporate firms, it will be worthwhile to extend the study by establishing the effects of systematic risk on the overall value of a corporate firm. Besides, there is always an enhanced scope for future researchers to extend this study by observing the above delineated research problem by looking at a larger sample as retrieved from other competitive growth indices available within the Indian capital markets.

In this paper, we seek to empirically examine the hypothesis surrounding the influence exerted by fundamental business variables on the systematic risk of the SENSEX constituent firms in India. We found a statistically significant evidence of the impact borne by FL in explaining the systematic risk. The implications of OL towards explaining the systematic risk are found only in conjunction with FL in the form of CL.

The fact that capital structure decisions still play an overwhelming large part in deciding the future corporate maneuvers at the board rooms is a testament to the large significance accorded to both management and mitigation of financial risks.

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## Appendix

**List of Sample Firms Constituting BSE SENSEX**

| | Scrip Code | Company | Sector |
|---|---|---|---|
| 1 | 532215 | Axis Bank Ltd | Banking |
| 2 | 500103 | Bharat Heavy Electricals Ltd | Heavy Industry |
| 3 | 532454 | Bharti Airtel Ltd | Telecommunications |
| 4 | 500124 | Dr. Reddy's Laboratories Ltd | Pharmaceuticals |
| 5 | 532155 | Gail India Ltd | Oil & Gas |
| 6 | 500180 | HDFC Bank Ltd | Banking |
| 7 | 500182 | Hero MotoCorp Ltd | Automobile |
| 9 | 500696 | Hindustan Unilever Ltd | FMCG |
| 10 | 500010 | Housing Development Finance Corp | Financial Institution |
| 11 | 532174 | ICICI Bank Ltd | Banking |
| 12 | 500209 | Infosys Ltd | IT Software |
| 13 | 500875 | ITC Ltd | Diversified Conglomerate |
| 14 | 500257 | Lupin Ltd | Pharmaceuticals |
| 15 | 500520 | Mahindra & Mahindra Ltd | Diversified Conglomerate |
| 16 | 532500 | Maruti Suzuki India Ltd | Automobile |
| 17 | 500312 | Oil & Natural Gas Corp Ltd | Oil & Gas |
| 18 | 500112 | State Bank of India | Banking |
| 19 | 532540 | Tata Consultancy Services Ltd | IT Software |
| 21 | 500470 | Tata Steel Ltd | Steel |
| 22 | 507685 | Wipro Ltd | IT Software |

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# Application of Performance Evaluation System and Benchmarking to Improve Operational Efficiency of Public Enterprises

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## Abstract

Absence of an appropriate performance evaluation system is frequently the major cause of inefficiencies in public enterprises (PEs). Such a system is needed in PE sector largely owing to their multiple objectives which create vagueness about their goals. An evaluation system, which is based on clear and quantifiable targets linked with an incentive system, minimizes vagueness and; motivates managers to achieve specified performance level. In order to improve PEs performance in Pakistan, the "Signaling System for Public Enterprises" was set up in 1980s. The system had two major components: performance evaluation system, and incentive system which operated within the framework of an autonomy structure. Under this arrangement, managers were free to act to achieve targets and they were rewarded for good performance. The system was based on productivity linked with profitability targets. It generated positive results from the beginning. However, operations were further strengthened by improved target setting by application of benchmarking, and; by introducing the concept of strategic planning to enhance performance in short as well as long term. Supplementing the operations of signaling system with improvisations improved its effectiveness resulting in: (a) improvement in PEs profitability within four years; (b) managers acknowledged that it was a useful initiative which generated positive results; and (c) experts from the World Bank and Boston University concluded that the system motivated managers to attain targets, which improved operational efficiency of PEs.

*Keywords*: Benchmarking, public enterprises, performance evaluation

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## Introduction

Global experience demonstrates that absence of appropriate performance evaluation of Public Enterprises (PEs) is one of the major causes of their inefficiencies. PE managers frequently lack the directions they are expected to primarily adopt because PEs have multiple objectives, such as the maximization of profit along with responsibilities like creations of employment opportunities, etc. In addition, these enterprises have plural principals, i.e., various organs of the government have different perceptions about the objectives of these enterprises. Therefore, the establishment of a target-based performance evaluation system, which is linked with incentives, is a pre-requisite for improving performance of public enterprises.

Due to multiplicity of objectives, the performance evaluation of PEs is a complex exercise. It is challenging and, at the same time critical, for stakeholders in the government to establish clear objectives of PE managers and evaluate them accordingly. Laying down clear directions for PE managers in the form of performance targets is even more difficult when a PE is operating in monopoly and/or noncompetitive environment. Such enterprises do not have matching enterprise to compare with. The operational framework of its analogue is so distinct and different that they cannot be compared with. Therefore, they cannot be taken as a standard to compare.

The following paras comprise of a discussion on various experiences and options for establishing performance targets and then evaluating them. The discussion is corroborated by a case study of establishing a target based performance evaluation system in Pakistan.

## Paramount Issues of PEs Performance Evaluation System

In order to set up a performance evaluation system to improve operational efficiency of PE sector three primary questions need to be answered (Jones, 1981):

1. What is the structure of autonomy in which PE managers will operate?
2. What will be the primary objectives of PEs, i.e., what will be their criterion of evaluation?
3. What are PE managers expected to accomplish, i.e., what will the criterion value be?

## Autonomy Structure

The development of an efficient autonomy structure for PE managers is one of the most fundamental issues to be addressed by the owners/stakeholders in the government. A well thought out autonomy framework is important for enterprise managers. Poor autonomy structure, where there is an over-centralization of decision-making and where there is little delegation of powers to managers, leaves little room and flexibility to move and work. It also provides an alibi to managers to hide their inefficiencies. At the same time, the owners and stakeholders in the government have to be clear about the manager's desired direction. They should provide the managers with the appropriate guidelines and directions and hold them accountable for their efforts and accomplishments. Indeed, this requires competence and skill among the controllers in the government to be able to give appropriate guidelines to managers. To develop such an efficient autonomy structure where the managers are granted required autonomy and at the same time they are held responsible for their achievements, is an extremely challenging task. One solution can be to treat public enterprise sector like a multinational corporation as a special case of the multidivisional firm. This recommended solution can be tested on a public industrial sector in Pakistan which was administrated by the

Ministry of Production in 1980s and 1990s. The ministry controlled more than fifty operating enterprises with the assistances of eight holding corporations. The ministry was functioning as the head office, the sector corporations as regional or product-line divisions, and the companies were working as operating units. In such organizations, what classes of decisions ought to be made at the center and which at the periphery? More generally, what decisions should be made by any superior unit in a hierarchy? The answers to these questions were provided by Olivier Williamson (1975) for the multi-divisional firm and by Elliot Jacques (1976) for general hierarchies were similar and may be paraphrased as follows. The head office (or superior unit) should:

- Set objectives,
- Appoint the chief executive officers,
- Evaluate the performance according to those objectives,
- Reward and penalize the chief executive officers according to their evaluation,
- Provide resources (finance),
- Conduct long-range planning and coordination among units, and
- Do (almost) nothing else.

There are, thus, six narrow prescriptions and one broad proscription. The proscription is particularly important since it is so often violated. To the extent that it is violated, it is no longer possible to hold managers accountable for performance according to the objectives. The advantages of hierarchical specialization then break down (Jones, 1981).

## Criterion of Evaluation

The criterion of evaluation in a way is indicating what kind of performance is expected from managers. One of the most critical questions is what criterion should be applied to evaluate managers' real performance. There was a long drawn debate on the choice of criterion. Typically, two classes of criteria are used for evaluation: Partial indicators, which demonstrate performance indicators such as labor to production or raw material to production etc. But these indicators have limitations, as only one cost is related to the total benefits. What happens to other costs is not addressed. If there is more than one partial indicator, then one benefit is counted more than once.

The other indicator is standard profit. Here, one benefit and one cost are counted only once. The problem in this is the accounting distortions and where the prices are determined by the governments which in turn influence profitability.

Profitability, in general, is the most acceptable criterion provided accounting and other distortions are removed. This was done by adjusting the standard profitability and evolving the concept of public profitability which reflect the true economic surplus generated by a PE. A short account of this concept is as follows:

## Public Profitability

According to this concept for evaluating real performance of public enterprises, their efficiency is assessed by an adjusted profit. This not only takes care of the public ownership aspect of an enterprise but, also makes alternations in the normal accounting procedure which distort information concerning the real surplus generated by a public enterprise. The adjusted profit is called *public profit* (Jones, 1981). The concept of public profit recognizes the fact

*I. Mehdi (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 92-117, 2016
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that while a private manager is taking care of only one economic factor (private shareholder), the manager of a public enterprise has to keep in view the interest of all the domestic economic groups. Public profit is derived from a single period variable social benefits less variable social costs; that is, the value to society of the difference between what the enterprise takes out of the economy (costs) and what it puts back (benefits) in any one period. Public profit, therefore, is:

$II^* = X - II - R\,k^w$

where:

II* = Public Profit
X = Output at factor cost
II = Intermediate inputs at purchaser's prices
R = Factor rental expenses
$Rk^w$ = Opportunity cost of working capital

In relation to standard private profit, public profit is worked out in following manners:

Profit after taxes
+ Taxes
+ Depreciation
+ Non -operating Income
- Opportunity cost of working capital
= Public Profit

Given the fixed capital at his disposal, the manager is to maximize the public profit. Thus, public profitability can be defined as follows:

$$\text{Public Profitability} = \frac{\text{Variable Benefits Less Variable Costs}}{\text{Fixed Operating Assets}}$$

To eliminate the distortions created by government fixed prices, public profitability at constant prices is considered the appropriate criterion for assessing real performance of managers.

The greatest problem in the application of public profitability is that it is difficult for the managers to comprehend its concepts and its working. It is, therefore, concluded that standard profit should remain the appropriate criterion. However, while employing it, appropriate and generally understood adjustments can be made. For instance; some partial indicators like capital to production reflecting capital productivity, etc. are linked with profitability to reflect real performance of managers.

### *Enterprise – Specific Criterion Value*

Given the choice of any performance criterion (be it private profit, public profit, labor productivity, and capacity utilization, or anything else) as appropriate for evaluating a particular endeavor, then the still more difficult task remains of selecting a particular criterion value. While the criterion establishes the scale, the criterion values

establishes the point on the scale which distinguishes, say-"bad" from "average" from "good performance". The function of the criterion value, then, is to allow for the plethora of enterprise-specific constraints, which affect the ability of a particular unit, to generate public or private profit. The number of such factors are large, thus, this can be a knotty task. The sources of information which can assist in setting criterion value include:

- Comparisons with similar firms elsewhere,
- Comparisons with the same firm in previous years,
- Professional judgment by third parties,
- Professional judgments at the ministry level, and
- Professional judgment at the enterprise level.

If there are a large number of similar units operating in similar circumstances, then the problem is mechanical. Simply collect data on relevant variables for a sufficiently large number of units and compare it with an individual enterprise. The difficulty with this approach for public enterprises is that the number of "similar" enterprises is usually small. For instance, in 1980s and 1990s, Pakistan had only one integrated steel mill and only two oil refineries. It had four public fertilizer plants but their technology was sufficiently different to make direct comparison difficult. Only in the cement sector there were a reasonable number of similar enterprises in Pakistan. As a consequence, Cement Corporation had the best cost control system in the public sector, precisely because of the ready availability of standards of comparison. The number of observations can be increased by introducing international comparisons, but then the number of control variables increase geometrically. In evaluating cement, in Pakistan it was essential to know that the international standard for operating days is 330 and that many developing countries in fact achieved this level of performance and it could be compared with those of Pakistan's plants. However, other exogenous factors (notably the availability, quality and price of inputs such as energy) differ, making global comparisons difficult. The point is that while comparisons with other domestic or foreign plants can serve as useful partial aids to judgment in setting criterion value, they are in themselves insufficient.

How then is a "similar" enterprise to be found as a basis for comparison? In the entire world, the enterprise most similar to enterprise "A" in year "t" is generally enterprise "A" in year "t-1". This leads to the use of last year's performance as the criterion value against which this year's performance is judged. The focus is on the trend in performance rather than level. While this is a step in the right direction, it is not a final solution, for two reasons. First, even for single enterprise things change from year to year. Most importantly, prices change. As already noted, this can and should be treated mechanically by shifting to constant price evaluations. However, other changes (e.g., in demand conditions or the availability of inputs) also affect performance and cannot be treated so simply. Moreover, a second factor needs to be considered, namely, that the room for improvement varies from unit to unit. In a plant which has historically been poorly run, a twenty percent improvement in the indicator might require the same level of managerial effort and skill as that required to produce a two percent improvement in the indicator of a plant that has always been well run (Jones, 1981).

> "In sum, inter-temporal and inter-enterprise comparisons are essential inputs into the process of setting criterion values, but in the end a subjective professional judgment is required. Third-party evaluations can sometimes be used for this purpose. For a new firm, the project proposal provides some standards. It is also possible to commission detailed internal evaluations by consultants, but this is expensive and should probably be confined to weaker firms. In most cases, the ultimate judgment will have to be made at the corporation or ministry level-in consultation with the enterprise." (Jones, 1981)

*I. Mehdi (2016)*
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## Setting Up of Benchmarking and Performance Evaluation System in Pakistan

### *Background of Setting Up an Evaluation System*

In line with other developing economies, public corporate sector in Pakistan acquired an important position by the late 1970s. During the period between 1947 and late 1960s, it was considered a well-run sector. Its importance was acknowledged when public corporate sector was discussed as a separate sector of the economy in the Third Five Year Plan (1965-70) of Pakistan (Government of Pakistan, 1965). This was also acknowledged by the fact that each of the major sectors of the economy like industry, agriculture, finance and water, and power etc., was led by a major public corporation. A prominent head of the electricity corporation described that public corporations were widely used in Pakistan to the extent that during this period government was run as "Government by Corporations" (Gorvine, 1966).

The performance of the public corporate sector experienced a major downswing during the 1970s. The primary reason was sudden expansion of public sector due to nationalization in most of the sectors of economy such as Manufacturing, Finance, Medium and Small enterprises etc. This sudden expansion of the public sector was beyond the existing management capacity of the then government. Even in the post-1977 period when policy of nationalization and management of economy through control of "Commanding Heights" was discontinued public sector continued to expand. This was due to gradual completion of projects which were initiated in the earlier period. This resulted in continued performance deterioration and resultant losses and in turn increasing fiscal deficit. The government established number of committees and task forces headed by secretary and finance minister to examine the reasons of their adverse performance and make recommendations. However, implementation of their recommendations could not make a dent on PEs performance. The report which made a major impact on PE sector was prepared in 1981 by a consultant Prof. Leroy P. Jones of Boston University. His report entitled "The efficiency of manufacturing enterprises in Pakistan" examined issues confronted by Public Industrial Enterprise (PIES). It summarized that the PEs management system in Pakistan was antiquated and needed major reform efforts. The report focused only on the public manufacturing sector, its organization, and autonomy structure and recommended a comprehensive reform program (Jones, 1981).

### *Reforming of SOEs by Establishment of Signaling System for Public Enterprises*

During the period covered by Leroy Jones Report the public industrial sector in Pakistan was managed by the Ministry of Production. The ministry with the assistance of a highly skilled and professional body, i.e., Experts Advisory Cell (EAC) controlled more than 50 operating enterprises through eight holding corporations. This conglomerate comprised the whole of large public industrial sector, i.e., steel, engineering, automobile, chemical, textile, cement, etc.

