Technical Efficiency Gains from Port Reform

The Potential for Yardstick Competition in Mexico

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undertaking for developing
countries unaccustomed to
such tasks.

Summary findings

Estache, González, and Trujillo show how relatively
standard methodologies can help to measure the
efficiency gains from reforming the organization of port
infrastructure, how those measures can be used to
promote competition between ports, and how
competition can be built into an incentive-driven
regulatory regime.

As illustration, they use a case study of port reform in
Mexico in 1993, the first efficiency analysis of port
restructuring in a developing country.

Their analysis, which covers 1996–99 and relies on a
stochastic production frontier, shows that overall,
Mexico has achieved annual efficiency gains of 6–8
percent in the use of port infrastructure since assigning
its management to independent. decentralized operators.

Changes in relative performance ratings are revealing.
They identify consistent sets of leaders and laggards,
including some that would not have been identified by
partial productivity indicators commonly used in the
sector. The authors' main conclusions:

• Reforms have significantly improved average port
performance.

• The analytically sound performance rankings
allowed by the port-specific efficiency measures can help
to promote yardstick competition in the sector. These
rankings are superior to those that would emerge from
use of partial productivity indicators. They account for
the joint effects of all inputs on outputs—which is
crucial, because it avoids the risk of inconsistent rankings
based on different partial indicators, arbitrarily chosen.

Developing the database needed to measure efficiency
in countries with no strong tradition of database
development is an enormous task—especially in
transport sectors, where the tradition of generating
databases useful to policymakers is in its infancy. The
most immediate effect of this exercise was to reveal the
poverty of the database in the Mexican port sector and
the need for regulators to invest in its development.

Technical Efficiency Gains from Port Reform:

The Potential for Yardstick Competition in Mexico[1]

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1. Introduction

Ports are one of the key components of the logistics chain and, this is why the desire to cut costs in the sector is becoming a mainstream component of most transport policy reforms. The most common instrument relied on is the introduction of some type of competition to stimulate efficiency. To achieve competition in ports, there are two main approaches. The first is *ex-ante* competition and relies on the auction of the right to operate the port or *in* the port. The second is *ex-post* competition between ports and stems from the assessment of the relative and absolute performance of each port--the basis of yardstick competition or competition by comparison.[3] Both forms of competitions are built-in the Mexican reforms initiated in 1993 which makes Mexico a particularly representative and interesting case study.

A common feature in post-reform monitoring is the focus on partial productivity indicators such as waiting time, labor productivity, use of capacity. These partial indicators are all useful but they can be quite misleading since they do not necessarily generate the same ranking of ports. This is why, in Mexico's reforms just as in most other port reforms they only have a limited value for the implementation of some of the recent regulatory mechanisms which require some explicit consistent estimates of efficiency gains.

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[3] In countries with multiple ports, this requires their decentralization and an increase in their autonomy to promote inter-port competition within the country—the strategy adopted by Mexico. In smaller countries, this requires international comparisons-which are often more difficult to implement because of the difficulties of comparing prices internationally.

The measurement of the absolute performance stemming from the joint of effects of all inputs on outputs is needed for the revision of the price caps adopted by Mexico--another common feature in port reform—and should be should be analytical—i.e. model or formula driven. These absolute performance measures could also be combined to generate relative performance assessments and promote inter-port competition.

With this background, the specific focus of the paper is twofold. First, we show that even in a set up with limited data availability we could assess through the estimation of a production frontier the efficiency gains achieved since Mexico introduced its reforms.We also discuss how the measure of these gains could be used in the context of a port tariff revision. Our results could indeed be helpful to regulators in the revision of the price caps under which it regulates its ports to share some of the gains with the users and give stronger incentive to improve efficiency to the poorest performers. Second, we show why efficiency measurements generated from production frontiers have the seeds of what could become a standard instrument to promote ex-post competition and formal yardstick competition in the sector.

The paper is organized as follows. Section 2 presents the recent reforms in the Mexican port system. Section 3 summarizes the main results available in the literature. Section 4 discusses the methodology followed to assess the efficiency effects of the reform in Mexico and the results of the analysis. Section 5 offers some concluding thoughts.

2. The Reform of the Mexican ports

The reform of the Mexican port system started in 1993 and followed a pattern similar to that of many other reforming countries. In Mexico, as in most countries, the port system was until then managed centrally by a network of public firms. This section describes the Mexican port system and its reform, emphasizing the institutional framework resulting from the changes and the facts that are most relevant to the assessment of improvements in performance.

2.1. Market Structure

Mexico is supported by a large port system composed of 108 ports and terminals[4] distributed along the 11,500 km coastline of the country, with a total berth length of 110 km. Half of these facilities are located on the Pacific coast, and the other half on the Mexican Gulf and the Caribbean. There are 39 ports dedicated to commercial activities, and approximately a similar number are fishing ports; 22 ports are specialized in tourist traffics, and 8 are specialized in oil traffic. This system handles 85% of total international trade, and more than 7 million passengers.

The core of the traffic is however extremely concentrated. Most goes through 27 commercial, industrial and tourist ports, and 10 terminals specialized in oil and mineral ores' traffics. In 1999, the main 8 ports handled 71% of total cargoes, four of them in the Atlantic coast and the other four on the Pacific. However, if oil is excluded, basically half of total movements of cargo are performed by 5 ports: Veracruz, Tampico and Altamira on the Gulf of Mexico; and Manzanillo and Lázaro Cárdenas on the Pacific side.

Total movement of cargo by Mexican ports increased from 169 million tons in 1990 to 248 million in 1999 Passengers' traffic has doubled during the same period, while container traffic has multiplied by

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[4] Facilities located outside port areas, as defined by the government, dedicated to port operations.

three. The main cargo types are oil and its derivatives, with a share of 62%, followed by mineral ores which amounts 23% of total tons handled by Mexican ports. General cargo, including both bulk and containerized goods, represents 8.5% of total tons. The percentage of goods transported in containers over total general cargo (containerization index) exhibits very low values –36% in 1999– compared to international standards—but it is improving. From the total TEUs handled by the port system, the ports of Manzanillo and Veracruz moved about 70%. These two ports have the more modern container terminals of the country, and therefore their productivity and efficiency are expected to be higher for than other ports.

