THE BROAD ECONOMIC IMPACT OF PORT INEFFICIENCY

A COMPARATIVE STUDY OF TWO PORTS

December 2004

This publication was produced by Nathan Associates Inc. for review by the United States Agency for International Development.

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Sponsored by USAID's Bureau of Economic Growth, Agriculture and Trade (EGAT) and implemented by Nathan Associates Inc., the Trade Capacity Building (TCB) Project, 2001–2004, helps developing countries assess their trade constraints and prioritize their trade-related technical assistance needs. The project provides trade experts for short-term technical assistance in developing countries and assists USAID Missions in designing, implementing, monitoring, and evaluating technical assistance that will stimulate economic growth and reduce poverty. Electronic copies of reports and materials related to trade needs assessments, resource guides, and trade training workshops are available at www.tcb-project.com. USAID Missions and Bureaus may seek assistance and funding for activities under this project by contacting John Ellis, USAID/EGAT, TCB Project Task Manager at jellis@usaid.gov.

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This report was made possible through support provided by the United States Agency for International Development under the terms of Contract No. PCE-I-00-98-00016-00, Task Order 13.

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EXECUTIVE SUMMARY

Weaknesses in trade-related transport and logistics, particularly in developing countries, impose costs on producers that erode the intended benefits of trade preferences in major markets, such as the United States and the European Union. In fact, the cost of such weaknesses may be many times greater than the benefit of preferences. Accordingly, trade capacity-building assistance should address these logistical and transport weaknesses so developing countries can join the global economy. Among weaknesses that need to be addressed, port inefficiencies may be the most serious and least understood. Improving ports can lower total transaction costs and boost the competitiveness of a country's exports—and in the long run create jobs, spur growth, and improve general welfare.

Studies relating port costs to national competitiveness have consistently shown a strong relationship between port efficiency and the cost of traded products. Until now, such studies have not made concrete linkages to the sources of those efficiencies, or attempted to quantify the effects of specific types of inefficient practices, much less calculate the overall trade and welfare effects of such inefficiencies, as we do in the original research presented here.

In this study, we analyze the operation of a port challenged by congestion, Puerto Limón (in Costa Rica), comparing it with a port known for its efficient operations, Cartagena (in Colombia). We compare the cost and performance of Cartagena with that of Puerto Limón by determining vessel berth and cargo dwell times and by "sailing" a model ship through our port tariff model. We then examine and explain processing procedures for each instance in which processing times in the inefficient port exceed those in the efficient one. This comparison enables us to identify factors that contribute directly and indirectly to the relatively high cost of using the Puerto Limón port facilities.

Together, these costs undercut the cost advantage Limón would otherwise have over our benchmark port in Cartagena. Furthermore, our analysis shows that excessive costs can be attributed not only to low cargo volumes, the usual explanation for Central America's high freight rates, but also to inefficiencies that carriers and shippers confront in Central American ports. Delays caused by inefficient ports on a ship's itinerary force the carrier to increase the sailing speed of its ships or introduce additional ships in its service patterns, raising carrier costs substantially.

We then calculate the overall cost difference between the efficient and the inefficient port and, in turn—using the Global Trade Analysis Project (GTAP) model—the impact of such inefficiency on the Costa Rican economy. Our simulation shows that removing the inefficiencies of Puerto Limón would improve Costa Rica's GDP by nearly 0.5 percent. This finding is significant: it shows that the performance of a country's ports affects its economy significantly. This suggests that the benefits of trade agreements cannot be fully realized unless port reforms, including private sector participation and the introduction of competition, complement advances in trade policy.

Our analysis and findings have important implications for USAID. First, USAID and other donor-supported trade capacity-building assistance should aim to improve the efficiency of trade-related transport and logistics. As the experience of Costa Rica shows, persistent weaknesses in trade infrastructure can seriously undermine the effectiveness of trade policy liberalization, whether through national reforms or embodied in a free trade

agreement. Such weaknesses and the inefficiencies associated with them can also undermine the intended benefits of trade preferences that developing countries enjoy in major markets.

Second, such assistance need not concentrate solely or even largely on physical infrastructure. For example, while some of Puerto Limon's problems can be traced to inadequate infrastructure and an inability to finance improvements, a carefully formulated port privatization program that leverages investment and promotes competition in port services can resolve these problems. USAID or other donor assistance in formulating port privatization strategies can help alleviate port inefficiencies.