The report reiterated that internationally, many of the problems of the public enterprise sector were traceable to inadequacies in the signaling system. This was because public enterprise goals were difficult to specify due to the problems of multiple objectives (commercial versus non-commercial) and plural principles (different control organs having different perceptions of what the goals should be). If goals could not be specified, then "good" performance could not be distinguished from "bad", managers could not be rewarded on the basis of performance, and inefficiencies could result.

It was also indicated that public enterprise was a hybrid, sharing characteristics of public and governmental institutions and private enterprise. Like government, some of its goals (non-commercial, for short) were difficult to quantify; like a private enterprise, some of its objectives (commercial, for short) were readily quantifiable. If "poor" commercial performance could readily explain away in terms of "non-commercial" objectives and if no effort was made to distinguish between legitimate reasons for poor commercial performance (e.g., government pricing policies) and illegitimate reasons (e.g., in-competence leading to high cost), then even the quantifiable objectives lost their power for guidance, motivation, evaluation and control. The enterprise then, in effect, became just like a government agency rather than a hybrid. The public enterprise manager played a game without a score (Mehdi, 2014).

Jones' report (1981) indicated that in Pakistan's public industrial Enterprises (PIEs) there was a poor autonomy structure which was over-controlled and there was little delegation of power. Restructuring the autonomy structure, therefore, was the pre-requisite for reform of PIES. In the proposed autonomy structure, the central office, i.e., Ministry of Production with the assistance of EAC, was expected to-operate like head office of a multi-national where barring strategic areas, as illustrated in earlier paras of this paper, remaining areas were to be delegated to subordinate units. However, if the autonomy was to be efficiently and permanently delegated to the enterprises, then accountability had to be insured by a signaling system which specified and rewarded socially desirable behavior. In the following paras the main features of Signaling System are summarized and an account of its operations in Pakistan is expounded (Mehdi, 1984).

### *Main Features of Signaling System Operations*

The main features of Signaling System operations (Mehdi, 1984, 1988) are the following:

- Selection of performance criteria,
- Selection of units by which performance is to be measured (e.g. % increase in profitability),
- Assignment of weights to reflect relative importance of chosen criteria,
- Negotiation and determination of targets to demonstrate strong and weak performance. For this a performance scale (A, B, C, D, and E targets) rather than one target is negotiated so that the unit can be categorized in any one of the five grades of performance,
- At the end of the year, based on the audited accounts, the achievement of the unit is compared with the original targets, and
- Following this appraisal, units are categorized in one of the five classes so that the predetermined bonus amount, linked with each grade, can be allocated to the chief executive officers who in turn distributed it among their managers.

### *Commencement of Preparations for Operations of the Signaling System*

Having developed the basic structure of performance evaluation, i.e., selection of performance criteria and criterion value, the EAC manager's first task was to prepare for commencement of operations of signaling system. The most important task in this regard was to prepare for target negotiations. In this pursuit EAC developed formats for collecting information on the budgetary proposals. The focus of these formats was to seek information to negotiate targets on the basis of real performance. Some of the important elements of the new budgetary formats were to collect following information:

- Break-up in volume and prices all the values e.g. sales and cost of sales, etc.,
- Details of gross margins of individual sales items, and
- Information on price trends of individual items of sales.

Seeking such information from large number of enterprises, where some of them did not possess adequate skill of accounting and more specifically cost accounting, was a challenging task. It took more than a year for EAC to develop now budgetary formats. Subsequently, the formats were communicated to PE managers; who were also briefed/ trained by EAC technicians how to fill them.

### *Development of Protocol for Negotiating Target*

EAC technicians developed a well thought out protocol to negotiate targets. It was an important exercise to attain the objective that the target shall be negotiated by EAC with the management of enterprises and they will not be imposed on them. To attain this objective EAC thoroughly examined each and every budgetary proposal so that they are able to raise appropriate questions and come to an agreement purely on basis of technical and professional considerations. EAC conducted negotiations at the level of Chief Executive and his team. The negotiations always culminated in a standard, well thought out and readable agreement. The standard format of the agreement is provided in the Appendix. The target negotiations exercise was developed and systematized over a period of time and in a gradual manner. The target negations were conducted within following protocol:

### *Protocol Adopted by EAC for Negotiating Targets*

The target setting should be carried out in a participative process. Without a participative approach, targets tend to take the form of formal directives which are often overtly accepted and covertly resisted. Keeping this in view EAC finalized targets in consultation with the Chief Executive, respective Holding Corporation, and with the approval of the Ministry.

Targets were explicit and clear-cut so that the performance aims were not hidden behind the vague objectives. Moreover, targets were neither too low nor too high to avoid emanating wrong signals to the managers. It was important to keep in view the general economic environment of the organization that the unit management was expected to experience during the coming year. It was also ensured that targets were large enough to generate surplus which was significantly more than the amount required for distribution by way of incentive bonus.

It was acknowledged that public enterprise managers are entrusted with various social tasks. While negotiating targets it was to be ensured that social costs should not be a source of alibi for poor performance. EAC therefore, attempted to verify if a certain cost is a genuine social cost and then adjusts targets to accommodate it.

Following the completion of the preparatory task, the process of target negotiations was initiated. The target setting was conducted on the principles described below.

### *Principles of Target Settings*

- What were the original objectives, designed capacity, and expected profit of the enterprise?
- What has been the performance of the enterprise in the past year?

- What is the achievement level of similar undertaking in the private sector?
- What are the standards achieved by similar undertaking in other selected developing and developed countries?
- What are the various financial and physical constraints expected to be experienced by an enterprise during the year?
- What is the macro-economic environment which is going to influence the demand and supply position of the inputs and outputs of the enterprises?

After commencing the target negotiating exercise with a canonic approach, EAC gradually improved the process of target setting by employing more innovative tools and methods including various new techniques of benchmarking.

## Modifications and Improvisation in Setting Target and Evaluation

Having experienced relatively efficient target setting and evaluation thereon, the managers of EAC reviewed the potency and impact of target setting and identified areas where improvements could be made. In fact, one of the major features of the operations of signaling system was that its managers remained open to suggestions and were more than willing to modify and change as when considered needed.

After the first four years of performance Evaluation and target setting experience the systems performance was reviewed both, internally by the EAC managers as well as experts such as Mary Shirley (1989) John Nellis (1989) of the World Bank. The external professionals carried out an in-depth evaluation of individual aspects of the system well as its overall effectiveness. While, evaluating the process of target negotiation following observation and recommendations were made:

> "One way to improve in depth knowledge of the companies might be to bring in outside experts from the academic or business communities, as is done in Korea. Or the EAC might rely more on the technical expertise in the corporations. There are some problems with these approaches: it could be harder and slower to reach agreement with a lot of outsiders involved, while the corporations have a vested interest in their enterprises earning a good score. Also the EAC has acquired skills in preparing and negotiating targets that would be lost if there were separate professionals involved. Nevertheless, the EAC could use some specialist knowledge, perhaps provided by a team of advisors brought in on a short-term basis at EAC discretion. Consideration should be given to expanding the EAC budget for this purpose. Also, the EAC should develop international benchmarking for comparison." (Shirley, 1989)

### *Reforms in Target Setting*

In order to make the system more effective and bring increasing optimality in the negotiation of targets and their evaluation some major steps were taken. They were as follows:

#### *Benchmarking*

To bring in greater optimality in the target negotiation EAC formulated the concept of benchmarking–both national and international benchmarking.

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### *Strategic Planning*

Originally the signaling system, aimed at improving performance of PEs in static situations. It focused on their operations in short term i.e., one year. To address the issues related to period beyond one year the scope of signaling system was enlarged by supplementing it with strategic planning. Thus, the fortified signaling system focused on improving performance of PEs both in short as well as long term.

### *Diagnostic Report*

It was noted that budgetary proposals were prepared with certain assumptions. During the course of the year unforeseen developments, such as changes in prices, took place. Consequently, compared to the originally conceived results there were frequently different outcomes because of unexpected circumstances. These changes frequently were outside the control of managers. Therefore, a concept of diagnosis of performance trends was introduced. At the end of the year, based on the audited reports of the PEs, an in-depth evaluation was carried out by EAC. The objective was to identify what was the real contribution of managers and what was the effect of non-controllable factors. An annual diagnostic report therefore was prepared which helped in grading the managers according to their real performance.

A brief account of the three improvisations of the signaling system is described below.

## ***Benchmarking***

The process of target negotiations commenced at EAC with somewhat rudimentary facilities, information and know-how. The benchmarking tools were employed from the beginning but owing to inadequate facilities the data base of performance of similar enterprises was not collected systematically. Based on the recommendations emerged from internal reviews as well as from those emanated from on outside sources, such as Mary Shirley's paper (1989), a systematic application of benchmarking was introduced gradually. A group of researchers was constituted to develop this information base in a more systematic manner. An account of various concepts of benchmarking, tools, and methods employed by EAC in setting up the targets is given as follows.

### *Concept of Benchmarking Employed by EAC*

Traditionally, performance measures have been comparison of the same organization at different times in the earlier period. It gave good indication of the improvement rate, or otherwise. It could demonstrate that, although the organization was improving, the competition was improving faster. In a changed environment, various models of benchmarking were developed in the public enterprise sector to determine how well a business unit, division, organization or corporation was performing compared with other similar organization (Mehdi, 1997; Jorion, 2007; Dahlberg & Isakson, 1996).

### *Advantage of Benchmarking*

Benchmarking emerged as a powerful management tool because it overcome the assumption that can be summed up as the following mode of thinking "the way we do it is the best because this is the way we have always done it".

Benchmarking opened organizations to new methods, ideas and tools to improve their effectiveness. It helped crack through resistance to change by demonstrating other methods of solving problems than the one currently employed and to demonstrate that they work, because they have been used by others.

### *Experience Curve*

The experience curve was developed by the Boston Consulting Group in 1966. It is based on the hypothesis that total per unit costs decline systematically by as much as 15–25% every time the cumulative production (i.e., "experience") doubles. It has been empirically confirmed by some firms at various points in their history. Costs declined due to a variety of factors, such as the learning curve, substitution of labor for capital (automation), and technological sophistication. Following were the basis of such assumption:

- A company can always improve its cost structure,
- Competitors have varying cost positions based on their experience, and
- Firms could achieve lower costs through higher market share, attaining a competitive advantage.

Some of the generally accepted tools and concepts employed by EAC to improve targets are described below.

#### *Best Practice*

The best practice was a method or technique that had consistently shown results superior to those achieved with other means, and that was used as a benchmark. In addition, a "best" practice could evolve to become better as improvements were discovered. Best practice was considered by some as a business buzzword, used to describe the process of developing and following a standard way of doing things that multiple organizations could use.

Best practices were used to maintain quality as an alternative to mandatory legislated standards and could be based on self-assessment or benchmarking. Best practice was a feature of accredited management standards such as ISO 9000 and ISO 14001.

#### *Internal Benchmarking*

Internal benchmarking was used when a company already had established and proven the best practices and they are simply shared. Internal benchmarking also may be necessary if comparable industry was not available.

#### *Competitive Benchmarking*

Competitive benchmarking was used when a company evaluated its position within its industry. In addition, competitive benchmarking was used when a company needed to identify industry leadership performance targets.

#### *Strategic Benchmarking*

Strategic benchmarking was used when identifying and analyzing world-class performance. This form of benchmarking was used when a company needed to go outside of its own industry

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ICPE

*Standards Benchmarking*

Standard, or a set of standards, was used as a point of reference for setting targets for evaluating performance: Benchmarking was drawn from a firms own experience, from the experience of other firms in the industry, or from government policy requirements. For instance, in the public industrial enterprise sector in Pakistan following a government decision each PE was expected to accrue 1% of total sales on research and development. In the absence of the competitive pressures for research in the private sector it provided significant incentive to PEs to focus in this area.

Above is a short and quick account of benchmarking which were employed in EAC's performing evaluation system in the subsequent phase of target setting exercise. This chronicle has shown only those concepts and tools of benchmarking which were employed in the performance evaluation system for reforming and improving the effectiveness of setting up targets of public enterprises in Pakistan. It also indicated that once the process of systematic benchmarking was introduced Quality of target negotiation improved significantly.

## *Strategic/Corporate Planning*

The technicians of EAC in the periodic review of performance evaluation system identified number of tools and ways and means to improve target setting. In this pursuit, they identified a system of corporate planning based on the model developed by a world–renowned consulting firm. This system focused on achievement of objectives of individual enterprises both in short, medium, and long term. This was a major shift from the original signaling system which had focused only on the performance in static situation, i.e., in one-year period. In the new strategic planning system, the managers' vision was enlarged. They were made to prepare themselves to compete in medium and long term both locally and globally by way of restructuring at all levels, i.e., organization, finance, plant and machinery, and HR, etc.

Until recently the focus of attention in target setting of the signaling system was on improving performance in short period. While this indeed helped in motivating managers to improve performance during the period, this effort frequently was at the expense of the long term interest of enterprises. This can be seen in following two cases:

1. Managers some time overlooked the repair and maintenance schedule to achieve the annual target.
2. The managers' focus was on performance during their tenure of service which was often for three years' period. Therefore, frequently, they did not pay attention to actions such as research and development etc., which were to produce results in period of time beyond their tenure.

In order to broaden the horizon of interest of managers, they were motivated not only to continue focusing on real performance in short period but also to keep into consideration the long term interest and requirements of the enterprise. They were encouraged to develop strategic plans to aim at long term objectives of enterprises.

## *Strategic Planning Model of EAC*

The strategic planning model adopted by EAC was initially acquired from Arthur D. Little International, Inc. (1987) consulting firm. This model was then modified to suit Pakistani's management environment. The strategic plan model adopted by EAC was based on two categories of assessments: Industry maturity and competitive position.

The combination of two assessments indicated the strategic condition of an enterprise. A strategic plan was evolved on the basis of this finding.

In the analysis of competitive intensity, future possible profitability of the industry was indicated. It analyzed the competitions in the industry and identified steps required to retain its market share and future trends of the competition. It was also supplemented by corporate strategy which involved answering a key question from a portfolio perspective: "What business should we be in?" Business strategy involved answering the question: "How shall we compete in this business? These questions/issues were addressed by strategic plan which was prepared on the basis of Strategic Business Unit (SBU) which was a completely independent unit based on competitive and market characteristics rather than legal and organizational consideration. A separate plan of SBU is prepared by the combination of two critical elements of planning in EAC model: i.e. Competitive position of SBU and maturity of related industry. Following is an account of the planning in EAC model.

### *Assessment of Maturity*

Once the SBU and its principal segments are defined, management assesses the maturity of relevant industry and its growth potentials and the stability and predictability of its operations and financial performance. We distinguish between four stages of maturity: embryonic, growth, mature, and aging. Knowledge of maturity is important for success in an industry. For instance, in growth industries, marketing is often the key success factor; in mature industries, production economics are often the key.