2.2. Restructuring and privatization

Modernization and reform of Mexican ports started in 1993. As part of the strategy used to reform the port system, two type of actions were followed. First, an adequate legal framework was needed to allow private firms to enter the port industry as operators. This was built in the new Ports Law passed in 1993. The second action was the dismantling of the public agency *Puertos Mexicanos* (PUMEX), responsible up to 1993 for the ports' network and was the only agency in the country authorized to build port infrastructures and to provide port services. The reform rested on three key instruments: decentralization, privatization and introduction of competition in the port system.

Decentralization implies that each port must have an autonomous, self-financing Port Administration, so that the government will have only a supervisory role over the system; it was pursued by creating independent Port Administrations (*Administraciones Portuarias Integrales*, APIs) at each port or group of small ports, which are publicly owned companies to which the administration of ports was directly granted. Thus, for example the API of the Veracruz port is legally established as a company whose shares are owned 99.8% by the federal government, and 0.2% by the development bank BANOBRAS. The board of the APIs must include representatives from the States and municipalities, and some from the private sector. The APIs were granted the rights over the port assets, and authorized to grant themselves concessions over those same assets to private firms, but making it clear that in no case those assets will be permanently transferred to the private sector. APIs pay compensations to the federal government for the use of assets publicly owned. The federal government, through *Secretaría de Comunicación y Transporte* (SCT), keeps the role of port authority, and it is the agency that grants all concessions, and licenses. Additionally, SCT acts as regulator in those cases where competition is absent or it is not strong enough, by determining maximum tariffs to be charged to users. Matters on safety are performed by the navigation authority (*Capitanía de Puertos*), which is an agency independent from SCT.

Privatization implies that the port industry must be open to the participation of private investors, both nationals and foreign, for the operation of terminals and other facilities, and eventually even the port administration. In almost every port, private participation has now been introduced through auctions for concession contracts between APIs and private firms to provide port services. For simple services, such as towage and pilotage, only a license is required, which can be obtained by any interested party sufficiently qualified. APIs are expetced to eventually be sold to the private sector. Private participation has induced significant changes in the port industry, in terms of investments on infrastructure, and improvements in quality of service and tariffs. Thus, total investments in equipment and new terminals was around 6,000 million pesos between 1995-1998, 60% of which was private investment. Investments in infrastructure and equipment have already generated substantial capacity increases for the Mexican port system. In 1993, the estimated installed capacity allowed to handle 59 million tons of commercial cargo. However, ports only moved 24 million tons. The reforms further increased this capacity to over 90 million tons by the end of the 1999 but also increased utilization to over 55 million tons.

Liberalization and Competition, between ports and between operators within ports, resulted from some restriction in the auctions for concessions and required liberalization of tariffs and elimination of cross-subsidies and barriers to entry. First, according to norms on competition, all request by private firms to participate in public auctions to obtain concessions over port assets were evaluated by the competition agency, CFC, to avoid risks of excessive market power after privatization. In practice, this obligation did not impose a relevant restriction over the outcomes, since most applicants were authorized to participate without reservations. However, an important ruling was the initial restriction for firms not to win more than one concession on each coast (Pacific, Atlantic). This geographical restriction was later modified, and now the only restriction is that a firm must not gain a relevant position in the relevant market (this was applied, for example, for the tourist cruise markets).

Second, port tariffs have been generally liberalized. Regulation is only used in those cases where it is considered that there is not enough competition between operators. The Ports Law establishes that the Federal Commission of Competition (the Mexican anti-trust institution) is to examine these questions and to determine when tariff regulation is or is not required. Port tariffs charged by APIs to ships for the use of common infrastructures are subject to price caps. The limits approximate the long-run marginal cost of each port--operating and investment costs--and therefore, limits and hence tariffs are different for each port but close to the level that would result from competition. To promote incentives for cost reductions and innovation, the limits are to be revised every five years to reflect any efficiency gains that may have been obtained from competition between the ports. In addition, with respect to the labor market, the reform transformed collective bargaining into firm-level bargaining, thus allowing firms to negotiate with their workers according to local and business conditions. As a result, the number of port workers employed by the public sector has been reduced, but total port employment by private firms is rising, due to an increase in the activity of ports. For example, the port of Manzanillo had 2,100 workers before the reform, and at the end of 1997 the number had doubled. In Veracruz, with an initial number of 6,647 employees, the increased was not so spectacular in relative terms, but it had also risen to 8,260.

Decentralization started in February 1994, when the APIs were created and assumed the functions of planning, building infrastructures and promoting the port, apart from tasks on safety. They act as landlords since the Ports Law precludes them generally to act as port operators and requires them to contract with third parties. However, there are not full port authorities, since that role is legally attributed to SCT. The main 16 ports created APIs accountable to the federal government mostly. Additionally, 5 ports have APIs which are controlled by State governments, all these are specialized ports (tourism, fishing) or attend small local markets. There is only a private API, in the port of Acapulco, specialized on tourists' traffic. Both the 5 State-controlled APIs and the one of Acapulco share the characteristic that the API is also the operator of port services, due to the small size of ports, or to their specialization. The last phase considered for the process of ports' reform is the transfer of APIs to the private sector, by selling their shares to investors. There is currently only one private API (Acapulco), and two ports are in the process of privatization (Topolobambo and Guaymas). There are no established dates or conditions for privatizing the port administration of the main ports of the country.

Overall, the most relevant fact emerging from this brief overview is that Mexico wants competition between its ports as a way of improving the competitiveness of these ports. To achieve this goal and to make the most of the regulatory tools the reform has granted to its regulator, Mexico needs to be able to measure the improvements in efficiency in each port in absolute and relative terms. It needs an absolute measure because the limits to the regulated tariff will have to reflect every five years the average efficiency gains achieved. It needs a relative measure because the spirit of the reform requires competition to be

sustained as a matter of process and that this, in turn, requires a regular assessment of the relative performance of the main ports, therefore creating the basis of a system of yardstick competition. It turns out that five years have just passed since the beginning of the reform and that enough data is available to make a fair assessment of absolute and relative efficiency improvements in the main Mexican ports.