And third, to be effective, USAID assistance to improve port efficiency in any given developing country often must also address the concerns of political constituencies that oppose needed reforms. In Costa Rica, for example, labor union resistance in Puerto Limón has delayed a privatization program; any port reform effort will have to consider labor mitigation as a means for overcoming resistance.

1. INFRASTRUCTURE AND COMPETITIVENESS

To increase their competitive edge in the U.S. and European markets, many trade partners are seeking trade agreements with the United States and the EU that will give them preferential access (in some cases duty-free access) to these large markets. At the same time, many developing countries are seeking to liberalize their trade regimes and undertake comprehensive reforms that will improve their ability to attract investment, improve productivity and product quality, and reduce production and transaction costs. The World Bank, the InterAmerican Development Bank, USAID, and many donor countries have increased their funding for such efforts. But persistent weaknesses in infrastructure and the policy and institutional frameworks that govern its development often hamper these efforts and dilute their effectiveness.

Recent research, for example, has shown how transport inefficiencies affect development, trade success, and foreign investment. Hummels (1999) provides evidence of the impact of high transportation costs (determined by distance to source and export markets), on development. Henderson, Shalizi, and Venables (2001) explore how transport costs influence trade and welfare. Hoffmann and Kumar (2002) show a symbiotic relationship between trade and maritime transport and their interplay with globalization. Other studies show the precise impact of high transport costs. Limao and Venables (2000), for example, show that increasing transport costs by 10 percent can reduce trade volumes by 20 percent; Radelet and Sachs (1998) show that a doubling of shipping costs can slow annual economic growth by about a half percentage point.

While these studies illustrate the effect of transport on trade flow patterns and the importance of transport costs to trade success, some use distance as a proxy for transport costs in their analysis. High transport costs, however, can be explained by many other factors, such as lower cargo volumes, trade flow imbalances, inadequate infrastructure, onerous border and cargo processing procedures, and port inefficiencies. Port costs, for example, represent about 8–12 percent of total transport costs from product origin to destination. Shippers, who consider port costs as one of the very few, if not the only, controllable costs in the logistics chain, make shipping decisions in part based on those costs. To the extent that port costs are a proxy for port performance (efficiency), then port performance influences shippers' choice of markets.

More and more studies of the impact of transportation on trade and welfare are focusing on ports and border crossings. Clark, Dollar, and Micco (CDM) (2001) declare that port efficiency can affect transportation costs and that an inefficient port can increase the distance to a shipper's export market by 60 percent. In a study of Asia Pacific Economic Cooperation (APEC) countries, Wilson, Mann, and Otsuki (WMO) (2003) explore the importance of port efficiency relative to other factors that enhance or constrain trade, such as customs performance, the regulatory environment, and e-business. Calculating indicators for each factor, WMO find that improvement in port efficiencies yields the largest increases in trade flows; specifically, an improvement of just 0.55 percent in the port efficiency indicator has the same impact as 5.5 and 3.3 percent improvements in customs performance and e-business indicators, respectively.

CDM and WMO, however, do not address port efficiencies in terms that shipping companies or shippers understand. Shippers and shipping companies (carriers) want to know how long it will take a port to process their ship or cargo and at what cost. CDM and WMO rely extensively on annual survey results of the *Global*

Competitiveness Report.[1] Only one survey question addresses ports: individuals are asked to respond on a scale of 1-7 to the statement "Port facilities and inland waterways in your country are (1 = underdeveloped, 7 = as developed as the world's best)." One can imagine how individuals from Montana, Lesotho, Malawi, Uganda, Bolivia, and cities in mountainous areas far from coastlines might respond to this question. Even if we accept these survey responses as realistic measures of port inefficiency, we still cannot discern the underlying causes of inefficiency.