Knowing the maturity of the industry should help to focus on analyzing the strengths and weaknesses of an SBU and its competitors. Maturity also has an impact on the appropriate style and system of management. For instance, embryonic industries require a more flexible attitude to risk and a less "systematic" approach than aging ones. Maturity also has a direct relationship with risk, in that less mature industries are often less predictable and therefore entail greater risk. The maturity of the industry and its segments becomes one factor in assessing strategic condition

### *Assessment of Competitive Position*

An analysis of competitive position considers the relative effectiveness of the SBU and its competitors in the market places in which they compete. The current market share of each SBU is considered, along with its rating against the criteria which must be met if the unit is to gain competitive advantage. These criteria (success factors) are derived from a consideration of the basis of competition in the relevant industry. Analysis of a competitive position therefore helps to identify businesses which, say, enjoy a high market share but which are currently poorly situated to maintain that position, and those which were set to gain a higher market share in future, as they score well against the key success factors, despite possibly having a low current market share.

### *Competitive Intensity*

By analyzing the competitive intensity of a business unit, management can shed light on the likely direction and future profitability of that industry and on the freedom of participants to select successful strategies. The internal rivalry between participants in the industry is studied, so as to determine competitors' possible reactions to strategies. Other key aspects also affect, and can dictate, strategies and profitability potential–such as the threat of new entrants, the threat of substitute products and the bargaining power of suppliers and customers.

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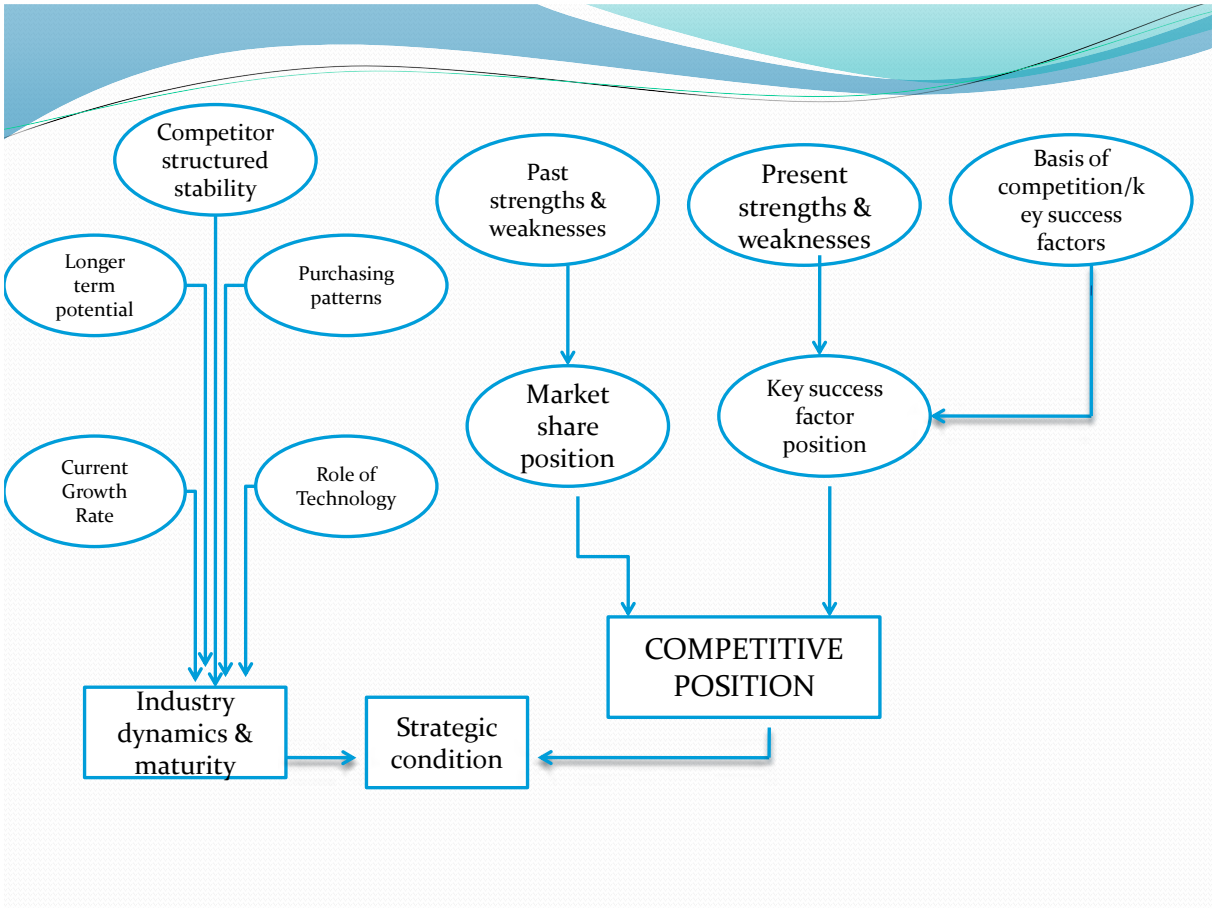
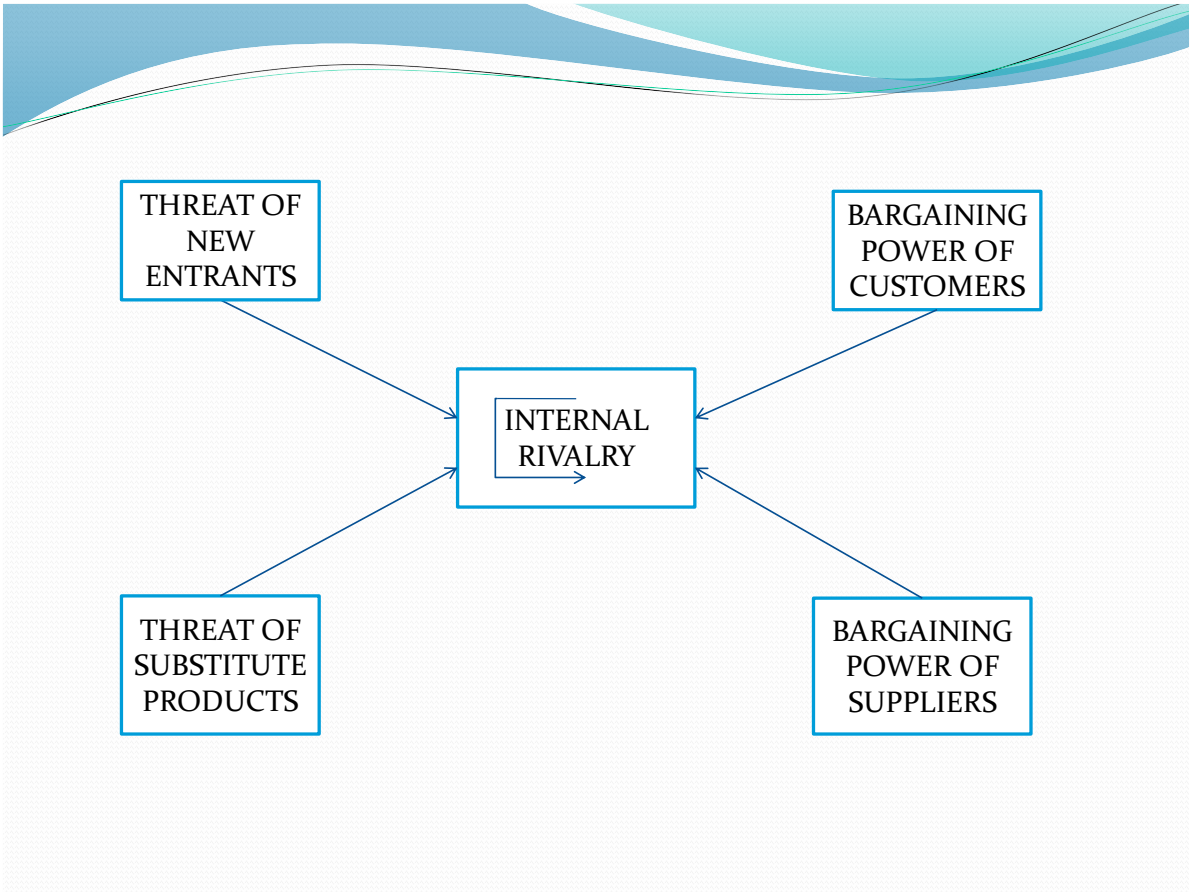



*Note.* Source: Arthur D. Little International, Inc.

*Figure 1*. Planning system for an individual strategic business unit.




*Note.* Source: Arthur D. Little International, Inc.

*Figure 2.* Competitive industry.

### *Key Factors in the Assessment of Competitive Intensity*

Assessing the intensity of competition is important in SBU planning. It affects the SBU's room for maneuverability in current activities, its profitability beyond the short term and influences the way it competes in its segment. It also indicates the extent to which competitors are likely to react to strategies.

There are five elements that determine how intense the competition in the industry is or could be. The effect of these elements is to be judged by considering the following questions:

- Internal rivalry: How would your competitors react to a major initiative by you, e.g. to increase sales volume by cutting prices?
- Threat of new entrants: How easy is it for a company to enter your industry and take some of your market share? What barriers to entry (economies of scale, product differentiation, capital requirements, etc.,) exist?

- Bargaining power of customers: How easily can your customer go elsewhere if you cannot provide the products and services he desires? How important is the industry's products to its customers? Are customers price-sensitive?
- Bargaining power of suppliers: How you have a supplier (or group of suppliers) on whom you are dependent, with little alternative? How important to the suppliers is the industry as a buyer? Is there a cost incurred in switching suppliers?
- Threat of substitute products: To what extent can your product be replaced by another product or another way of doing things and is it likely to happen?

### *Analyzing the Competitive Position*

Analyzing the competitive position gives an indication of future market share and profitability in a market environment. Determining competitive position, along with the competitive intensity of the business, is essential for understanding the freedom of strategic movement of each competitor within the industry.

Market share alone is insufficient as a measure of competitive position because:

- Although market share was clearly a key determinant of competitive position, its importance varied with industry maturity, and
- Market share today reflects past strengths, weaknesses and strategies; similarly, future market share will be influenced by today's strengths, weaknesses and strategies.

An SBU's present competitive position and, therefore, the outlook for its future market share and profitability is determined by two main factors:

- Its present market share, which is itself a result of past strengths and weaknesses, and
- The rating of the SBU against the key success factors.

### *Assessment of Strategic Condition and Selection of Strategies*

By combining findings from the analysis of industry maturity and competitive position, we could assess strategic condition. This indicates the degree of strategic freedom which an SBU could enjoy. For instance, a strong competitor in a growth industry has wider range of strategic options open to him than a weak competitor in an aging industry. Understanding present strategic condition could ensure that the functional strategies selected for the future are individually and collectively consistent. The combined effect of the selected functional strategies gives out the strategic thrust. The thrust should be consistent with the strategic condition and also compatible with the mission of the business. The mission is expressed in a short overall statement of the fundamental purpose of the business and its role in the industry. Each of the functional strategies is directed toward a clearly stated strategic target. Indeed, each of the strategy is implemented by a well thought-out action plan.

The introduction of strategic planning clearly introduced a new dimension to signaling system operations. The major impact was indeed, on the target setting process. The manager of PEs focus was enlarged to incorporate the long and medium term objectives of the enterprise. The targets set for the medium and long term are achievable on basis of efficient implementation of plan and actions which are worked out for the current period. The implementation of the

identified action plans has become part of the target negations process. For instance, to achieve a profit by new investment in x years, certain actions have to be taken in year1 which is the current year. This can become part of agreed targets for the current year.

### *Diagnostic Report*

After negotiating targets for the year, EAC monitored performance during the course of the year. At the end of the year as a first step of evaluating performance, PE accomplishment of the year was placed against the pre-determined target scale. Based on this evaluation, the company was placed in one of the five categories: A, B, C, D, E. Each category was also linked with the following specific incentive rewards:

- Qualified the enterprise three-month bonus,
- Two months,
- One month,
- 15 days, and
- Nothing.

However, EAC improvised evaluation process by initiating the preparation of a diagnostic report, (EAC). The report basically aimed at in-depth evaluation of enterprise performance. The performance was broken up initially on two considerations: based on identification of controllable and uncontrollable factors. It distinguished the real performance of managers against the one achieved as a result of wind fall or other uncontrollable reason. For instance, during the year the prices may have been changed following the government policies or there may have been the problem of unforeseen load- shedding of electricity. These unforeseen and unbudgeted factors are taken into consideration for arriving at the real performance of managers and grade them accordingly.

## Performance Evaluation of Signaling System

It is critical to assess what has been the impact of target based performance evaluation system operations on the performance of PEs which were managed under its purview.

The signaling system was applied on most of the public enterprises under the Ministry of Production. The system was based on following key assumptions:

- Manger can be given a clear perception of their objectives,
- PEs performance in Pakistan can be improved,
- Managers can control enterprise performance,
- PE managers will respond to incentives (monetary and non-monetary),
- Managers can be given ready access to information and other resources necessary to improve PE performance, and
- Performance can be measured objectively and fairly, hence its evaluation will send the right “signals” to managers.

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*Performance Trend as per Current Prices Profits*

As per approved performance evaluation system, Performance grades and incentives were awarded principally on the basis of private profits after taxes in current prices. On the basis of that indicator Industrial Public Enterprises (IPEs) performance generally improved. Thirty-three IPEs were in the system for its entire three years of operation, of which 19(or about 58percent) improved their private profits after tax, from 100 million Rupees in 1982/83 to 617 million in 1985-86. Thus, the majority of these PEs showed an improvement as per the main indicator employed in the targeting system. After three years the total profits of the 33 PEs in the system were almost twice what it had been before the system began (Table 1).

Table 1
*Performance of PEs under Signaling System for Three Years: Profits (millions of Rupees)*

| | 1982/1983 | 1983/1984 | 1984/1985 | 1985/1986 |
|---|---|---|---|---|
| 33 IPEs in system for Three year. | 344.14 | 467.10 | 937.81 | 684.00 |
| 19 IPEs with profit improvements | -100.75 | 221.08 | 717.45 | 616.74 |
| 14 IPEs with profit deteriorating | 444.89 | 246.08 | 220.36 | 67.30 |

*Note*. Based on data retrieved from the Expert Advisory Cell's "Annual Reports on Performance of Public Industrial Enterprises," various years.

## Trends of Attainments of Grades

Similar trend of performance improvement is observed in the distribution and trend of grades achievement. It is reflected in the table I which shows that higher grades were awarded in 1984-1985, 1985-1986, and 1986-1987 compared to the first year, i.e., 1983-1984.

Table 2
*Performance of IPEs in Terms of Grade Achievement*

| | 1983-1984 | | 1984-1985 | | 1985-1986 | | 1986-1987 | |
|---|---|---|---|---|---|---|---|---|
| | No. of units | In % | No. of units | In % | No. of units | In % | No. of units | In % |
| A | 7 | 17 | 13 | 23 | 16 | 35 | 13 | 31 |
| B | 7 | 17 | 9 | 16 | 9 | 19 | 6 | 14 |
| C | 6 | 15 | 5 | 9 | 4 | 9 | 4 | 10 |
| D | 5 | 12 | 2 | 4 | - | - | 2 | 5 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| E | 16 | 39 | 27 | 48 | 17 | 37 | 17 | 40 |
| Total | 41 | | 56 | | 46 | | 42 | |

*Note*. Based on data retrieved from the Expert Advisory Cell's "Annual Reports on Performance of Public Industrial Enterprises" various years.