3. A brief survey of efficiency measures in the port sector

The efficiency literature on ports' performance is relatively modest in comparison to the efficiency literature available on other infrastructure activities. It is evolving however and can be classified into two main groups.[5] The first covers partial indicators of productivity in the port system but presents only a very limited view of efficiency zooming on specific ports. The second, more recent and much less developed, adopts the types of approaches recommended by this paper.[6]

The literature covering partial indicators of port productivity continues to prevail among practitioners as revealed by a random look at annual reports published by port authorities[7]. The more academic literature adopting this approach to focus on specific ports spans over a 15 years period starting in the early 1980s after which a first attempt at using these indicators for inter-port comparisons was suggested by Tongzon (1995) and Talley (). Their approach was quite simple and consisted in defining a set of comparable indicators. Heaver (1995) or the Australian Productivity Commission (1998) went further and used comparable indicators to try to see how inter-port competition could be promoted analytically. Similar studies relevant to the concerns of a regulator include the study of scale economies by Jara et al. (1997) or Cullinane and Khanna (1998). Fernández et al. (1999) also covers the effects of privatization. While all these studies generate useful insights on the performance of ports and the factors driving their costs, their main drawback was their partial view and the failure to recognize the need to have an analytically consistent approach to efficiency measurement.

The second generation of studies relying on formal measures of efficiency is an attempt to address this failure. It is still too recent to have generated many publications. However, the diversity of approaches followed by the relatively modest volume of papers is quite revealing of the lack of concensus on the ideal approach. The main contributions of these studies are summarized in Table 2. A few clear trends appear.

In general, researchers focus on panels of ports cost or production performance to make the most of the information available. Only two papers rely on a simple cross-section. Roll and Hayuth (1993) rely on data commonly available from annual reports in ports and Tongzon (2001) covers 16 ports for which he obtained comparable data for 1996.

Second, the models preferences are evenly distributed between stochastic frontiers and DEA, with one study by Baños, Coto and Rodríguez (1999) also testing a distance function to show the difficulty faced by ports in adjusting in the short run its quasi fix factors. Liu (1995) focuses on production to

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[5] See Trujillo, L and G. Nombela (2000) for a longer review of port economics.

[6] For a recent overview of the literature see Campos, Estache and Trujillo (2001); "Information, Accounting and Regulation for Argentina's railways", WBI, mimeo; For a more rigorous survey see, Coelli, T., D.S..P. Rao and G.E. Battese or CRB (1998). For a survey targeted to infrastructure regulators, see Coelli, Estache, Perelman and Trujillo (2000).

[7] It includes papers by Neufville and Tsunokawa (1981), Suykens (), Kim and Sachis (1986) providing simple productivity assessments. The role of investment has been studied by Shneerson (1981) and planning by Bobrovitch (1982), Sheerson (1983) or Goodman (1984).

calculate technical efficiency and compares the influence of public and private ownership in Britain. Coto, Baños and Rodríguez (2000) test a cost frontier. Roll and Hayuth (1993) show how DEA can be useful in assessing the relative effectiveness of various ways of organizing port services when limited data is available. Martínez, Díaz, Navarro and Ravelo (1999) relies on a DEA to assess the evolution of the relative efficiency of Spain's ports. Tongzon (2001) uses DEA to make an international comparison of efficiency in 4 Australian and 12 other ports from around the world.

A third noticeable feature of the comparison of the studies is that all stochastic frontiers are tested for translogs but the type of technical progress—i.e. neutral vs. non neutral-- built-in varies across studies. Moreover, the production or output measures also vary. Coto et al. (2000), Martínez et al. (1999), Baños et al. (1999) and Roll and Hayuth (1993) all adopt a measure of physical quantities of merchandises manipulated. In addition, Roll and Hayuth include service level, service satisfaction and ship traffic as outputs. Martínez et al. and Roll and Hayuth model explicitly the multi-product nature of ports[8]. They aggregate the three main components of the port activity: tons of merchandises moved, passengers loaded and unloaded and number of vehicles with passengers. The product can also aggregate freight (a weighted sum of containers, general cargo and grain) and service level (ratio of hanlding time to total stay) as done by Roll and Hayuth (1993). Liu (1995), Baños et al. (1999) and Coto et al. (2000) assume a single output technology and measure output through the volume of merchandise handled. Liu (1995) measures the output through the revenue generated—excluding revenue from the sale of goods. This approach assumes that the ports are quite competitive and that tariffs reflect costs and hence that revenue reflects output.

All studies model capital and labor as inputs—as expected. The labor input is approximated by the number of employees or the related expenses. Roll and Hayuth (1993), Baños et al. (1999) and Tongzon (2001) adopt the first option and define labor as the average annual number of workers in the port. Liu (1995) and Martínez et al. (1999) assume that the total wage payments are a good approximation of the labor input. The modeling of the capital input gives rise to more approaches. Liu (1995) defines capital as the net value of fixed capital, including land, buildings, docks, berths, roads, storage and equipment. Roll and Hayuth (1993) consider that capital is the annnual average of all capital invested in ports and installations. Martínez et al. (1999) assumes that it can be approximated by depreciation expenditures. Baños et al. consider two types: one variable, approximated as a percentage of the net value and one quasi-fixed definied as the length of the docks/berth with a depth over 4 meters. Other production factors include "other expenditures" representing intermediate inputs (Martínez et al., 1999); energy consumption, non-recurrent labor inputs (Baños et al. (1999); and the diversity of load to pick up the degree of specialization of the port (Roll and Hayuth, 1993). Tongzon (2001) includes separately the number of cranes, of container berths, of tugs and of terminal areas. In addition, he adds a quality variable approximated by the delay time—which may seem strange since it could be seen as a proxy for an output as well.

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[8] So does Tongzon but because the two outputs case yields unrealistic results, he ends up focusing on a single output.

Table 2. A survey of the literature on efficiency measures in the ports sector

Author	Data (1)	Model (2)	Functional Form	Variables (3)	Estimation Method (4)	Efficiency measure (5)	
Liu (1995)	Panel 28 UK ports 1983-1990	SPF	Translog Neutral and non neutral Technological change	$Y_1 (X_1, X_2, Z_1, Z_2, Z_3, Z_4, T)$	Model 1: OLS, ML Model 2: Within, GLS, ML	Technical efficiency Mod. 1 (ML): Mod 2 (GLS): Mod 2 (ML): Mod 2 (ML, with T):	1983-1990 78.0 76.9 68.3 69.7
Coto, Baños and Rodríguez (2000)	Panel 27 Spanish ports 1985-1989	SCF	Translog Non neutral Technological change	$CT_0 (Y_0, W_1, W_2, W_3, T)$	Within	Economic efficiency Maximum: Minimum Average	1985-1989 100 11 33
Baños, Coto and Rodríguez (1999)	Panel 27 Spanish ports 1985-1997	SCF DF	Translog Neutral Technological change	$CV_0 (Y_0, W_1, W_3, W_4, W_5, T)$ $D (Y_0, X_1, X_3, X_4, X_5, T)$	Instrumental Variables	Technical efficiency Distance function Maximum: Minimum Average	1985-1997 100 15 41
Roll and Hayuth (1993)	Cross Section 1993	DEA	Not applicable	$Y_0, Y_1, Y_2, Y_3, X_1, X_2, X_6$	Not relevant	Average Medium Efficiency Total ports: Ports region 1 and 2	1993o 78.2 .93.4 86.1
Martínez, Díaz, Navarro and Ravelo (1999)	Panel 26 Spanish ports 1993-1997	DEA	Not applicable	Y_0, Y_1, X_1, X_2, X_3	Not relevant	Average global efficiency Group I:, II and III	1993-1997 88.7 80.1 85.7
Tongzon (2001)	Panel 16 ports 1996	DEA	Not applicable Tests both CRS and VRS	$Y_0 X_1, X_2, X_3, X_4, X_5, Z_1$ Delay Time	Not relevant	Average efficiency if: Constant Return to Scale Variable return to Scale	1996 59.5 93.1