Researchers are also scrutinizing how border processing procedures affect trade. Given the relationship between border processing time and transport costs, delays at crossings create a "virtual" border of several hundred miles. Inefficient procedures undermine the intended benefits not only of liberalized trade policies, but also of investments in border infrastructure and information technologies. Improving those procedures can lower total transaction costs and thereby improve the competitiveness of a country's trade—and recent research suggests that better procedures can lower costs substantially. These studies, however, focus on formal trade barriers, with relatively little attention to informal trade barriers, particularly at border crossings. As Hummels (2001, 5) asserts,

> non-tariff barriers of various sorts and structural impediments are less obvious and perhaps more interesting, but also much more difficult to directly measure. As a consequence, researchers rely primarily on indirect methods: positing a model of bilateral trade flows and correlating flows with proxy variables meant to represent trade barriers.

Recent research sheds some light on border logistics processing requirements and, more important, the underlying causes of cross-border inefficiencies. Haralambides and Londoño-Kent (2002) "capture" the movements, times, and costs of each procedure in freight transport (via truck) across the Laredo (Mexico) to Nuevo Laredo (United States) border by sending a "hypothetical shipment" from Chicago (United States) to Monterrey (Mexico). Francois, Fox, and Londoño-Kent (2003) identify the cost impact associated with these border procedures, potential savings if improved, and the consequent impact of improvement: welfare increases of $1.8 billion and $1.4 billion for Mexico and the United States, respectively, and a nearly 10-percent increase in cross-border trade flows.

Likewise, Ashar, Hochstein, and Kent (1998) address port efficiency (as defined by a combination of cost and performance) when they examine the extraordinarily high freight rates to Central American ports. The study explicitly recognizes the economies-of-scale disadvantage of smaller economies and proposes a new system of maritime shipping to consolidate shipments and increase volumes at specific ports that would serve as hubs (i.e., a coast to coast pendulum service with a Canal transit). The study implicitly addresses port inefficiencies by calculating total port costs per container for specific ports; port charges that use time as a basis for calculating charges, such as berthage, serve as a proxy for inefficiency (e.g., the longer a vessel stays at the berth, the more the port charges for the vessel's stay). This study, however, still does not capture all costs associated with a vessel's call to a port; the ship itself incurs greater operational costs, for example, when poor port performance extends its stay in the port. Similarly, a shipper incurs more port storage costs if the time required for processing its container goes beyond "acceptable" bounds.

Though we have made much progress in understanding how port performance affects trade and welfare, research that addresses port inefficiencies in commercial terms—in fact, the underlying causes of inefficiencies—and their impact on the cost of using a specific port, is rare. In this paper, we therefore extend the approaches of Haralambides and Londoño-Kent and of Ashar, Hochstein, and Kent to assess port costs and inefficiencies and discern their underlying causes. We compare the cost and performance of an efficient

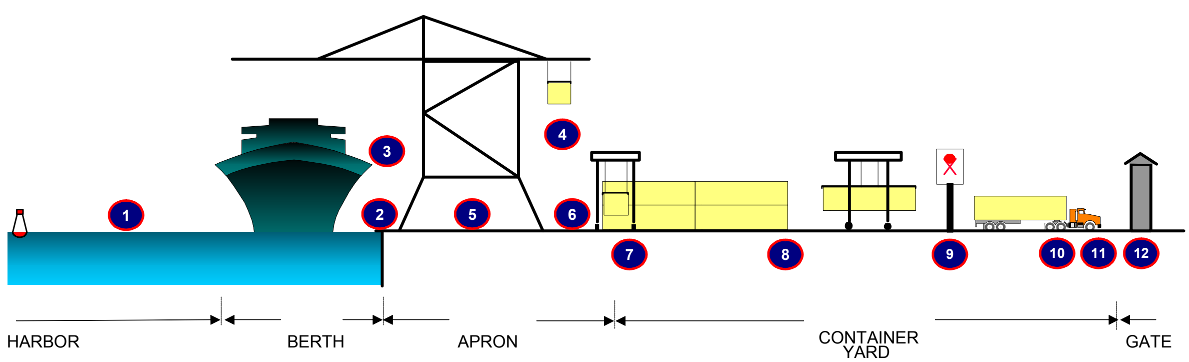
[1] Question 5.03 of the *Global Competitiveness Report* refers to port infrastructure quality. See World Economic Forum, *Global Competitiveness Report, 2004-2005*, *Table* 5.03, p. 514 for results of this survey question.

port (i.e., one that is known to operate at global standards) with an inefficient one by determining vessel berth and cargo dwell times and by "sailing" a model ship through our port tariff model. We then examine and explain times in the inefficient port that exceed those of the efficient one in view of the processing procedures used in the inefficient port. In calculating the cost difference between the efficient and the inefficient port, we arrive at the cost of inefficiency. This cost is treated as a tax in the Global Trade Analysis Project (GTAP) model to derive the impact of port inefficiency on trade and welfare.