### *Assessment of Other Possible Influences on Performance of Pes*

While there appears to be direct positive impact on the performance of PEs, an attempt was made to assess if other factor were also solely or partially responsible for the changes. Following were some of the probable influencing factors:

- Change in prices,
- Changes in the macroeconomics environment,
- Changes in markets,
- Changes in PEs liquidity positions, and
- Changes in management due to changes in the supervisory environment of the PEs and /or the signaling system.

Other possible explanations which were rejected because they do not fit with the circumstances are:

- A drop or rise in labor unrest (no significant change occurred),
- Improvement or deterioration in the supply of inputs or services such as electricity, water, transport (PEs experiencing problems saw little change), and
- Technology change (there were no significant change in the technology used in the sample enterprises during this period).
- A change in liquidity was another explanation that was considered and rejected. Levels of liquidity were low in most of the sample firms and showed little change during 1983-1984 or 1984-1985.

Some of the critical factors mentioned above are analyzed as follows:

#### *Changes in Market*

Competition could explain an improvement in profit and efficiency if the PEs react to competitive pressures by working harder to cut costs, expand production, improve quality, etc. In contrast, if the PEs cannot or will not respond, the result will be deterioration in performance. Competition increased in Pakistan during the period under review, thanks to trade liberalization, easier private entry into previously public activities, and the earmarking for credit for the private sector. Competition has had a favorable impact on some public firms which were striving hard to improve efficiency and retained their market. However, competitive pressure did not seem to be the main explanation for the efficiency improvements in the firm covered by the signaling system. Some of these firms, such as HMC and PECO two engineering enterprises, have faced competition since before the period under examination. Others, such as the fertilizer plants and the refinery, faced no change in competition but, nonetheless, showed efficiency gains. In most cases where PEs have faced an increase in competition the result during the short period under examination has been deterioration in performance.

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*Public Enterprise*
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*Changes in Management*

In several of the sample companies, the improvement in performance seems to be explained in large part by management changes. This is especially true for the four companies which show efficiency gains above their past trends. Probably much of the improvement in the performance of Sind Alkalis could be attributed to a change in the management team at the start of the period. In other cases, the same managers strove harder to curb costs and expand output. For example, Sind Alkalis increased its soda ash capacity utilization from 38 to 90 percent; thus, the argument that the efficiency improvements were partly due to the system cannot be ruled out since none of the other explanations fully explain the efficiency improvement.

## *Issues Faced in the Operation of Performance Evaluation System*

The operation of performance evaluation system has highlighted the complexities involved in the systematic assessment of public enterprise management performance. Some of the critical issues faced by EAC in operating the performance evaluation system were as follows (Jones & Mehdi, 1985):

- Pricing Policy: Public sector enterprises sold their products in two pricing regimes, i.e., prices controlled by government and prices determined by the market. In 1983–84, the first year of operation of the system, more than 65% of the total sales of the public sector industries were directly or indirectly controlled by the government pricing policy. PEs were selling their products at government fixed prices faced the problem of accommodating the government instructions of setting up targets of private profitability and at the same time ensuring motivation for improving performance. In such cases where prices were fixed and supply was constrained, profit targets were supplemented by assigning some weights to capacity utilization and conservation of costs by using selected physical consumption ratios.

- Profit after tax as a primary criterion also presented a problem in forecasting the tax at the beginning of the year since it varied with various levels of profits. EAC established targets on the basis of assumed tax rates and evaluated performance against that basis.

- Non-operating income (selling of scrap and income from financial investment, etc.) frequently was a major source of profit. Assessment of whether this income was owing to the efforts of the management or by a management policy decision created numerous debates at the time of evaluation.

- Additional costs on account of social obligation such as construction of a road for the benefit of the local population, etc., called for strict assessment of the cost and its validity. This was adjusted to profit before the evaluation of the performance.

- The problem was also experienced due to costs and incomes attributed to the previous years. EAC's target clearly stated that targets relate to the performance attributable to the year under review only. Evaluation exercises, therefore, remained indifferent to previous period.

- The emphasis on maximization of profit also led to a problem of management making efforts to attain the targets for the year by ignoring the long term interest for the year by ignoring the long term interest of the

enterprises specially maintenance program etc. In view of the importance of these elements EAC made the targets conditional to the maintenance schedule provided for in the units' budgets.

- The setting up of targets on the basis of profitability (profit/assets) led the PE management's towards extremely profit orientation. It was noted that managers aimed only at the elements which influenced immediate profit and ignored critical areas like asset management which may affect their performance in the subsequent period. Consequently, after the EAC's first year's evaluation of results on the basis of profitability number of chief executives (some of whom were senior accountants and financial experts) were surprised to see that they may have performed well in terms of profit but owing to their inadequate asset management, i.e., increase in current assets such as receivable etc., their profitability target could not be attained.

- In arriving at optimal targets for the units' information regarding production capacity was necessary. However, finding the capacity of some units presented an issue since an accurate information regarding this was not available due to:
    - Age of the units: in course of time either the unit deteriorated the original capacity; or it was increased owing to new investments.
    - There was a tendency to indicate low capacity due to past capacity taxation policy. EAC had to carry out special exercise just to determine capacities of certain units.

- In order to ensure that credit is given to all efforts made by managers, evaluation of performance was carried out at two stages. In the first instance actual achievement of the unit was placed against originally negotiated target. Secondly, in consultation with concerned holding corporations the uncontrollable and unforeseen elements of units' managements were identified and the original assessment was adjusted accordingly. For instance, in case of a fertilizer unit the government had decided to stop supply of natural gas for three months because of shortage of energy in the country. Thus the targets of the unit were adjusted for an operation of nine months before final grading of performance. Subsequently, such issues were addressed in the diagnostic report.

- Some of the firms were also constrained in their choice of markets, products and suppliers. Not surprisingly, import substituting enterprises like oil refineries it must satisfy domestic demand before exporting.

- Government imposed social welfare objectives placed another burden on the PEs. It sometime reduced management's flexibility to cut costs. For example, one company was required to train five people for every one person they intended to hire. Plants located in remote areas at government behest had to provide education, housing, health services and transportation to employees as well as bear added transport costs. Again such issues were addressed in diagnostic report.

- Finally, management was constrained by the inherited capital stock. Management could still improve operating efficiency within that constraint, but the task could be considerably harder when the plant was grossly under or oversized or the equipment was antiquated and worn out. Subsequently, strategic plans addressed number of such issues.

*I. Mehdi (2016)*
*Public Enterprise*
Volume 22, Issue 1, pp. 92-117, 2016
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### *Managers Attitude towards the System*

A preliminary survey of the managers' attitude toward the signaling system indicated that it had at least been able to draw their attention towards operational efficiency. The CEOs of PEs were conscious, to say the least, of year-end evaluation and grading which made them accountable for their performance. Indeed, the reaction of PEs managers ranged from a positive support to skepticism to strong opposition towards the system. The reaction of managers towards this system divided them into two classes:

- Managers who were favorably inclined towards this system, and
- Managers who were skeptical towards this system.

### *Managers Reacting Positively*

The reasons for some managers supporting the system were as follows:

Managers whose units have been generating profit for a number of years had grievances that there was no method and system for acknowledging their achievements. The issue had become important since workers' bonus was to a large extent determined by the profit-earning performance of the unit and they were getting away with as much as ten bonuses. As a consequence, often managers at the junior level were getting less financial emoluments than some workers. Incentive system provided a method of rewarding bonus to the officers in profit earning units.

Managers of some units especially those where prices were fixed found a way of demonstrating their good performance. For instance, in case of a petroleum unit, in the past their managers had argued that their unit was working at a high level of efficiency. However, the conventional performance indicators, such as profit, could not demonstrate this irrespective of its performance. EAC in its efforts to motivate management to improve productivity evolved a set of criteria of evaluation which along with targets to maximize profitability (by reducing assets, i.e. inventory and receivables, etc.) assigned weights to productivity through partial indicators such as capital production etc. which showed their real performance and achievements.
Generally, it was experienced that the managers of process industries were more enthusiastic towards the system than those in the batch industries. One of the reasons of this was that most of the process industries were selling in a supply constrained situation where they aimed at maximization of production. As against this, batch industries were operating in a competitive environment where the performance was largely determined by the market. Since marketing was one of the weakest areas of the public sector managers, the managers of these units generally felt uneasy and uncertain while negotiating target for sales. However, among those units those with a profit making record found the evaluation system helpful to them.

The reaction toward the system was also very largely dependent on the personality of the managers. Managers, who had the drive, ambition, and endeavor, should their enthusiasm towards the system; indeed, these managers were also the most difficult ones to negotiate targets with.

### *Skeptical Managers*

The managers who were consistently in the E grade were skeptical. However, none of them ever disagreed with results.

## Conclusions

By and large various professional reports were positive towards the signaling system (Mary Shirley 1989, Jones & Mehdi 1985). One of the major arguments were that for the first time there was a system which acknowledged managers' efforts. Perhaps the best conclusion about effectiveness of the signaling system in Pakistan is reflected in the concluding remarks of a World Banks report which recommended its application to other countries (Mary Shirley, 1989).

> "The Pakistan signaling system, for all the flaws discussed here, represents a major advance in holding managers accountable for performance. In many developing countries, there is no attempt to develop targets, and no meaningful reporting on PE results; good managers went unrewarded and bad managers unsanctioned. As a result, the interest in the Pakistan signaling system is very strong and a number of countries are considering introducing something similar, including the Philippines, Egypt, and Venezuela. Korea already has a similar system in place. This assessment of the experience in Pakistan provides a number of lessons for such countries about the potential costs and benefits and how to adapt the system to different circumstances".

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## Biographical Note

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# Appendix

**Experts Advisory Cell**
**Performance Evaluation System**
**1993-94**

Name of the Unit: _____

After discussion the following targets are mutually agreed for the year 1993-94

Table 1

| | Wts | A | B | C | D | E |
|---|---|---|---|---|---|---|
| 1. Profitability | | | | | | |
| 2. Physical Production | | | | | | |
| 3. Sales Volume | | | | | | |
| 4. Unit Cost of Production | | | | | | |

It is agreed that pre-tax profit (Loss)* shall not be less than (more than) Rs. _____million. In addition, any increase in the targets for following costs ration shall proportionately affect the final grades:

| | | | | |
|---|---|---|---|---|
| I. | Raw Material Consumption | Unit of Measurement | Physical | Financial |
| | i. | | | |
| | ii | | | |
| | iii | | | |
| | iv | | | |
| | v | | | |
| II. | Energy Consumption | | | |
| | i. | | | |
| | ii | | | |
| | iii | | | |

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III. Labour Cost
IV. Financial Expenses

CHIEF EXECUTIVE (I. MEHDI)
GENERAL MANAGER
(Economic Appraisal)
Expert Advisory Cell

Islamabad, dated _____

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Profitability * profit before on x 100. Profit before tax reflecting actual performance of the
Total bonus
year under review only. Unit shall be entitled for performance bonus in case of profit after tax only.

Note:

1. Target can be adjusted according to the impact of National Budget 1993-94. Revised budget if any, for monitoring shall be submitted by 31st July, 1993, Budget shall be revised keeping in view the basic parameters of the targets.
2. Targets can be reviewed by EAC after the unit's budget is approved by the Board, the Corporation and the Ministry of Production.
3. Above targets are subject to unit's strict adherence to safety measures and required maintenance schedule.

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# Technical Efficiency Analytics for the Public Banks in Argentina

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## Abstract

In a context in which the competitive landscape of the Argentinian banking industry continues to mature as a result of phenomena such as globalization, modification of regulations, new technologies, and mergers and acquisitions, the quest for higher revenues has never been more stringent. It becomes relevant, therefore, to perform systematic benchmarking through the measurement of the efficiency of the banks. The present research paper uses data envelopment analysis (DEA) to rank the Argentinian public banks based on their performance over 17 years, between 1998 and 2014. The results reveal that 1999 and 2002 were "black years" for the public banking sector, years during which the country registered political and economic and financial crises, respectively. Furthermore, the trend analysis shows that the Argentinian public banks are converging towards better consistency in their performance over the years. It is hoped that the present paper will provide the concerned authorities a ground to assess the health of the individual public banks.

*Keywords*: Argentinian banks, public banks, data envelopment analysis, progressive time-weighted mean

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## Introduction

After having experienced challenging economic and financial difficulties in the 1980s, which made the banking system to practically collapse, the 1990s brought structural reforms in Argentina, including financial system reforms, liberalization of trade and the capital account, and public sector reforms (Pou, 2000). In particular, the *Convertibility Law* of 1991 and the *Central Bank Charter* of 1992 have played a fundamental role in re-shaping the financial system, by means of eliminating the inflation and proclaiming the central bank's independence of the executive and legislative branches. The liberalization process has, furthermore, opened the local market to foreign banks, increasing the competition pressure, while imposing more regulatory and market discipline. It is also interesting to note that the mergers and acquisitions, as well as the closures following the *Tequila crisis* in 1995 led to the number of banks to decline from 167 (of which 35 were public and 132 were private) to 119 (of which 16 were public and 103 were private) between 1991 and 1999. Additionally, during the same time period, 16 small government-owned banks were privatized (Pou, 2000). Further details on a number of features of the Argentinian banking sector will be provided in the following section.

Although progress has been made in time to establish the basis for a healthy financial system in Argentina, there are a number of ongoing concerns. According to the 2015 Index of Economic Freedom (The Heritage Foundation, 2015), Argentina occupies the 169$^{th}$ place in the world rank, ranking 27$^{th}$ out of 29 countries in South and Central America/ Caribbean region, with its overall score remaining far below the regional and world averages. Furthermore, according to the same source, monetary stability is particularly weak, with government interference and price controls on almost all goods and services, making Argentina's country risk premium to remain high and variable. In this context, another problem is represented by the expansion of the informal economic activities, which further distort price levels, and consequently, the financial sector.

Judging by international standards, the financial sector is still small, nevertheless, it is expected to continue growing, fact that requires the concerned authorities to consider financial innovation on their working agenda as a means to strengthen the regulatory framework. The stability of the financial system is a priority. Moreover, "small and medium-sized companies are the main sources of employment and output, and more needs to be done to improve their access to the system's financial resources without impairing loan portfolio quality" (Pou, 2000).

In brief, several sectors of the Argentinian economy have experienced profound changes in the structural conditions in which they compete, due to the pressure of phenomena such as globalization, modification of regulations, and new technologies, among others. The current economic situation faces significant challenges to achieve growth and a better integration into the world arena. The competitive conditions under which businesses are conducted today have expanded the management and comptroller function to include a future strategic direction, with the need to make large and small decisions efficiently and effectively.

Although the international literature reports a large number of studies that have been carried out to measure the efficiency and productivity of the banking sector, the great majority has been conducted in developed countries, with little or no focus on emerging economies. For example, Barros, Managi, and Matousek (2012) studied the Japanese banks, Berger, Leusner, and Mingo (1997) the American banks, Paradi, Zhu, and Edelstein (2012) the Canadian banks, and Tsolas and Charles (2015) the Greek banks, just to name a few. As such, studies in this regard for the Argentinian banking sector are rather scant and lack a more systematic research approach.