(1): To indicate sample size

(2): SPF: Stochastic production frontier; SCF: Stochastic cost frontier; DF: Distance function and D Distance; DEA: Data Envelopment Analysis;

(3): CT: total cost
   CV: variable cost
   Yo: Production (measured in tons of merchandise or TEUs handled) Y_1: Production (measured by billing for services) Y_2: Service level (number of containers moved/hour), Y_3: User satisfaction Y_4: N° of ships arrivals
   X_1: Labor Input; X_2: Capital Input; X_3: Intermediate Inputs; X_4: Variable capital; X_5: Quasi fixed Capital Input X_6: Uniformity of merchandise
   W_1: labor price; W_2: capital price; W_3: intermediate input price; W_4: variable capital price; W_5: quasi fixed capital price
   T: time trend; Z_1: port size/terminal area; Z_2: port location Z_3: port ownership; Z_4: capital intensity

(4) OLS: ordinary least squares, ML: maximum likelihood; GLS: generalized least squares

(5): Measured in %; and in some cases calculated by the authors based on published results.

(6): Specific Efficiency levels assessed

For the two papers with cost functions, Baños et al. (1999) and Coto et al. (2000), labor prices are approximated by the ratio of total labor cost to the number of workers and the price of capital is obtained by dividing the amortization of the period by the length of docks in Coto et al, 2000. Baños et al. (1999) distinguish between the price of variable capital, defined as the ratio of investments realized in one year over investments over the previous year and the price of capital quasi -fixed approximated by the ratio between the use of capacity and the length of docks with a depth over 4 meters. The price of intermediate inputs is the ratio of consumption, external services and service costs over other port expenditures. The price of energy is obtained by allocating the energy inputs cost to ports according to the volume handled[9].

The environmental variables covered are usually included to approximate some institutional or market specific characteristics and are usually built in the second stage of two stages approaches to the measurement of efficiency. Liu (1995) relies on 3 variables. Ownership is a dummy differentiating between private, trust and municipal ports. The size of ports enters as a dummy distinguishing between large, and, "medium and small" ports. Localization on the shore vs. elsewhere also enters as a dummy. Finally, the intensity of capital is measured as the ratio between the net value of fixed capital and the total wage bill. Coto et al. (2000) rely on a dummy as well to distinguish between autonomous and other ports and on dock length to model the relevance of the size of ports.

While intuitively quite attractive, the idea of using these variables in a second stage to explain efficiency is criticized by some of the top econometricians in the field. Indeed, starting with Battese and Coelli (1995), the criticism is based on the fact that the variable used in the second stage should have already been used in the first stage to ensure that inefficiency is measured properly. The failure to do so leads to a mispecified model. To the extent that they are relevant, the residual of the first stage generate wrong estimates of efficiency. The critique is however not addressed to the general approach since frontiers can indeed provide other policy insights on the functioning of ports

This leads to a discussion of the estimation methods used. As can be seen in Table 1, the diversity of methods used is quite impressive. Two stages methods relying on instrumental variables and maximum likelyhood approaches are quite common to estimate the parametric frontiers. Most of them also look into the fixed effects of each port to ease the relative performance assessment. As for the non-parametric approach, it may be worth pointing out that Martínez et al. (1999) and Tongzon (2001) rely on a methodology proposed by BCC (Banker, Charnes and Cooper, 1984) to account for scale. They adopt a two stages radial approach to generate the efficient frontier by solving a linear programming model.

While not strictly comparable, the measures of efficiency obtained by the various authors are summarized in the last column since none of the papers rely on methods comparing strictly the same sample with different methods or of the same time period with comparable output variables. Liu (1995) does focus on technical efficiency but does not compute port specific efficiency measures. He computes simply an average which he uses as a variable to explain in a second stage. His comparison of the various ports leads him to suggest that in the UK for the 1983-1990 period, there is no significant advantage to private or public ownership when the policy environment is competitive. He also shows that size matters and being larger helps, that location matters but not a lot and that capital intensity has no significant impact. Coto et al. (2000) assess the economic efficiency of each Spanish port for the second half of the 1980s. The first stage of their analytical works reveals a ranking in which the smallest ports were the most efficient and the largest the least efficient and that autonomy did not necessarily help. When testing in a

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[9] Most of the definitions of the variables in this paper are quite complex to implement and may reflect characteristics specific to the way the annual report is presented in Spain by port authorities.

second stage the relevance of size for the level of efficiency, they conclude that sized does in fact not matter but that autonomy hurts efficieny levels.

Covering a longer period for the same set of ports, 1985-1997, and focusing on technical efficiency, Baños, Coto and Rodríguez (1999) conclude that there is an overcapitalization of the sector and that the Spanish ports are not minimizing costs, hence reinforcing the attractiveness of the distance function—although both the cost and the distance function lead to the same policy conclusions. Relying on DEA, Tongzon (2001) confirms the relevance of the degree of capital and labor utilization in the assessment of efficiency. Also relying on DEA, Martínez et al. (1999) show that a three level grouping of the Spanish ports (large, medium, and small) for the 93-97 period refines the earlier results. In recent years, the largest ports have been the most efficient and exhibited the largest efficiency gains. The smallest ports on the other hand have been the victim of a progressive decline in their performance and medium ports seem to catch up. The main additional policy contribution of the Roll and Hayuth (1993) paper is to confirm that location matters, as revealed by a different sample.