2. THE PORT LOGISTICS CHAIN: A PRIMER

A port effectively serves as a border crossing for international carriers. Cargo and ships coming to and crossing the border are assessed charges for their use of port facilities and services. The port logistics chain consists of a variety of nodes through which the ship and cargo move. The chain starts at the entrance buoy to the harbor and usually ends as the cargo passes through the port gate after it is nationalized and claimed by the consignee.[2] The ship or cargo is assessed a charge as it proceeds through each node. Figure 2-1 depicts what happens inside a port as a ship arrives and its cargo is discharged and handled inside the port terminal. Here, we use a container ship as an example because container activity tends to capture all port services.

Figure 2-1
Nodes in Port Logistics Chain Where Cargo is Exchanged



Focusing on the movement of the container, the following steps keyed to Figure 2-1 describe the logistics procedures that occur in a port terminal. A flow of paperwork parallels and documents each step:

1. At the entrance buoy, a pilot boards the vessel and guides the captain through the navigation channel. If no berth is available, the ship is assigned an anchorage area. The port usually does not charge an anchorage fee if no berth is available. As the ship approaches the berth, one or two tugs, depending on ship size and port regulations, will greet it and help maneuver it to the berth. Line handlers greet the ship at the berth and secure it by tying down its lines. At this point, the ship has incurred charges for navigation or port dues (to cover the cost of dredging the channel and providing lights and buoys for

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[2] Sometimes, the port logistics chain does not end at the port gate; the container in which the cargo is carried can be moved immediately after its discharge from a ship to a satellite storage area where it is stored until processing is complete and the consignee picks it up.

navigation safety), pilotage, tug assist, and line handling. In some ports, navigation, pilotage, and tug assist may be combined into a single charge. These charges all apply to the carrier.

2. Once the ship is secured to the berth, the port applies a berthage charge (i.e., "parking" fee) usually calculated on the basis of time and vessel size. The berthage charge stops when the last line is untied from the ship as it leaves the berth. The charge is applied to the vessel.
3. Inspection authorities (e.g., defense security and drug enforcement) may board the ship. Usually cargo is not loaded or unloaded until the authorities have completed their inspections. Inspection may not carry a charge.
4. The first gang loads or unloads cargo using a crane, in modern terminals, usually gantry cranes or harbor cranes. Some ships, referred to as "geared" vessels, have their own cranes, which, however, are not as productive as gantry or harbor cranes. Productivity rates for gantry cranes are about 25 moves per hour, for harbor cranes about 18-20 moves per hour. "Moves" are the movements of a container between the ship and the apron, the area set aside for loading and unloading. The charge for crane use, which is applied to the ship, can be on a per move basis or on a time (hourly) basis. When ship's gear is used, the crane charge does not apply, but "wharfage" is still charged.
5. The charge for the "move" is intended to cover the use of the apron and other areas of the terminal where the container is moved to or from storage. This constitutes a wharfage charge. Wharfage is charged to the shipper (i.e., importer or exporter).
6. The seal is inspected and a fee may apply. If so, it is charged to the shipper.
7. This area as a whole constitutes "dispatch," where the container is moved to or from an assigned slot (a space in the yard). Container storage operations occur in the yard. Dispatch fees are charged to the shipper.
8. The container is stored until it is inspected and claimed by the consignee (importer). Ports offer free storage for about 3-5 days. After that, storage charges apply, in many cases even when the container must remain in storage because Customs has not yet cleared the cargo. If the terminal is congested, ports raise storage charges to discourage shippers from using the port for cheap storage. If the terminal is not congested, ports lower fees to encourage longer storage so that the ports can collect a fee. Shippers usually have other storage options if the port's prices are too high. Charges vary according to the direction of the container (import or export), whether it is full or empty, or by size. Container size is measured in terms of 20-foot equivalent units (TEUs). A typical container is one TEU (a 20 footer) or 2 TEU (a 40 footer). The storage fee is charged to the shipper.
9. The container is moved from the yard onto a truck chassis and cleared by Customs.
10. If necessary, the container is fumigated. The charge for fumigation is applied by a government agency, not the port.
11. Some ports impose a "traffic" tax on trucks so they may enter the terminal.
12. Gate processing includes weighing the container (for which there is a scale charge), reviewing paperwork, and conducting a security check, for which there may also be a charge. These charges apply to the shipper.