In this context, the present research work seeks to contribute to the efficiency literature with evidence from Argentina, a still relatively little explored country with a banking system that has undergone major transformations. As Mishkin and Eakins (2014) advocated, the banking sector plays a vital role in the transfer of funds, which is

important in ensuring that both the financial systems and the economy run efficiently. Thus, the efficiency analysis can provide the concerned authorities and regulators a ground to assess the health of individual banks by means of identifying the areas of inefficiency, while also helping to formulate appropriate strategies to improve the banks' relative position on the market in an attempt to prevent systemic failures (Charles, Kumar, Zegarra, & Avolio, 2011; Lacasta, 1988).

## The Argentinian Banking Sector

In Argentina, the local practices are not far from those followed in other emerging countries: financial repression, controlled taxes, and credit directed to sectors prioritized by the political power. Ever since the mid-1970s, the banking sector has been registering several waves of liberalization; nevertheless, successive banking and macroeconomic crises have also been present. Argentina had a very high inflation rate for fifteen years starting in the mid-1970s (80-600%) and a hyperinflation rate in 1989 and 1990 (4,000% in the first case). After the second hyperinflation period in 1990, the system began to grow as bi-monetary, with the banks having both their assets and liabilities in US dollars.

Argentina's economy unfolded between 1991 and 2001 under the incentives provided by the regime known as the Convertibility Plan, which fixed the parity of the local currency against the US dollar. Nevertheless, midway through the period, there was a severe financial crisis caused by the Mexican devaluation in 1995 (*the Tequila crisis*), which involved the disappearance of many entities. Furthermore, the delays associated with the exchange rate, coupled with the diminished domestic purchasing power caused by the loss of jobs and wages, led to an exponential increase in the foreign debt after the year 1997.

At the end of this period, a new recession started to grow severely; the balance sheets of the banks deteriorated, the deposits dropped, and a process of capital flight was registered. For some economists, this was the longest recession in Argentina's history, which began in the mid-1998, at the end of Carlos Saul Menem's second term. The political climate and uncertainty regarding the presidential elections characterized this period until 24$^{th}$ October 1999, when Fernando de la Rua and Carlos Alvarez were proclaimed president and vice president of Argentina, respectively. Menem's Government left a high fiscal deficit of 7,350 million Argentinian pesos in 1999; therefore, president De La Rua took harsh measures in order to improve the finances sector; nevertheless, always considering as the very foundation of his economic program the strict maintenance of the discipline of fixed exchange rates pegged against the US dollar. This, in turn, had a negative impact on the domestic industry and especially on the export sector.

The tax increase decreed on the middle and upper classes in January 2000 was part of an overall package that sought to improve the public finances, and subsequently, the entire economy. Nevertheless, this adjustment stopped what some specialists affirmed was an incipient reactivation in the first months of the new Government, with an economic growth in the first quarter of the year. The burden of the external debt 'drowned' the Government and increased the fiscal deficit. Banks were closely linked with the national government finances, and the doubt that the state entered into receivership fed the possibility of a bank run.

The crisis reached its peak by the end of 2001, when large investors began withdrawing their monetary deposits from the banks, leading to a massive capital flight, which made the banking system to collapse. In order to protect their liquidity, banks virtually ceased to grant new loans to the private sector. In response to these incidents, a new economic policy was announced. This introduced temporary restrictions to the withdrawal of bank deposits (cash from fixed term deposits, current accounts, and savings account) – which was popularly known as "Corralito" – and the pesoization of assets and liabilities in US dollars from financial institutions. These measures deepened the economic crisis that then led to a political crisis. This caused a crisis of confidence that could not be attenuated by

the Government, which had to declare default, as it did not have dollars or pesos to cope with the massive withdrawal of deposits. The shareholders, also, could not capitalize entities, as many of them belonged to the Government, while others suffered an asymmetric pesoization which complicated the balance sheet. On 23rd December 2001, the sovereign debt was placed into receivership, the arrears involving sovereign bonds for US$ 102,000 million, which became the largest debt in the modern world history (Magliano et al., 2009).

Finally, in January 2002, the convertibility scheme was abandoned and then the US dollar began to fluctuate, with an initial exchange rate of US$1 = $1.4 for deposits, a rate that rose considerably in the subsequent months. The *Public Emergency and Exchange System Reform* law enacted on 6th January 2002 legally determined the abandonment of convertibility. This law, together with the sharp devaluation of the Argentinian peso, marked the beginning of the promulgation of many decrees and laws – approved by the National Executive and regulated by the Central Bank – that impacted directly and indirectly on the development of the banking system.

Some of the consequences of the crisis can be described through macroeconomic variables. The Gross Domestic Product (GDP) at 1993 prices experienced a fall of 10.89% on an average between 2001 and 2002, the GDP per capita declined by a similar percentage, and the deposits and loans (as a proportion of the GDP) suffered a decline of 0.75% and 2.83%, respectively (Gonzalez Padilla, 2009).

In the early 2003, the financial sector began to recover along with the total deposits, while the total loans began to grow at constant prices only as of the next year. The economic recovery occurred regardless of the use of bank financing. The virtual disappearance of bank loans was partly due to the increase of the companies' self-financing capacity through the increased sales revenue and decreased costs. Additionally, it was also due to the fact that, initially, the banks drastically cut down on the new credits and privileged the improvement of their liquidity under conditions of high uncertainty. Although bank closures were scarce in relation to the magnitude of the crisis (Magliano et al., 2005), it is important to note that between December 2001 and December 2002, seven banks were forced to close, and in August 2010, this number had increased to 19 financial institutions, including 14 banks, which represented about 15% of the qualified entities.

After the most critical moments of the crisis, the liquidity of the banks recovered significantly and the public and cooperative banks led the supply of credit to businesses. Since 2005, the financing terms had been gradually extending the offer and began to include up to five-year loans for the purchase of machinery and equipment. Also, by the end of 2000, machinery and equipment leasing operations became significant thanks to the tax benefits.

The recovery from the crisis brought important changes in the system structure: some foreign banks – although not the large ones – gradually and voluntarily left the market since they were absorbed by the domestic banks, particularly the awardees of the privatization of official provincial banks after the *Tequila crisis* in 1995. In addition, the post-crisis period is characterized by a greater nationalization of banks and short-term loans and operations in Argentinian pesos. Almost all the deposits were made within one year.

In short, since the 2001 crisis and the end of the convertibility regime, "many developments have affected the financial markets where banks operate: deregulation, liberalization, globalization, and several financial and technological innovations", along with important changes in monetary and exchange rate policies from 2002, as well as the official discourse on the economic policy (Cibils & Allami, 2008).

All of these events influenced the competitive conditions faced by the banks, i.e., the market power, the profitability and efficiency, and the stability of the financial system, which justifies a more detailed study in this regard.

The objective of the present research study is fivefold. We employ the Data Envelopment Analysis (DEA) technique to (a) study the technical efficiency of the public banking sector in Argentina between 1998-2014, (b) compare the crises period with the non-crises period, (c) compare and contrast two different returns-to-scale, namely, constant returns-to-scale (CRS) and variable returns-to-scale (VRS), (d) rank the Argentinian public banks based on their consistency and performance over 17 years, and (e) rank the Argentinian public banks by means of applying the progressive time-weighted mean (PTWM) approach.

The remainder of the paper is organized as follows: the next two sections discuss the relevant literature on efficiency measurement in the Latin American banking sector, as well as in the Argentinian banking sector. Subsequently, the DEA technique is introduced, along with the detailed computational procedures for efficiency and PTWM approach for ranking. Next, the choice between the intermediation and the production approach in the selection of inputs and outputs is explained, followed by the results of the empirical analysis. A more detailed analysis of the political and financial crises and of the crisis-free period is also provided. The last section concludes the paper.

## Efficiency Measurement in the Latin American Banking Sector

As previously mentioned, the literature is abundant in research studies measuring the efficiency and productivity of banks in developed countries (in this regard, the interested reader is further referred to the studies by Berger and Humphrey, 1997; Berger, Demsetz, and Strahan, 1999; Isik and Hassan, 2002a, 2002b; and Yildirim and Philippatos, 2007). Nevertheless, the number of studies covering Latin American countries is quite small. As a matter of fact, in a recent survey conducted by Fethi and Pasiouras (2010), who provided a comprehensive review of 179 studies focusing on assessing the bank performance, it is interesting to note that none of these studies focused on Latin American countries (Charles et al., 2011). However, there are a couple of studies that focused on efficiency measurement using both parametric frontier models (Carvallo & Kasman, 2005; Negrin & Guerrero, 2005) and non-parametric DEA models (Charles et al., 2011; Chortareas, Girardone, & Garza-Garcia, 2010; Taylor, Thompson, Thrall, & Dharmapala, 1997). The below lines briefly depict the most notable studies.

At the level of Latin America, we highlight the following research works: Rivas, Ozuna, and Policastro (2006) who studied the impact of derivatives on the efficiency of banks in Latin America; Carvallo and Kasman (2005) who estimated a common stochastic cost frontier for banks from 16 Latin American countries; Forster and Shaffer (2005) who analyzed the relationship between bank efficiency and the absolute size of Latin American banks; and Chortareas, Girardone, and Garza-Garcia (2010), who employed the technique of DEA to measure the technical and scale efficiency of the banks across nine Latin American countries between 1997 and 2005 in an endeavor to investigate the relationship between market structure, efficiency, and bank performance.

At the country level, few studies should be mentioned, as well. For the Mexican banking sector, Taylor et al. (1997), for example, applied DEA to estimate a production frontier to classify 13 public banks according to their efficiency levels. In 1999, Leon took a sample of 23 Mexican banks and employed DEA to estimate a cost frontier. The Mexican commercial banking sector was also investigated by Negrin and Guerrero (2005) who applied a stochastic frontier analysis approach to estimate static and dynamic parametric models of banking efficiency. In Chile, it is to be noted the study by Fuentes and Vergara (2007) who estimated the efficiency at the bank level through cost and profit functions. Staub, da Silva e Souza, and Tabak (2010) employed DEA to investigate the Brazilian banks between 2000 and 2007 by means of analyzing their associated cost, technical, and allocative efficiencies. Additionally, the more recent studies by Charles et al. (2011) and Charles and Kumar (2012) used the DEA technique to investigate the efficiency of Peruvian banks for the period 2000 to 2009 to benchmark existing banks based on their CRS super-efficiency scores over time and for the period 2008 to 2010 to benchmark existing banks based on their VRS super-efficiency scores over time, respectively.

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## Efficiency Measurement in the Argentinian Banking Sector

Continuing with evidence from the Argentinian arena, Burdisso, Catena, and D'Amato (2001) studied the competitiveness of Argentinian banking markets. They extended the conjectural variations to companies with multiple products, which operate in two markets: retail and corporate. The authors sought to measure the degree of market power for a panel of banks from 1997 to 1999. They concluded that for both the markets, retail and corporate, the banks were very close to the competitive solution. However, they did not deepen their analysis with a specific study on efficiency. Dabos and Aromi (2001) also studied the market power of the banks and the impact that asymmetric information had on it.

Guala (2002a) assessed the Argentinian banking efficiency in the last years of the 1990s, using the cost frontier approach and the Quantile Regression Analysis method. This study covers the years with improved performance during the *Convertibility* period. Subsequently, Guala (2002b) evaluated the economies of scale and the scope of the Argentinian banking system during the early 1990s, following the financial reforms. Moya (2012) studied the bank productivity after the 2002 crisis, with emphasis on the distinction between public and private banks. Stagnant productivity levels were found after the year 2007.

It is essential to observe that all of these previously mentioned studies focused on analyzing the existence of a relationship between the banks' profit, the concentration, and the market power. Nevertheless, there are no specific local studies with regard to the efficiency of the banking sector.

In recent years, two studies, in particular, used the DEA technique to study the performance of the banking sector, although they did not exclusively measure the efficiency. On the one hand, Yanguas (2010) studied the behavior of the banking sector with an approach focused on the evolution of the efficiency and the market power before and after the economic crisis. It is important to mention the author's use of the structural approach which was popular in the 1990s when assessing the hypotheses regarding the 'market power' (Structure-Conduct-Performance and RMP [Relative Market Power]) and the 'structure efficiency' (X-efficiency and scale-efficiency) for all of the banks, covering the time period between 1994-2010, by using the DEA technique to obtain reliable estimates of efficiency.

On the other hand, Ferro, Leon, Romero, and Wilson (2013) studied the efficiency of the Argentinian banking system from 2005 to 2011. The analysis included the study of efficiency frontiers of the system as a whole and of subsamples of different categories of banks. Econometric and mathematical programming methods were used and consistency tests were applied. The results showed a moderate average efficiency of the system.

## Data Envelopment Analysis

Built on the seminal ideas of Farrell (1957), DEA is a non-parametric benchmarking approach used to assess the relative efficiency of a set of peer entities denominated as decision-making units (DMUs) that have multiple inputs and multiple outputs (Charnes, Cooper, & Rhodes, 1978). One of the main advantages of DEA is that it readily incorporates the existence of multiple inputs and multiple outputs without any underlying assumption of a functional form. Thus, its popularity lies within.

Ever since the introduction of the first DEA model (namely, CCR) in 1978, it has been widely used in efficiency analysis in almost every field, such as agriculture, banking, benchmarking, economy, education, environment, government, health, human resources, information technology, insurance, manufacturing, marketing, operations, public policy, regulation, retail, services, and tourism, having emerged as a powerful management science tool.

It is to be mentioned that DEA models can be distinguished according to whether they are input-oriented (i.e., minimization of input for a given level of output) or output-oriented (i.e., maximization of output for a given level of input). In the present research paper, we employ an output-oriented DEA model to analyze the technical efficiency of Argentinian banks between 1998 and 2014.

## Methodology

It is assumed that *n* DMUs exist. Each $DMU_j$ ($j$ = 1, 2,…, $n$) consumes a vector of inputs, $x_j = \left(x_{1j}, x_{2j}, ..., x_{mj}\right)^T$ to produce a vector of outputs, $y_j = \left(y_{1j}, y_{2j}, ..., y_{sj}\right)^T$. The superscript $T$ represents the transpose. The DMU to be evaluated is designated as $DMU_0$ and its input-output vector is denoted as $\left(x_0, y_0\right)$. Consider the following output-oriented BCC model in line with Banker, Charnes, and Cooper (1984), which involves a two-stage DEA process:

$$
\begin{aligned}
&\text{Max}\,\phi + \varepsilon\left(\sum_{r=1}^{s} s_r^+ + \sum_{i=1}^{m} s_i^-\right) \\
&s.t. \\
&\phi y_{r0} - \sum_{j=1}^{n} y_{rj}\lambda_j + s_r^+ = 0, r = 1, 2, ..., s, \\
&\sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = x_{i0}, i = 1, 2, ..., m, \\
&\sum_{j=1}^{n} \lambda_j = 1 \\
&\lambda_j \geq 0, s_r^+ \geq 0, s_i^- \geq 0;\ j = 1, 2, ..., n; \\
&r = 1, 2, ..., s; i = 1, 2, ..., m
\end{aligned}
\qquad (1)
$$

and $\phi$ is otherwise unconstrained. Here, $\lambda_j$ represents the 'structural' variables, $s_r^+$ and $s_i^-$ represent 'slacks' and ε is a non-Archimedean infinitesimal, which is defined to be smaller than any positive real number. System (1) assumes the best-practice frontier exhibits VRS; by ignoring the convexity constraint, i.e., $\sum_{j=1}^{n} \lambda_j = 1$ in System (1), the model becomes CRS (Charnes, Cooper, & Rhodes, 1978). For a complete discussion on standard DEA models, refer to Cooper, Seiford, and Tone (2000).