Ignoring momentarily the doubts that the Battese-Coelli critique could cast on the results, an overall glance at the last column is however useful to get a rough order of magnitude of the levels of efficiency that can be expected for various types of combinations of models and output variables in sector. It suggests first that the efficiency of the sector is likely to be stronger in terms of production variables than in terms of cost variables, confirming that the local monopoly power many ports have is sufficient to generate rent which regulators are failing to redistribute to users. It also shows that the standard policy concerns such as overcapitalization, size or autonomy can be relevant but not always in the expected direction.

Overall, in addition to these fairly generic results, the overview provides some insights on what seems to be the minimum information requirements needed to implement a comparative performance evaluation in the port sector. The multiple output nature of the port business yields a large variety of indicators to pick from which includes non transport related activities such as the rental of space for any purpose. If allocative efficiency is important a cost function must be estimated. The challenge of separating costs between variable and total is in itself significant but modest in comparison to the challenge of assessing the opportunity cost of capital in many developing countries. This may explain why the production function will probably have to be the preferred option for efficiency measures for developing countries. The main challenge for labor inputs is obtaining a disaggregation distinguishing white and blue collars and/or permanent and temporary employees. Capital inputs will generally be the most difficult one to assess, in particular in the context of a cost function. The physical inputs or their monetary valuations will often provide good approximations. Intermediate inputs tends to be a residual category. Other factors include anything that the analyst thinks may be relevant to the port activity level. This includes of course its ownership (public vs private) in international comparisons and in some countries. It can also include market size (in Mexico, the East and West coast markets are different) and the port size, if the data available does not allow to build in economies of scale carefully enough. Finally, a time trend will often have to be tested in most of these models to pick up any technological change.

4. Measuring the efficiency effects of Mexico's port reform

This section summarizes the major steps needed to generate the efficiency measures. It cover a somewhat detailed discussion of the data because it turns out that the limitations to the implementation of stadnard efficiency measurement technique is significantly driven by data restrictions.

4.1. The general focus of the efficiency measure and the data available

While the reform was decided in 1993 and the bulk of its implementation took most of 1994, the new autonomous APIs needed another couple of year to put together a reasonable monitoring system demanded by the Transport Subscretariat. The data available is annual and spans over 4 years starting in 1996 and ending in 1999. It only covers the 14 APIs but these are the main ones. This provides a panel of data of 56 observations which is large enough to rely on parametric methods and in particular on a production frontier. The limited coverage is good enough to allow a fair assessment of the continued progress and efforts made by the APIs to meet the mandate assigned by the reformers. It is also good enough to allow an assessment of the evolution of the relative performance of the main APIs.

The APIs covered by the study are: Ensenada, Guaymas, Topolobampo, Mazatlán, Manzanillo, Lázaro Cárdenas and Salina Cruz, on the Pacific coast of Mexico and Altamira, Tampico, Tuxpan, Veracruz, Coatzacoalcos and Progreso, on the Atlantic coast. Excluding oil and its derivatives, these APIs handle 70% of the traffic going through the Mexican port system. This is significant. Among the largest ports, the main ones missing are Puerto Madero, Puerto Vallarta and Acapulco due to lack of enough comparable data. Puerto Madero was closed for a number of years while under repair. Puerto Vallarta is mostly a tourist port and has very little cargo. Acapulco, also a mostly passenger oriented port, has the only API privatized so far (since 1997). Since Mexican law prevents the regulator from requesting any cost information, that could also be used by the fiscal authorities from any tax payer, no data is available on that API. The rest of the ports are generally too small to allocate major resources to meet detailed regulatory informational requirements.

Since the ports are subject to a price cap and their interactions are designed to be competitive, it would make sense to construct both cost and production efficiency measures to identify possible rents from a comparison of cost and production efficiency in preparation for the revision of maximum tariff allowed. The econometric techniques available so far however do not allow yet much inference from a comparison of the efficiency estimated from cost and production functions.[10] While an estimation of both the production and cost frontier through stochastistic models should, in principle, allow for calculation of technical and allocative efficiency from different but related information bases, the reality is that such comparisons are still almost impossible to conduct in any robust way.

In view of the data restriction on the cost side, the analysis of the efficiency effect of the reforms is based on a production frontier. A production frontier assumes an output maximization rather than a cost minimization effort.[11] This may a reasonable assumption when focusing on the promotion of competition but may not be the most desirable one in view of the fact that the regulated tariffs are under a price cap regime with the explicit purpose of promoting cost reductions. The fact that market shares are a clear concern for APIs' managers and that most of the initial investment decisions were taken for them as part

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[10] See Coelli, Estache, Trujillo and Perelman (2001)

[11] In Mexico, the lack of a tradition of regulatory accounting is also a source of concern for the confidence that can be attached to cost data and the estimation of a cost function.

of the restructuring process suggests that the production orientation is overall a reasonable one. Indeed, the efficiency measures generated from the production frontier in a sector with scale economies provide information on the opportunities for expansion of outputs for a given quantity of inputs, for a given level of costs[12]..

The production variable reflecting the output of the infrastructure can be approximated by the volume of merchandise handled (in tons) in each API. This is clearly a second best. Ideally, it would have been desirable to address the multi-product nature of the APIs activities through a disaggregation of the various types of cargoes handled and through the explicit recognition that APIs also provide other services such equipment rental, commercial building and space rental, water services to the ships, etc...While these activities confirm the multi-product nature of the APIs activities, the data on these other activities is unfortunately not available for each port for the period covered. This is why we assume a single output activity which focuses on the API's main activity: the operation of an infrastructure which supports the loading and unloading of merchandise and takes the resulting volume of merchandise handled as an approximation of each API's production.

The production function builds on three inputs: labor, capital and intermediate inputs. Labor is measured by the number of workers in each API[13]. For some APIs, this includes workers used to load and unload ships which in other APIs is a service provided by private operators. The four APIs providing merchandise handling are: Topolobampo, Guaymas, Mazatlán and Salina Cruz. The capital input is approximated by the surface concessioned by the government to the API, corrected by a percentage reflecting the actual use of this capacity. As for the intermediate inputs, their heterogeneity impedes the use of any physical measure, imposing instead the use of a monetary approximation. This is provided by the sum of the expenditures on intermediate input variables used here, they are expressed in constant 1994 prices. Table 3 summarizes the main statistics and illustrates the diversity of Mexican ports.