Terminals are more efficient when port operators use computerized process control systems to optimize container movement and storage and to provide for electronic conveyance of documents and data.

3. RESEARCH SAMPLE: PUERTO LIMÓN AND CARTAGENA

In deciding which ports to use to calculate differences in costs, we searched for two ports with distinctly different levels of efficiency but operations similar in scope and scale. For example, we did not want to compare a port involved primarily in transshipment trade with a port involved primarily in domestic trade. The operational services for transshipment ports[3] have higher productivity rates at the berth, storage areas for transshipment tend to be closer to the berth, and the operations between berth and storage tend to be highly integrated because this is what mainline (transshipment) vessels require. Vessel turnaround time—the time it takes to serve the vessel and its cargo at the berth—is important for both transshipment and domestic container operations, but even more so for transshipment. We therefore excluded "pure" transshipment ports, such as Singapore, Hong Kong, Freeport (Bahamas), and Manzanillo (Panama).

For our efficient port, we sought a port (1) operating in a developing country with a liberalized economy and experiencing strong trade growth, and (2) meeting global standards (i.e., quick vessel turnaround time and high berth productivity).[4] Why did our efficient port need to be in a developing country? Efficient ports in developing countries tend to operate in a privatized environment (with competition). As such, an efficient port so selected shows what an inefficient port—most of which are in developing countries—can reasonably aspire to. In selecting an inefficient port, we first identified ports well known in industry circles for being inefficient. We also sought a port in a developing country that has made progress in trade reform, but not in liberalizing trade infrastructure assets (e.g., ports). Additionally, we sought an "inefficient" port that could be affected by trade opportunity (e.g., impending regional trade agreements and new rules of origin) and challenges (e.g., termination of quota systems).

Given these criteria, as well as our concern for comparable scale and scope of operations, we selected the Port of Cartagena, Colombia as the efficient port and Puerto Limón in Costa Rica as the inefficient port. To a great extent, Puerto Limón is what Cartagena was ten years ago, and Cartagena is what Puerto Limón can aspire to be. Before describing our sample ports in detail, we shall first review the Costa Rican trade context.

THE COSTA RICAN CONTEXT

Costa Rica has long had a tradition of exporting bananas, coffee, sugar, and beef. In 1970, these products represented about 60 percent of Costa Rica's exports. Over the years, Costa Rica realized that continual dependence on these products was risky given the instability in global demand. So, the country embarked on a program of economic diversification, promoting ecotourism; developing export processing zones targeting apparel, electronics, and other exports; "modernizing" foreign direct investment policy; and liberalizing the trade regime. Since 1990, Costa Rica has concluded trade agreements with Canada, Chile, the Dominican

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[3] Transshipment ports serve as hub exchange points where containers from a larger ("mother") ship are discharged temporarily onto the berth apron for immediate loading onto a "feeder" (smaller) vessel. Today, such mother ships can approach 8,000-TEU capacity, while feeder ships tend to range up to about 3,000 TEUs.

[4] Berth productivity is measured by the number of moves per ship hour at the berth.

Republic, Mexico, and the United States as part of the U.S.-Central American Free Trade Agreement (US-CAFTA).

Costa Rica's trade performance has improved dramatically. Today, the traditional four products represent less than 15 percent of the country's total exports. Agricultural exports now include melons, pineapples, and cut flowers, among other agricultural items. With a large investment by Intel in a new integrated circuit plant in San Jose, computer technology and other non-traditional products now account for the greatest share of export value (Fox 2003).[5] Costa Rica exports to 130 countries, and its primary trading partner is the United States, which takes about 47 percent of the country's exports (including products from export processing zones). Exports to the European Union and to other Central American countries account for about 18 percent and 13 percent of total exports, respectively.