*DEA efficiency definition:* $DMU_0$ is DEA efficient if, and only if, the following two conditions are satisfied: (a) $\phi^* = 1$ and (b) $s_r^{+*} = s_i^{-*} = 0, \forall i, r$, where * designates an optimum.

## Progressive Time-Weighted Mean (Kumar & Vincent, 2011)

The PTWM is a method for computing a kind of weighted average of a non-empty set of numbers that gives more weight to the recent data points to make it more responsive to the new information. For the period 1 to $\tau$, let us

consider a set of values (in our context, technical efficiency values), say $e_t$, $t$ = 1, 2,..., $\tau$ and associated non-negative normalized weights, say $w_t = 2t / (\tau^2 + \tau)$, $t$ = 1, 2,..., $\tau$. The PTWM can be defined as:

$$\text{PTWM} = \sum_{t=1}^{\tau} w_t e_t \tag{2}$$

where $0 < w_t < w_{t+1}$, $\forall t$. One can notice that more emphasis is placed on the recent data points than on the data points from the immediate past. In this study, we apply the above equation (2) to measure the mean technical efficiency scores of all of the banks during a 17-year period to find their positioning in the banking sector.

## The Data

What exactly constitutes inputs and outputs in the banking sector, as well as how to measure them, represents an area of constant debate in the literature on banking (Casu & Girardone, 2002; Sathye, 2003). Nevertheless, although there is no comprehensive theory, two main approaches regarding the measurement of inputs and outputs compete in this literature: the 'intermediation approach' and the 'production approach' (Humphrey, 1985). In the intermediation approach, banks are seen as intermediaries that use the volume of financial liabilities (mostly deposits) as inputs, to produce loans and other means of financing, as outputs. The production approach, on the other hand, treats both loans and deposits as outputs, given that deposits also provide liquidity, safekeeping, and payments services to depositors (Berger & Humphrey, 1997). Kumar and Gulati (2008) highlighted that both approaches have their pros and cons and this is due to the fact that deposits count with both input and output characteristics, which are not easily disaggregated empirically. Berger and Humphrey (1997) suggested that the intermediation approach should be used for estimating the performance of whole banks, while the production approach should be employed for analyzing the performance of bank branches.

In the present study, following Berger and Humphrey (1997), the intermediation approach has been used with a restricted choice of variables, as opposed to the production approach for selecting inputs and outputs. A similar approach towards considering deposits as an output using an intermediation approach can be found in the study by Chen, Skully, and Brown (2005), who analyzed the cost, technical, and allocative efficiency of 43 Chinese banks over the period 1993-2000.

As such, the choice of inputs and outputs has been dictated by both the existent literature and the data availability. In the current study, one input, namely, total cost ($x_1$), has been used. The input total cost is measured as the sum of total interest expenses and non-interest expenses, including personal expenses. Non-interest expenses include service charges and commissions, expenses of general management affairs, salaries, and other expenses, including health insurance and securities portfolios. Although some researchers (Kao & Liu, 2004; Ram Mohan & Ray, 2004; Sathye, 2003; Yeh, 1996) treated interest expenses and non-interest expenses as two different inputs, in the present study we have followed the path of Casu and Molyneux (2003), Sealey and Lindley (1977), and Udhayakumar, Charles, and Kumar (2011) and, therefore, treated both expenses as one single input. The reason behind such treatment lies in the fact that when there is a high number of variables relative to the number of observations, the risk is that more units will tend to be wrongly identified as efficient. When too many constraints are specified, the observations tend to become incomparable (Zhao, Casu, & Ferrari, 2008). The above input is used to produce three outputs: total loans ($y_1$), total deposits ($y_2$), and other earning assets (OEA) ($y_3$). The output 'total loans' is measured as the sum of all of the loan accounts intermediated by banks; the output 'total deposits' is taken as the sum of demand and savings deposits held by the bank and non-bank depositors; and the output 'OEA' ($y_3$) is measured as the sum of total securities (treasury bills, government bonds, and other securities), deposits with banks, and equity investments.

An isotonicity test (Avkiran, 1999), involving the calculation of all inter-correlations between inputs and outputs to identify whether increasing amounts of inputs lead to greater outputs, was performed to ensure the validity of the DEA model specification and to justify the inclusion of inputs and outputs. As the inter-correlation between the input and outputs was deemed to be positive (Pearson correlations > 0.90; $\alpha = 0.01$), the isotonicity test was passed.

The basic data on inputs and outputs have been taken from the bulletins published on a regular basis by the Central Bank of Argentina (BCRA), which include detailed balance sheets of every institution. The sample consists of all of the public banks in Argentina during the period spanning 1998 to 2014. As such, 14 banks are included; at any point in time, data for at least 11 banks and at most 13 banks were incorporated in the analysis.

Regarding the number of DMUs, it is quite clear that there are advantages to having larger data sets; nevertheless, the literature indicates some minimum requirements, as well. For example, Golany and Roll (1989) and Homburg (2001) suggested that the number of DMUs should be at least twice the number of inputs and outputs. Nunamaker (1985) and Raab and Lichty (2002), on the other hand, suggested that there should be three times the number of DMUs as there are inputs and outputs. In this study, with a total of one input and three outputs, a minimum sample size ranging between 8 and 12 was required. However, as Cook, Tone, and Zhu (2014) pointed out, whereas in statistical regression analysis, sample size is a vital issue – as it tries to estimate the average behavior of a set of DMUs –, when used as a benchmarking tool, DEA focuses on the performance of each DMU, and as such, the sample size or the number of DMUs being evaluated may be immaterial. Summary statistics of both inputs and outputs for the Argentinian banks for each year under study is available from the authors.

## Results and Discussion

When analyzing the trend of the CRS efficiency indices (see Appendix A), two significant drops in the efficiency levels can be observed during the 1998-2014 period. They correspond to both a political change (as the presidential elections were held in 1999) and the economic and financial crisis of 2001-2002. This can also be appreciated in the levels of the coefficient of variation (CV), which record very high values in the two specific years: 96% in 1999 and 145% in 2002. Thus, this indicates that the technical efficiencies of the banks were not consistent in those years when compared to the other years. With respect to the average efficiency of the public banks, in 1999 this was 0.2490 and in 2002 it was 0.2020. It is interesting to note that the lowest overall average efficiency was recorded in 2002 (0.2020); however, the recovery that took place the very next year, in 2003, translated into the highest average efficiency (0.7391) for the entire period of study.

The trend of the VRS efficiency indices during the 1998-2014 period (see Appendix B) also indicates two significant declines in the efficiency levels of the public banks: in 1999 and in 2002. While the levels of the CV once again record high value for these two years, the assumed values are lower than those obtained under the CRS approach: 75% in 1999 and 61% in 2002, which shows that the technical efficiencies of the banks were less consistent in 1999 as a result of the political situation in the country. With respect to the average efficiency of the public banks, these values were also higher than those obtained under CRS: 0.4958 in 1999 and 0.6276 in 2002.

Furthermore, it has been found that there is a high positive correlation (0.867) between CRS and VRS across the period of study. The paired t-test statistic ($t = -7.372$; df = 16; $p = 0.000$) reveals with a 5% level of significance that the VRS technical efficiency is not less than the CRS technical efficiency (paired mean difference of -0.15 with standard error 0.0204), which is clearly seen in Figure 1.

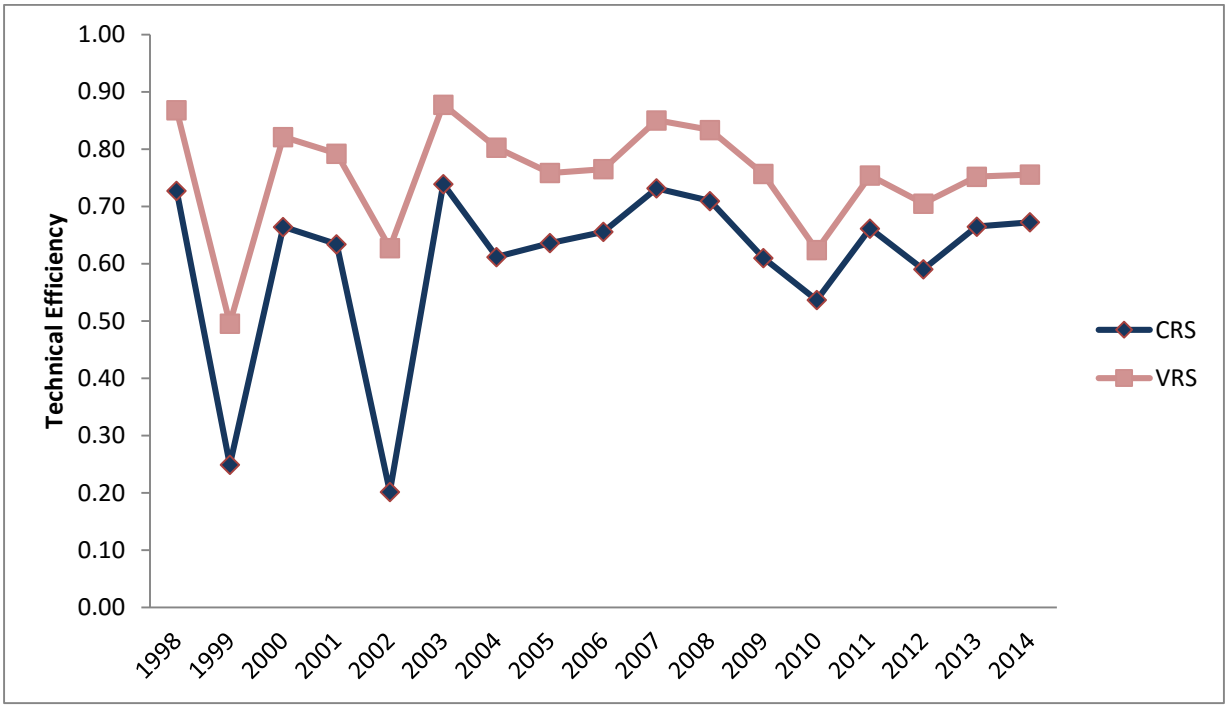


*Figure 1*. Trends of CRS and VRS.

By performing an individual analysis of the banks under the CRS technology (see Appendix A), it can be observed that Banco de la Nación Argentina registered a substantial fall during 1999, and it was also affected – like the rest of the public banks – in 2002. Then, this bank achieved high efficiency levels, which were maintained until 2014 with little variation. One of the noteworthy insights is that Banco de la Ciudad de Buenos Aires was the only bank to maintain good levels of efficiency during the political change of 1999. By contrast, Banco del Chubut S.A. was affected by the political crisis of 1999, but it did not suffer the fall of the other public banks in 2002. Another bank with similar performance is Banco de La Pampa, which suffered a slight decrease in efficiency in 2002, although less than the other public banks. The bank that was affected the most and suffered the greatest fall was Banco Municipal del Rosario (with an average efficiency of 0.0672 in 1999 and 0.0395 in 2002).

An individual analysis of the banks under the VRS technology (see Appendix B) reveals that their performance was quite similar during the time period, with more entities (such as Banco de la Ciudad de Buenos Aires and Banco de la Nación Argentina) having sustained high efficiency levels during the time period or having slight variations. It is interesting to note, however, that while Banco Municipal del Rosario maintained a high level of efficiency during the political crisis of 1999, during the economic and financial crisis of 2002, the same bank was the one that registered the greatest fall among all the banks. Equally remarkable is the bank's immediate recovery during the very next year, which was then able to maintain for seven years until 2010. Interesting, as well, is the case of Banco del Chubut S.A., which had an important fall during 1999, but did not suffer the fall of other banks in 2002. The two banks that suffered the most during both 1999 and 2002 were Banco Municipal de la Plata and Banco Provincia de Tierra del Fuego.

It is probably most notable the case of Banco Municipal de la Plata, which was strongly affected by the both the crises and which exited the market in 2003.

Table 1 below provides the summary of the bank-wise mean and PTWM efficiency scores, for the entire period of study. The CV values are also reported along with the efficiency scores in order to observe the consistency in efficiency across the banks. The information provided in Table 1 can be graphically appreciated in Figure 2.

Table 1
*Analytics of Efficiency Derived from CRS and VRS*

| | | VRS | | | CRS | | |
|---|---|---|---|---|---|---|---|
| **N°** | **Bank** | **Mean** | **CV** | **PTWM** | **Mean** | **CV** | **PTWM** |
| 1 | Banco de Corrientes S.A. | 0.6041 | 0.3638 | 0.5902 | 0.4888 | 0.3382 | 0.4926 |
| 2 | Banco de Inversión y Com. Ext. S.A. | 1.0000 | 0.0000 | 1.0000 | 1.0000 | 0.0000 | 1.0000 |
| 3 | Banco de la Ciudad de Buenos Aires | 0.9960 | 0.0103 | 0.9990 | 0.8786 | 0.2568 | 0.8925 |
| 4 | Banco de la Nación Argentina | 1.0000 | 0.0000 | 1.0000 | 0.8637 | 0.3167 | 0.9206 |
| 5 | Banco de La Pampa | 0.6891 | 0.2736 | 0.6526 | 0.6126 | 0.3046 | 0.5970 |
| 6 | Banco de la Provincia de Buenos As. | 0.7220 | 0.2297 | 0.6630 | 0.5791 | 0.3515 | 0.5714 |
| 7 | Banco de la Provincia de Córdoba | 0.6210 | 0.3273 | 0.5788 | 0.5226 | 0.4165 | 0.5121 |
| 8 | Banco del Chubut S.A. | 0.8370 | 0.2989 | 0.8571 | 0.7382 | 0.3366 | 0.7599 |
| 9 | Banco Municipal de La Plata | 0.4692 | 0.6487 | 0.0396 | 0.3333 | 0.6877 | 0.0271 |
| 10 | Banco Municipal de Rosario | 0.8730 | 0.2941 | 0.8519 | 0.3588 | 0.3935 | 0.4042 |
| 11 | Banco Provincia de Tierra del Fuego | 0.8262 | 0.3595 | 0.8953 | 0.5650 | 0.3544 | 0.6021 |
| 12 | Banco Provincia del Neuquén S.A. | 0.6013 | 0.3462 | 0.5844 | 0.5293 | 0.4256 | 0.5215 |
| 13 | Nuevo Banco Bisel S.A. | 0.5923 | 0.2514 | 0.1603 | 0.4537 | 0.4608 | 0.1297 |
| 14 | Nuevo Banco del Chaco S.A. | 0.6007 | 0.4041 | 0.5734 | 0.5085 | 0.3970 | 0.5082 |

The similarity of values obtained was tested. The rank correlation between CV of VRS and CRS is highly positively correlated, with the Spearman correlation coefficient of 0.644 (Kendall tau (b) 0.495). The rank correlation between the means of VRS and CRS is highly positively correlated, with the Spearman correlation coefficient of 0.758 (Kendall tau (b) 0.648). Furthermore, the rank correlation between the weighted average of VRS and CRS is highly positively correlated, with the Spearman correlation coefficient of 0.873 (Kendall tau (b) 0.758).