Table 3: Summary Statistics for Mexico's Main APIs

Variable	Average	Maximum	Minimum
Production (tons)	6,823,559	17,737,060	719,459
Labor input (workers)	66	226	13
Capital input (m^2)	4,113,642	213,909,375	29,216,300
Intermediate inputs (1994 million pesos)	22,412,050	131,070,006	2,704,849

4.2. The specific model

The production frontier estimated is designed to get the best possible assessment of the sector's potential efficiency gains during the period of observation and the average position of each port with respect to these gains. This is important for the regulator since it needs to decide by how much the maximum port tariff can be cut in each port to redistribute efficiency gains achieved since the reform to

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[12] Under constant returns to scale, the results are quite different: Instead of increasing production x%, the firm could get the same output by cutting inputs by 1/x% and the corresponding change in costs can be calculated immediately when factor prices are known.

[13] This number excludes all workers allocated only to loading and unloading of ships since that activity is not being measured in this production function.

port users. The model must thus be able to allow the regulator to track down the average evolution of efficiency in the sector but also to track down over time, as effectively as possible, the absolute and relative efficiency ranking of a panel of ports to identify outliers—i.e. systematic laggards or leaders. The estimation of the model is allowed by the access to a panel of data which covers a four year period—1996-99-- that follows a two year implementation period which should have already built in the frontier shift these reforms tend to introduce. In other words, catch up is the expected outcome measure to come from this sampel rather than technological progress at this stage of the reforms.

Following the literature in the field, we tested two functional forms for a stochastic producion function, a Cobb-Douglas and a Translog. The estimates are based on the maximum likelihood method relying on the FRONTIER package, version 4.1. The specific functional formal tested are the following:

$$\ln Q_{it} = \beta_o + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 \ln I_{it} + \beta_4 T + \beta_5 \ln(K_{it})^2 + \beta_6 \ln(K_{it})\ln(L_{it})$$
$$\beta_7 \ln(K_{it})\ln(I_{it}) + \beta_8 \ln(K_{it})T + \beta_9 \ln(L_{it})^2 + \beta_{10} \ln(L_{it})\ln(I_{it}) + \beta_{11} \ln(L_{it})T + \qquad (1)$$
$$+ \beta_{12} \ln(I_{it})^2 + \beta_{13} \ln(I_{it})T + \beta_{14} T^2 + v_{it} - u_{it}$$

where: the variables are all deviations from the geometric mean and defined as follows:
$i = 1,...,N$ and $t=1,...,N$
Q_{it} is the volume of merchandise handled in port i during period t
K_{it} is the capital used by port i in period t as defined in the text
L_{it} is the number of workers employed in port i in period t
I_{it} are intermediate inputs costs in port i in period t
T is a time trend
v_{it} is the random error assumed to be iid distributed as a normal $N(0, \sigma^2_v)$ and independently distributed from u_{it} which is a non negative random variable associated with technical inefficiency and supposed to be distributed independently as a $N(0, \sigma_u^2)^{14}$.

Since the specification of the residual can in fact take various forms, we need a test to chose between the various models. This can be done through a ratio of likelihood test which works as follows:

$$LR = -2\{\ln[L(H_0)] - \ln[L(H_1)]\} \qquad (2)$$

where $L(H_0)$ and $L(H_1)$ are the value of the likelihood function under the null assumption (H_0) and the alternative (H_1), respectively. If H_0 is correct, this statistic LR is distributed as a χ^2 with as many degree of freedom as there are restrictions imposed.

Applied to the specification of the distribution of the inefficiency term, the tests leads sometimes to reject the assumption of a normal. This rejection combined with the difficulty of estimating a model

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[14] The term $-u_i$ cannot be observed in practice. Since the frontier has been estimated, the only thing observable is the difference v_i-u_i, the only solution is to rely on a predictor of this term. The best one is the expected value of v_i conditioned to the value of v_i-u_i. When the models includes explanatory variables for the efficiency of ports, it becomes a $N(\mu_{it}, \sigma_u^2)$, where $\mu_{it} = z_{it}\delta$, and z_{it} is the vector of all variables which could influence the efficiency of ports and δ is a vector of parameters to estimate in the modes including explanatory variables for port inefficiency

under a normality assumption in such a small sample (Ritter and Simar, 1997), leads to the selection of a semi-normal for the inefficiency term.

4.3. The statistical results

Table 4 presents the results of a maximum likelihood estimate of the frontier under these assumptions for three different model spefications: a translog with technological change, a translog without this change and Cobb-Douglas without technological change. The most striking result from Table 4 is that in every model the parameter γ has a value not significantly different from 1. This suggests that most of the fluctuations in the residual term is due to inefficiency (U_i) and that the random error (V_i) is approximatively 0. This implies that the stochastic frontier is not significantly different from a deterministic frontier for these ports during this period. A reasonable explanation may be that the reforms have significantly leveled the playing field and that at least in the short run, except for inefficiency, there is not much scope for randomness in the system. Considering that the reformers adjusted employment and made most of the investment necessary as part of the reform implementation that preceded immediately the period of estimation, determinism seems to be acceptable intuitively.

Table 4. Maximum Likelihood Estimates of the Stochastic Frontiers

Coeficient	Translog (nonneutral technical change)	Translog (no technical change)	Cobb-Douglas (no technical change)
Constant	0.405 (3.969)	0.565 (10.398)	0.901 (14.829)
Ln (K)	-0.142 (-14.323)	-0.202 (-4.107)	-0.156] (-7.932)
Ln (L)	-0.169 (-0.801)	0.169 (2.208)	0.106 (0.777)
Ln (I)	0.700 (10.859)	0.185 (3.962)	0.007 (0.176)
Ln (T)	-0.168 (2.227)		
Ln (K)^2	0.200 (3.303)	0.079 (1.444)	
Ln (K) Ln (L)	-0.418 (-0.668)	-0.019 (-0.160)	
Ln (K) Ln (I)	0.335 (2.468)	0.151 (3.750)	
Ln (K) Ln (T)	-0.066 (-0.845)		
Ln (L)^2	2.781 (4.313)	1.500 (3.284)	
Ln (L) Ln (I)	-1.956] (-4.995)	-0.558 (-2.048)	
Ln (L) Ln (T)	0.485 (4.052)		
Ln (I)^2	0.995 (6.270)	0.017 (0.066)	
Ln (I) ln (T)	-0.245 (-3.132)		
Ln (T)^2	0.148 (1.894)		
σ^2	0.883 (21.484)	0.990 (7.108)	1.569 (3.256)
γ	0.999	0.999	0.999

	(14051.3)	(7018185.8)	(2415717.7)
Log Likelihood funcion	-37.225	-37.961	-47.609

The t statistic is given in parenthesis below the corresponding coefficient.