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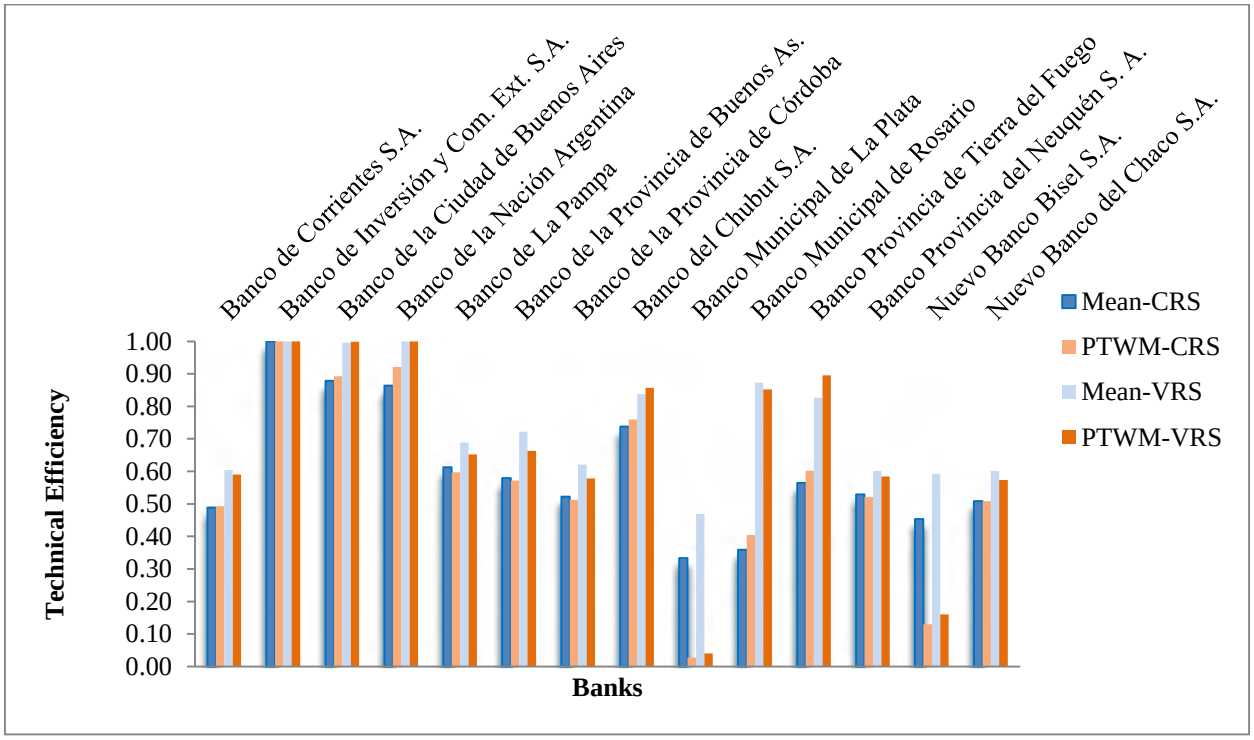


*Figure 2*. Mean technical efficiency of public banks.

It can be observed that Banco de Inversión y Com. Ext. S.A., Banco de la Ciudad de Buenos Aires, and Banco de la Nación Argentina were the banks to have registered the highest efficiency levels throughout the entire period of study, under both the CRS and VRS technologies, with slight variations for the last two banks.

By contrast, Banco Municipal de la Plata was the worst performer under both the technologies, with extremely low values under the PTWM approach, fact that can be explained by the bank's exit from the market in 2003. A similar phenomenon can be observed in the case of Nuevo Banco Bisel S.A., which exited the market in 2007.

As initially proposed, the existing public banks are ranked based on their CRS and VRS performance over the entire period of study by applying: (a) the mean, (b) the CV, and (c) the PTWM approach (Kumar & Vincent, 2011). Thus, Table 2 reports the position of the banks in the public banking sector.

As it can be observed, Banco de Inversión y Com. Ext. S.A. is the best performer based on the PTWM method in both CRS and VRS technologies, and since the technical efficiency is very consistent, the bank is positioned as 1$^{st}$ even based on the simple average approach.

Banco de la Nación Argentina is the second best performer based on the PTWM method in both CRS and VRS technologies; however, the consistency of the technical efficiency is slightly better in VRS than in CRS, which can be seen through the positioning of the bank as 2$^{nd}$ and 3$^{rd}$ based on the simple average method. A similar analysis stands for the case of Banco de la Ciudad de Buenos Aires.

Table 2
*Rank Order Derived from the Technical Efficiency*

| | | VRS | | | CRS | | |
|---|---|---|---|---|---|---|---|
| **N°** | **Bank** | **Mean** | **CV** | **PTWM** | **Mean** | **CV** | **PTWM** |
| 1 | Banco de Corrientes S.A. | 10 | 11 | 9 | 11 | 6 | 11 |
| 2 | Banco de Inversión y Com. Ext. S.A. | 1 | 1 | 1 | 1 | 1 | 1 |
| 3 | Banco de la Ciudad de Buenos Aires | 3 | 3 | 3 | 2 | 2 | 3 |
| 4 | Banco de la Nación Argentina | 2 | 2 | 2 | 3 | 4 | 2 |
| 5 | Banco de La Pampa | 8 | 5 | 8 | 5 | 3 | 6 |
| 6 | Banco de la Provincia de Buenos As. | 7 | 4 | 7 | 6 | 7 | 7 |
| 7 | Banco de la Provincia de Córdoba | 9 | 8 | 11 | 9 | 11 | 9 |
| 8 | Banco del Chubut S.A. | 5 | 7 | 5 | 4 | 5 | 4 |
| 9 | Banco Municipal de La Plata | x | x | x | x | x | x |
| 10 | Banco Municipal de Rosario | 4 | 6 | 6 | 12 | 9 | 12 |
| 11 | Banco Provincia de Tierra del Fuego | 6 | 10 | 4 | 7 | 8 | 5 |
| 12 | Banco Provincia del Neuquén S. A. | 11 | 9 | 10 | 8 | 12 | 8 |
| 13 | Nuevo Banco Bisel S.A. | x | x | x | x | x | x |
| 14 | Nuevo Banco del Chaco S.A. | 12 | 12 | 12 | 10 | 10 | 10 |

*Note*. The x indicates that since the bank exited the market, it cannot be a part of the current rank.

Nuevo Banco del Chaco S.A., on the other hand, is the worst performer, ranked as 12$^{th}$ by the VRS method and 10$^{th}$ by the CRS method. However, it is interesting to note that the bank's technical efficiency is not consistent when compared with all the other existing banks.

## Analysis of the Political and Economic and Financial Crises and of the Crisis-Free Period

From the analysis of the CRS efficiency levels during 1999 (characterized by a political crisis), 2002 (characterized by an economic and financial crisis), and the years without a crisis, it can be noted, that in general, the average efficiency level of the public banks was slightly higher in 1999 (0.2490) than in 2002 (0.2020). However, it is worth to point out that Banco de la Pampa and Banco del Chubut S.A. were the only two banks that were affected more by the political situation of 1999 than by the economic and financial crisis of 2002 (see Table 3, also Figure 3 for a pictorial representation); all this while the other banks decreased their performance more remarkably because of the economic and financial crisis.

Table 3
*CRS Technical Efficiency during the Crises Period versus Other Years*

| **N°** | **Bank** | **1999** | **2002** | **Other Years** | **Difference 1999-2002** |
|---|---|---|---|---|---|
| 1 | Banco de Corrientes S.A. | 0.1698 | 0.1229 | 0.5345 | 0.0469 |
| 2 | Banco de Inversión y Com. Ext. S.A. | | | 1.0000 | 0.0000 |
| 3 | Banco de la Ciudad de Buenos Aires | 1.0000 | 0.0873 | 0.9232 | 0.9127 |

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Table 3 *(cont.)*
*CRS Technical Efficiency during the Crises Period versus Other Years*

| N° | Bank | 1999 | 2002 | Other Years | Difference 1999-2002 |
|---|---|---|---|---|---|
| 4 | Banco de la Nación Argentina | 0.2667 | 0.0784 | 0.9559 | 0.1883 |
| 5 | Banco de La Pampa | 0.1912 | 0.6849 | 0.6359 | -0.4937 |
| 6 | Banco de la Provincia de Buenos As. | 0.2421 | 0.0898 | 0.6342 | 0.1524 |
| 7 | Banco de la Provincia de Córdoba | 0.1376 | 0.1212 | 0.5751 | 0.0163 |
| 8 | Banco del Chubut S.A. | 0.1524 | 1.0000 | 0.7598 | -0.8476 |
| 9 | Banco Municipal de La Plata | 0.1305 | 0.0792 | 0.4856 | 0.0513 |
| 10 | Banco Municipal de Rosario | 0.0672 | 0.0395 | 0.3996 | 0.0277 |
| 11 | Banco Provincia de Tierra del Fuego | 0.2212 | 0.0914 | 0.6195 | 0.1298 |
| 12 | Banco Provincia del Neuquén S. A. | 0.1792 | 0.0810 | 0.5825 | 0.0982 |
| 13 | Nuevo Banco Bisel S.A. | 0.3788 | 0.0888 | 0.5270 | 0.2900 |
| 14 | Nuevo Banco del Chaco S.A. | 0.0996 | 0.0623 | 0.5655 | 0.0373 |
| | Mean | 0.2490 | 0.2020 | 0.6570 | |
| | Standard Deviation | 0.2394 | 0.2922 | 0.1838 | |
| | CV | 96% | 145% | 28% | |

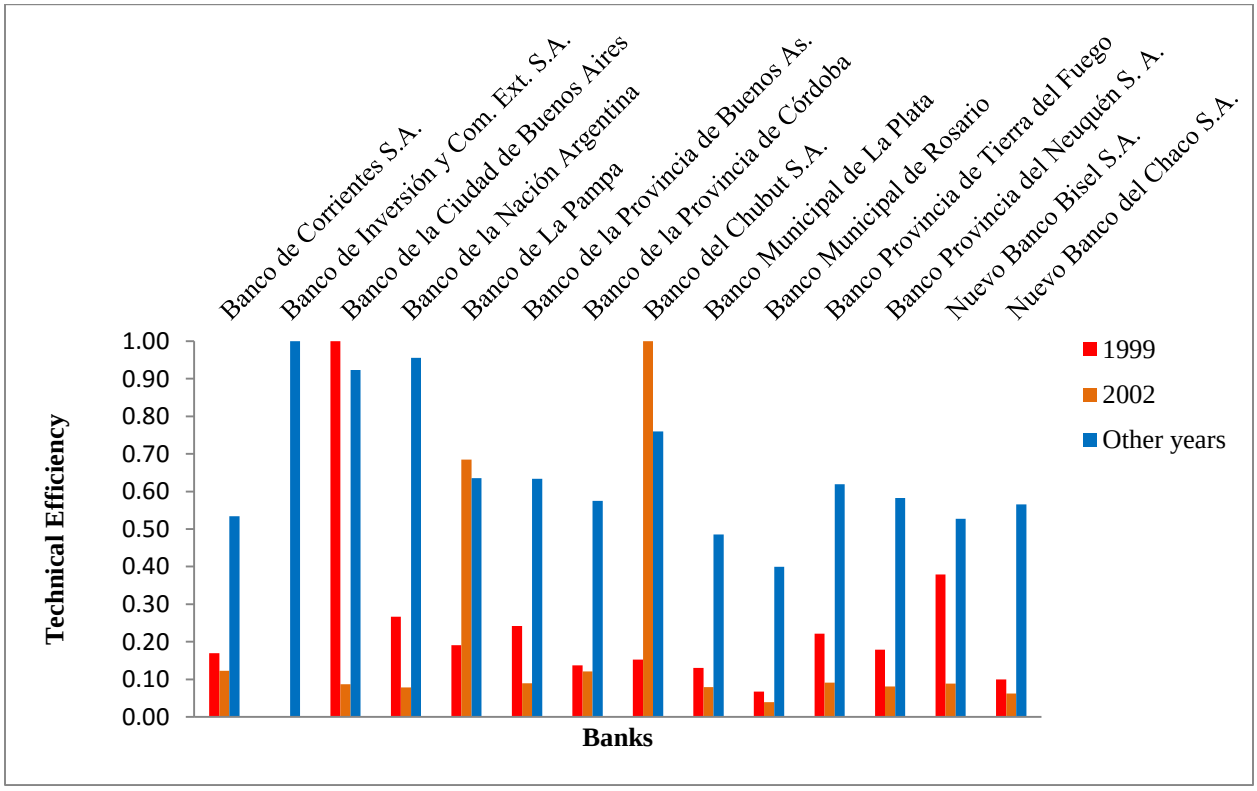


*Figure 3*. CRS technical efficiency during the crises period versus other years.

On a different note, Banco de Inversión y Com. Ext. S.A. entered the market in 2010, which is why no efficiency scores are displayed for this bank during the crises period. It can also be observed that, in general, the highest technical efficiency was achieved during the non-crises period, with three exceptions: Banco de la Ciudad de Buenos Aires Argentina – that registered its highest efficiency score during the political crisis of 1999, and Banco de la Pampa and Banco del Chubut S.A. – that reached their highest efficiency during the economic and financial crisis of 2002.

With regard to the VRS efficiency levels during 1999, 2002, and the years without a crisis, it is worth to point out that nine public banks were affected more by the political situation of 1999 than by the economic and financial crisis of 2002 (see Table 4, also Figure 4 for a pictorial representation). In this case, the average efficiency level of the public banks was higher in 2002 (0.6276) than in 1999 (0.4958).

Table 4
*VRS Technical Efficiency during the Crises Period versus Other Years*

| N° | Bank | 1999 | 2002 | Other Years | Difference 1999-2002 |
|---|---|---|---|---|---|
| 1 | Banco de Corrientes S.A. | 0.2370 | 0.2793 | 0.6502 | -0.0424 |
| 2 | Banco de Inversión y Com. Ext. S.A. | | | 1.0000 | 0.0000 |
| 3 | Banco de la Ciudad de Buenos Aires | 1.0000 | 1.0000 | 0.9955 | 0.0000 |
| 4 | Banco de la Nación Argentina | 1.0000 | 1.0000 | 1.0000 | 0.0000 |
| 5 | Banco de La Pampa | 0.3497 | 1.0000 | 0.6910 | -0.6503 |
| 6 | Banco de la Provincia de Buenos As. | 0.9709 | 1.0000 | 0.6868 | -0.0291 |
| 7 | Banco de la Provincia de Córdoba | 0.3937 | 1.0000 | 0.6109 | -0.6063 |
| 8 | Banco del Chubut S.A. | 0.1828 | 1.0000 | 0.8697 | -0.8172 |
| 9 | Banco Municipal de La Plata | 0.1416 | 0.2320 | 0.6574 | -0.0904 |
| 10 | Banco Municipal de Rosario | 1.0000 | 0.1040 | 0.9158 | 0.8960 |
| 11 | Banco Provincia de Tierra del Fuego | 0.2212 | 0.1905 | 0.9089 | 0.0308 |
| 12 | Banco Provincia del Neuquén S. A. | 0.1815 | 0.4405 | 0.6401 | -0.2590 |
| 13 | Nuevo Banco Bisel S.A. | 0.6410 | 0.6803 | 0.5696 | -0.0392 |
| 14 | Nuevo Banco del Chaco S.A. | 0.1261 | 0.2326 | 0.6569 | -0.1065 |
| | Mean | 0.4958 | 0.6276 | 0.7752 | |
| | Standard Deviation | 0.3700 | 0.3839 | 0.1622 | |
| | CV | 75% | 61% | 21% | |

It is in this context that Banco Municipal del Rosario and Banco Provincia de Tierra del Fuego are the only two banks that were affected more by the economic and financial crisis of 2002 than by the political crisis of 1999. Once again, no efficiency scores are calculated for Banco de Inversión y Com. Ext. S.A., as this bank entered the market in 2010.

It is interesting to note that among the 14 banks analyzed, seven banks achieved their highest efficiency during the non-crises period, while the other remaining seven banks achieved their highest efficiency score during the crises period. Among the latter, five banks achieved their highest efficiency during the economic and financial crisis of 2002 and only one bank (Banco Municipal del Rosario) reached its highest efficiency during the political crisis of

1999). Lastly, one bank (Banco de la Ciudad de Buenos Aires) experienced similar levels of efficiency during both 1999 and 2002.

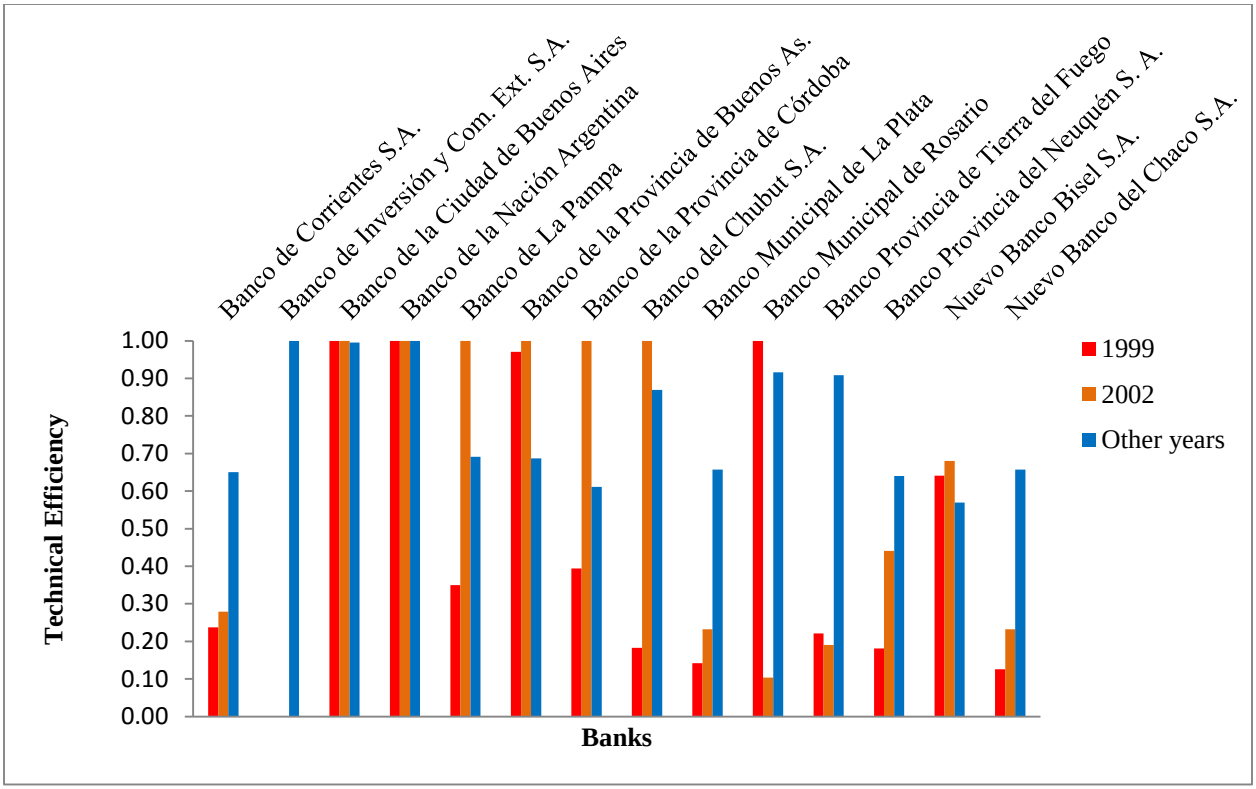


*Figure 4.* VRS technical efficiency during the crises period versus other years.

## Conclusion

The performance of the banking sector has always been of interest, especially to policy makers, since banks in general are considered to be a key component of a country's development prospects. In this study, the DEA technique was used to measure the efficiency of the Argentinian public banks following both the CRS and VRS technologies. In addition, a comparative assessment of the existing banks was performed in the pre- and post-crises period of 1999 and 2001-2002, based on the PTWM method proposed by Kumar & Vincent (2011). On average, the technical efficiency shows a sharp drop in both 1999 and 2002, which could be attributable to the political and economic and financial crises, respectively; furthermore, the banks achieved high efficiency levels for the rest of the period, which were maintained until 2014 with little variation.

An in-depth individual analysis of the existing banks in the recent years of the period under discussion shows that the efficiency scores are consistent in the case of the best performers. Among the 14 existing banks, Banco de Inversión y Com. Ext. S.A., Banco de la Nación Argentina, and Banco de la Ciudad de Buenos Aires were the best performers under both the CRS and VRS technologies and under both the PTWM and simple average approaches. This result can be explained by the fact that the technical efficiency is very consistent. In the case of the worst performers, on the other hand, efficiency scores are less consistent. Under the VRS technology, Nuevo Banco del

Chaco S.A. is the worst performer (ranked as 12th), a result which is confirmed even by the simple average method in the context of a high CV that indicates less consistency; however, under the CRS technology, the same bank is ranked as 10th by both the methods – classifying Banco Municipal del Rosario as the worst performer.

Overall, the present research study contributes to the body of literature on banking efficiency with evidence from the Argentinian arena and provides empirical information that concerned authorities may use in deliberations regarding future reform policies. Future research endeavours may consider identifying and exploring the factors that affect the performance of the Argentinian banking sector, as well as expanding the analysis to include private banks, as well.

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# Appendix A

## CRS Efficiency Indices

| Year | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Banco de Corrientes S.A. | 0.5464 | 0.1698 | 0.6494 | 0.5405 | 0.1229 | 0.6993 | 0.7042 | 0.4032 | 0.5291 | 0.6579 | 0.4762 | 0.4329 | 0.3906 | 0.6410 | 0.4348 | 0.4444 | 0.4673 |
| Banco de Inversión y Com. Ext. S.A. | x | x | x | x | x | x | x | x | x | x | x | x | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Banco de la Ciudad de Buenos Aires | 0.9434 | 1.0000 | 0.9709 | 0.6623 | 0.0873 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9174 | 1.0000 | 0.7463 | 0.9259 | 0.9091 | 0.9259 | 0.8475 |
| Banco de la Nación Argentina | 1.0000 | 0.2667 | 1.0000 | 0.8000 | 0.0784 | 1.0000 | 0.9259 | 1.0000 | 1.0000 | 1.0000 | 0.8547 | 1.0000 | 0.7576 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Banco de La Pampa | 0.8130 | 0.1912 | 0.6849 | 0.6329 | 0.6849 | 0.6452 | 0.5682 | 0.7299 | 0.6667 | 0.8475 | 1.0000 | 0.4902 | 0.3953 | 0.5208 | 0.5181 | 0.5587 | 0.4673 |
| Banco de la Provincia de Buenos As. | 0.8929 | 0.2421 | 0.7752 | 0.7463 | 0.0898 | 0.8772 | 0.6024 | 0.5464 | 0.4950 | 0.6289 | 0.6061 | 0.5618 | 0.3906 | 0.5464 | 0.5650 | 0.6452 | 0.6329 |
| Banco de la Provincia de Córdoba | 0.5102 | 0.1376 | 0.6173 | 0.8850 | 0.1212 | 0.9009 | 0.8475 | 0.5747 | 0.5025 | 0.5650 | 0.5208 | 0.4082 | 0.3401 | 0.4566 | 0.4630 | 0.5051 | 0.5291 |
| Banco del Chubut S.A. | 0.7042 | 0.1524 | 0.6250 | 1.0000 | 1.0000 | 0.7299 | 0.5848 | 0.8547 | 0.8621 | 0.4695 | 1.0000 | 0.7752 | 1.0000 | 0.9346 | 0.3077 | 0.7299 | 0.8197 |
| Banco Municipal de La Plata | 0.6211 | 0.1305 | 0.4785 | 0.3571 | 0.0792 | x | x | x | x | x | x | x | x | x | x | x | x |
| Banco Municipal de Rosario | 0.4525 | 0.0672 | 0.3802 | 0.2747 | 0.0395 | 0.4219 | 0.2703 | 0.3195 | 0.3378 | 0.4367 | 0.3676 | 0.3559 | 0.3344 | 0.4785 | 0.4878 | 0.5291 | 0.5464 |
| Banco Provincia de Tierra del Fuego | 0.7246 | 0.2212 | 0.4545 | 0.4854 | 0.0914 | 0.6711 | 0.4608 | 0.6536 | 0.7692 | 0.8696 | 0.7092 | 0.6329 | 0.4132 | 0.5435 | 0.5076 | 0.6623 | 0.7353 |
| Banco Provincia del Neuquén S. A. | 0.8850 | 0.1792 | 0.4808 | 0.9346 | 0.0810 | 0.5952 | 0.4717 | 0.4695 | 0.5025 | 0.8475 | 0.6897 | 0.5682 | 0.3344 | 0.4405 | 0.4386 | 0.5208 | 0.5587 |
| Nuevo Banco Bisel S.A. | x | 0.3788 | 0.7463 | 0.4505 | 0.0888 | 0.6667 | 0.3676 | 0.3460 | 0.5848 | x | x | x | x | x | x | x | x |
| Nuevo Banco del Chaco S.A. | 0.6329 | 0.0996 | 0.7752 | 0.4739 | 0.0623 | 0.6623 | 0.5405 | 0.7353 | 0.6173 | 0.7246 | 0.6623 | 0.4878 | 0.3390 | 0.4505 | 0.4545 | 0.4587 | 0.4673 |
| Mean | 0.7272 | 0.2490 | 0.6645 | 0.6341 | 0.2020 | 0.7391 | 0.6120 | 0.6361 | 0.6556 | 0.7316 | 0.7095 | 0.6103 | 0.5368 | 0.6615 | 0.5905 | 0.6650 | 0.6726 |
| Standard Deviation | 0.1801 | 0.2394 | 0.1905 | 0.2281 | 0.2922 | 0.1729 | 0.2215 | 0.2354 | 0.2108 | 0.1973 | 0.2129 | 0.2241 | 0.2628 | 0.2316 | 0.2378 | 0.2055 | 0.2018 |
| CV | 25% | 96% | 29% | 36% | 145% | 23% | 36% | 37% | 32% | 27% | 30% | 37% | 49% | 35% | 40% | 31% | 30% |

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## Appendix B

### VRS Efficiency Indices

| Year | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Banco de Corrientes S.A. | 0.6897 | 0.2370 | 0.9434 | 0.5464 | 0.2793 | 0.8696 | 1.0000 | 0.4587 | 0.6289 | 0.8696 | 0.4808 | 0.5556 | 0.4464 | 0.7299 | 0.5525 | 0.4739 | 0.5076 |
| Banco de Inversión y Com. Ext. S.A. | x | x | x | x | x | x | x | x | x | x | x | x | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Banco de la Ciudad de Buenos Aires | 0.9615 | 1.0000 | 0.9901 | 0.9804 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Banco de la Nación Argentina | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Banco de La Pampa | 0.8547 | 0.3497 | 0.7407 | 0.8264 | 1.0000 | 0.7042 | 0.6494 | 0.7813 | 0.7092 | 0.9009 | 1.0000 | 0.5556 | 0.4854 | 0.5348 | 0.5587 | 0.5882 | 0.4762 |
| Banco de la Provincia de Buenos As. | 0.9009 | 0.9709 | 0.8197 | 0.9346 | 1.0000 | 0.8772 | 0.6452 | 0.5714 | 0.5208 | 0.6329 | 0.7194 | 0.5618 | 0.5348 | 0.5495 | 0.5814 | 0.6897 | 0.7634 |
| Banco de la Provincia de Córdoba | 0.5208 | 0.3937 | 0.6329 | 1.0000 | 1.0000 | 0.9259 | 0.8929 | 0.5848 | 0.5102 | 0.5747 | 0.6024 | 0.4202 | 0.4405 | 0.4630 | 0.4739 | 0.5263 | 0.5952 |
| Banco del Chubut S.A. | 0.7634 | 0.1828 | 0.8264 | 1.0000 | 1.0000 | 1.0000 | 0.7874 | 1.0000 | 1.0000 | 0.5405 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.3559 | 0.8547 | 0.9174 |
| Banco Municipal de La Plata | 0.8547 | 0.1416 | 0.7042 | 0.4132 | 0.2320 | x | x | x | x | x | x | x | x | x | x | x | x |
| Banco Municipal de Rosario | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.1040 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.3597 | 0.8475 | 0.9346 | 0.8547 | 0.7407 |
| Banco Provincia de Tierra del Fuego | 1.0000 | 0.2212 | 0.6993 | 0.5181 | 0.1905 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.4167 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Banco Provincia del Neuquén S. A. | 1.0000 | 0.1815 | 0.5556 | 0.9615 | 0.4405 | 0.6579 | 0.5435 | 0.5076 | 0.5348 | 0.9174 | 0.6993 | 0.6667 | 0.3937 | 0.4651 | 0.5348 | 0.5747 | 0.5882 |
| Nuevo Banco Bisel S.A. | x | 0.6410 | 0.7634 | 0.6250 | 0.6803 | 0.6993 | 0.3788 | 0.3521 | 0.5988 | x | x | x | x | x | x | x | x |
| Nuevo Banco del Chaco S.A. | 0.8696 | 0.1261 | 1.0000 | 0.4926 | 0.2326 | 0.8000 | 0.7353 | 0.8475 | 0.6803 | 0.9174 | 0.6667 | 0.5650 | 0.4098 | 0.4566 | 0.4695 | 0.4630 | 0.4808 |
| Mean | 0.8679 | 0.4958 | 0.8212 | 0.7922 | 0.6276 | 0.8778 | 0.8027 | 0.7586 | 0.7653 | 0.8503 | 0.8335 | 0.7568 | 0.6239 | 0.7539 | 0.7051 | 0.7521 | 0.7558 |
| Standard Deviation | 0.1487 | 0.3700 | 0.1538 | 0.2336 | 0.3839 | 0.1326 | 0.2138 | 0.2492 | 0.2153 | 0.1791 | 0.2008 | 0.2394 | 0.2812 | 0.2447 | 0.2559 | 0.2218 | 0.2204 |
| CV | 17% | 75% | 19% | 29% | 61% | 15% | 27% | 33% | 28% | 21% | 24% | 32% | 45% | 32% | 36% | 29% | 29% |

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