In addition, the analysis of the significance of the coefficients reported in Table 4 provides useful insights. The estimation of the frontier which assumes no technological change has only 3 non-significant coefficients while the specifications with technological change shows 4 non significant coefficients. Since we estimated the translog as an approximation to an unknown form, the first order coefficients are the elasticities of production at the expansion point and the other coefficients are less important. The negative sign on capital reflects the fact that for the period covered by the analysis, there is an excess capacity.This results from significant investments made by the government at the initial stages of the restructuring process. Addition to the capital factor is a burden in the short run rather than an asset and a source of efficiency gains for the system as a whole. To be as complete as possible we also need to compare the relative validity of the various specifications. This is achieved through likelihood ratios tests reported in Table 5.

Table 5. Tests of the various specifications of the frontier

Restrictions	Model	Log Likelihood function	Likelihood Ratio Test	Critical value χ^2 (5%)	Decision
	1.Translog (non-neutral technological change)	-37.22			
$\gamma=0$	3.Translog (OLS) (no technical inefficiency)	-48.16	20.39	2.71 (*)	Reject
$\beta_4=\beta_8=\beta_{11}=\beta_{13}=\beta_{14}=0$	2.Translog (no non-neutral technical change)	-37.96	1.47	11.07	Do not reject
$\beta_5=\beta_6=\beta_7=\beta_9=\beta_{10}=\beta_{12}=0$	4. Cobb-Douglas (no technological change)	-47.61	19.29	12.59	Reject

(*) Critical Value obtained from Table 1 in Kodde and Palm (1986).

Table 6 summarizes the various restrictions tested on each model, the test value calculated and the corresponding critical value of the χ^2 distribution at 5% of significance. The last column specifies the decision revealed by the test on each set of parameters restrictions. The first test checks for the presence or absence of technical inefficiency in the port industry. If there is no such inefficiency, U_{it} could be eliminated from the model and it could be estimated though OLS[15]. This corresponds to a test of H_0: $\gamma=0$. The statistical value 20.39 is larger than the critical value and hence the assumption is rejected, meaning that technical inefficiency must be included.

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[15] When H_0:$\gamma=0$ is right, the production function is equivalent to a regular average response function and OLS estimates will yield efficient estimates.

With respect to technology, two aspects were considered. The first tests the existence of non-neutral technological change. The calculated value (1.47) is lower than the critical value and hence we cannot reject the specification without technological change. This is a bit confusing since the direct assessment based on the significance of the coefficients would have suggested the opposite. Once more the very short period covered by the analysis which follows a strong sector adjustment may provide the explanation. The second test refers to the evaluation of a Cobb-Douglas as a representation of production technology. The calculated test value (19.29) is greater than the critical value (12.59) and hence the translog function can be considered a better choice to represent the production technology of the Mexican port sector.

4.4. The efficiency scores

With the statistical results settled, we can now assess the technical efficiency of each port in each year based on the translog production function specified earlier. The annual estimates and their average for each port and for the port system as a while are reported in Table 6. The average technical efficiency of the Mexican ports for the period is _58.8%_ when the outlier Ensenada is included. This is within the order of magnitude of other estimates in the sector as seen in Table 1. The average without Ensenada is even higher. The variance across ports is however generally quite high. It varies from 6.1% in Ensenada in 1996 and 99.9% in Salina Cruz and Tuxpan en 1996; Manzanillo and Lázaro Cárdenas in 1998; and Manzanillo en 1999.[16] From an overall policy viewpoint, the results confirm that the expected gains from reform are becoming reality.

Table 6. Evolution of the port specific technical efficiency (in %)

Year	Ens	Gua	Top	Maz	Man	LC	SC	Alt	Tam	Tux	Ver	Coa	Pro	Avge without Ensenada	Average With Ensenada
1996	0.061	0.610	0.722	0.234	0.726	0.334	0.999	0.227	0.841	0.999	0.248	0.227	0.678	0.570	0.531
1997	0.071	0.566	0.726	0.298	0.849	0.828	0.943	0.305	0.743	0.853	0.541	0.229	0.777	0.638	0.594
1998	0.086	0.419	0.631	0.347	0.999	0.999	0.896	0.413	0.698	0.996	0.903	0.306	0.573	0.682	0.636
1999	0.106	0.370	0.779	0.368	0.999	0.702	0.671	0.457	0.665	0.960	0.735	0.239	0.643	0.632	0.592
Average efficiency level	0.081	0.491	0.715	0.312	0.893	0.716	0.877	0.350	0.737	0.952	0.607	0.250	0.668	0.631	0.588
Average Annual Growth rate	18.4	-16.7	2.5	15.1	10.6	24.8	-13.3	23.3	-7.8	-1.3	36.2	1.7	-1.8	6.1	8.3
Total Catchup	55.3	-50	7.6	45.3	31.9	74.3	-39.8	70.0	-23.0	-4.0	109	5.2	-5.3	18.4	25.0

During that period, the annual average technical efficiency increased from 53.1% in 1996 to 63.6% in 1998.—and is in fact higher when one ignores the clear outlier, Ensenada. The last year of the period saw a decline, possibly reflecting a demand shock resulting from the Asian crisis which the model is not

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[16] Ensenada is somewhat of an outlier because it was a fishing port until the early 1990s and is only progressively starting to handle containers for less than 10 years. In fact most of its recent growth seems to be coming from passenger ferrys.

accounting for explicitly. A potential source of concern for port regulators is that a couple of ports (Guaymas and Salinas Cruz) are showing a decline in efficiency which deserve a closer look.

The last two rows of the table give the average annual catch-up rate (measured by the rate of change in the technical efficiency measure) and the total rate for the period under observation (the accumulated rate of change obtained from a comparison of the beginning and end of period effiency level). The last row shows that 5 ports (Guaymas, Salinas Cruz, Tampico, Tuxpan and Progreso) lost some ground to the frontier over the period and with the exception of Tuxpan and Progreso for which the loss ground is minor and may simply reflect a demand shock, the regulators should be interested in taking a closer look reasons for the deterioration in the other three ports. The average annual growth rate should also be useful to the regulator in that it gives an educated guess on the range of average efficiency gains the ports should have been able to achieve over the period. This can be used to specify the reduction in price cap to be allowed for the next regulatory period of 5 years. In other words, the average efficiency gains in the sector was around 6-8% since the reform. Any port which did not achieve that should provide a good justification in order not to see its maximum tariffs cut by that much. [17]

4.5. Towards yardstick competition in the Mexican port sector

The frontiers as estimated here have just as many advantages and disadvantages as many of the other instruments regulators must rely on—asset valuation for instance is one of the key jobs of any regulator and is at least as controversial as efficiency measurement in the context of regulated industries. The disadvantages are obvious once you try to put together a data base from scratch and start having to make assumptions for almost every input and even for the number of outputs you can take into account. But for most practitioners, in particular in countries in which governance (i.e. corruption) is an issue, the transparency of the information gathering process and of the estimation rules selected here allows an increased accountability for all parties involved and better fairness in regulatory decisions. Ranking is likely to be more robust than the specific estimates and this makes this instrument useful for weak forms of yardstick competition in spite of any reservation the policymakers may have on the specific efficiency scores.

By way of illustration, Table 7 provides a ranking of the four best and four worse performers in terms of efficiency levels every year in an effort to reveal some performance patterns in technical efficiency—the regulator could also look into the ranking in terms of efficiency changes just discussed as a complement. Given this approach to ranking and given the methodology adopted to estimate efficiency, there is no doubt that Manzanillo and Tuxpan are the only port consistently among the best performers and Veracruz has joined them for the last two years. At the other extreme, the worse performers included Ensenada, Coatzacoalcos and Mazatlán. Altamira has managed to pull out of that group in 99. While this is clearly not sufficient to be used as a yardstick competition system, the results are robust enough to suggest that the regulator does have some problems on its hands and that it may be worth to take a closer look at the worse performers.

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[17] Taking the specific figures in every cell of Table 6 for granted would not be a good move for any regulator. Minor changes in the specification of the model could change some of them even if they do not change the ranking or the overall trend

Table 7. Ranking of technical efficiency[18]

Year	Maximum	Minimum
1996	Salina Cruz, Tuxpan, Tampico Manzanillo	Ensenada, Coatzacoalcos,Altamira Mazatlán
1997	Salina Cruz, Tuxpan,Manzanillo Lázaro Cárdenas	Ensenada, Coatzacoalcos, Mazatlán Altamira
1998	Lázaro Cárdenas, Manzanillo, Tuxpan Veracruz	Ensenada, Coatzacoalcos,Mazatlán Altamira
1999	Manzanillo, Tuxpan,Topolobampo Veracruz	Ensenada, Coatzacoalcos, Mazatlán Guaymas

The regulators could decide to zoom only on the top and bottom 3 or to the contrary on the top and bottom 5. They could also decide that DEA or distance functions are more appropriate because they can deal with multiple outputs. Indeed, since the production level is approximated by the volume of merchandise handled, the characteristics of these three ports may have penalized them more than the others. Coatzacoalcos only restarted container manipulation in 1999, while Ensenada—in addition to suffering from its proximity to the US ports—and Mazatlán should also have received more credit for their important handling of passenger traffic which is not allowed by the single output assumption of the production function estimated. This is why these results should be seen only as a beginning of the analytical work supporting the policy decisions.

The fact is that within their short run data constraints, regulators have many choices and must make decisions--ideally in consultation with the regulated operators. Once taken, these decisions define the rules of the game for interactions between the various actors. Once these games rules are set, competition to be on the top and reduce the risk of detailed audits for being an underperformer can become effective. The desire to sustain competition in the sector depends on the ability to create the right incentives. Comparative efficiency measures, however they are generated, can help in ports, just like they helped in water or electricity in the UK and Australia for instance. This paper suggests that it should also be possible to do it in a developing country context.

5. Concluding comments

There are three main conclusions to the paper. The first is that the reforms have resulted in significant improvements in the performance of ports on average. The average annual growth rate in efficiency was between 6 and 8% for the sector. This adds up to an almost 10% point increase in the average efficiency level over a 4 year period which starts two years after the reform were implemented. This is a significant achievement. Even if a couple of ports have not followed the trend, the results suggest that there is something virtuous about the trend promoted by the reforms. There is some scope for concern with a partial reversal in the last year of the period but as mentioned earlier, this is probably a demand driven slowdown. The lack of detailed information on the specific sources of efficiency growth due to lack

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[18] The ranking that would have obtained from a simple analysis of labor productivity would not have implied a major change with a significant exception. Veracruz which according to the technical efficiency measure is one of the best performing port would have fared quite poorly. Indeed, its labor productivity is one of the poorest in the country. The port handles 13% of the output with 26% of the total of workers, 7% of the capital and 12% of total intermediate inputs. Similarly, the analysis of capital productivity also coincides somewhat with the technical efficiency ranking but also shows a few exception. Capital productivity indicators overestimate the ranking of Guaymas while they underestimate the ranking Tampico and Topolobampo.

of data can also be a concern. From the viewpoint of a regulator, however, what matters mostly in the context of a tariff revision is the extent to which a specific port achieves efficiency gains which can be passed on to the port users and which can be showcased to other ports to promote competition and these estimates provides a reasonably rigorous estimate. This is a useful lower bound for what these gains may have been.

The second is that the analytically sound performance rankings allowed by these port specific efficiency measures can help in promoting yardstick competition in the sector. This ranking is superior to the one that would emerge from a ranking based on partial productivity indicators. It accounts for the joint effects of all inputs on outputs. This is crucial because it avoids the risks on inconsistent rankings based on different arbitrary choice of partial indicators.

Finally, while hopefully the paper provides some light on the potential payoffs from efforts to measure technical efficiency to assess the caching up effect generated by reform, it does not do justice to the sweat and tears that go into developing the data base needed to measure efficiency in countries without a strong tradition of putting consistent and policy relevant data bases together. While the objective of trying to come up with a fair quantitative ranking is clearly policy relevant, it is important to recognize that the task is a major challenge in most developing countries, in particular in transport sectors where the tradition to generate policy friendly information is still in its infancy. Even in almost ideal situations—i.e. when the regulator actually want to identify the necessary information--as is the case in Mexico--, the most immediate impact of the exercise was to reveal the poverty of the data base and the need for the regulators to invest in its development. In the end, the quality of the data did define our ability to be specific in the performance ranking challenge subce the quality of the model specification is driven by data limitations. With this initial work, the regulator should be able to improve upon these results for future policy use.

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