In recent years, Costa Rica's apparel exports have lost some competitiveness. Producers have not kept pace with producers in neighboring countries that have lower wages, or with low-cost Asian producers who are no longer subject to quotas on their exports to the United States and European Union. Still, the sector remains important. Apparel exports of about $300 million annually make up about 5 percent of Costa Rica's total exports—nearly all of which is destined for the U.S. market. According to the Costa Rican Investment Board, high production quality has encouraged foreign investors in apparel factories to remain, but the reputation for quality has not attracted new investment in the face of rising price pressure from large-scale, low-cost apparel producers in China and India. Costa Rica's ability to attract sizable foreign investment from chip-maker Intel, despite the country's high wages by regional standards, is partly attributable to the quality of its workforce(Fox 2003).[6]

In January 2004, Costa Rica agreed to join in the U.S.-CAFTA a month after the negotiations had concluded between the United States and El Salvador, Guatemala, Nicaragua, and Honduras. This agreement has yet to be ratified by any of the six legislatures. The Dominican Republic has also now "docked" onto the agreement.

One objective of the negotiations was to improve the textile and apparel export benefits these countries enjoy. Some of these benefits, as pointed out in Nathan (2003), include permanent duty-free access and hence elimination of the need to resort to U.S. Congressional approval for such access (as is required under the Caribbean Basin Trade Preferences Act, which ends in 2008) and changes in the rules of origin for products eligible for duty-free access to U.S. markets. While these benefits should help Costa Rica preserve its competitiveness in textile and apparel exports, that competitiveness will be challenged by other countries (predominantly Asian) no longer restricted by textile and apparel quotas after December 31, 2004 under provisions of the WTO Agreement on Textiles and Clothing.[7]

The importance of sustaining Costa Rica's competitiveness in the face of new rivals is underscored by its dependence on its ports; about 92 percent of its textile and apparel exports are shipped via water. In fact, Costa Rica relies much more on maritime shipping to the United States for its textile and apparel industry than many other countries competing for the same market (Table 3-1).

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[5] See Fox, James W., *Successful Integration into the Global Economy: Costa Rica and Mauritius*, Nathan Associates Inc., TCB Project, January 2003 (available at www.tcb-project.com).

[6] Frequency of air flights to pertinent markets also influenced Intel's decision to locate in Costa Rica.

[7] See Minor, Peter, *Changes in Global Trade Rules for Textiles and Apparel: Implications for Developing Countries*, Nathan Associates Inc.: The TCB Project, November 2002 (available at www.tcb-project.com).

Table 3-1

Use of Shipping Modes to the United States for Textile and Apparel Industry

Country	Average Charge (% f.o.b.)		% Shipped by Air
	Ocean	Air	
CENTRAL AND SOUTH AMERICA			
Costa Rica	2.4	4.7	7.6
Nicaragua	2.8	4.8	11.1
Honduras	1.9	8.0	2.7
Guatemala	2.5	8.1	10.0
El Salvador	2.0	5.9	6.5
Mexico	2.2	5.6	2.0
Argentina	6.9	11.8	33.4
Brazil	7.0	10.0	39.3
Colombia	1.6	4.3	56.3
Ecuador	5.0	15.3	36.3
Peru	2.6	7.2	41.5
ASIA			
Bangladesh	5.3	22.9	11.3
China	3.6	11.1	24.3
Hong Kong	2.8	12.4	24.0
Indonesia	4.2	17.0	17.0
AFRICA			
Kenya	4.5	20.3	19.3
Lesotho	4.3	18.5	16.5
Mauritius	4.1	14.4	27.6
South Africa	5.1	17.1	18.3

SOURCE: *Nathan Associates Inc.,* Economic and Employment Impacts on the Dominican Republic of Change in Global Trade Rules for Textiles and Apparel*, USAID Bureau of Economic Growth, Agriculture, and Trade, Washington, D.C., June 2003 (citing U.S. Bureau of Census, Imports of Merchandise Trade, 2002).*

While Costa Rica offers distance advantages relative to its emerging rivals from Asia and South and East Africa, these rivals will be reducing their production costs to gain greater access to U.S. markets. Indeed, South Africa, Mauritius, Hong Kong, and China already allocate at least 18 percent of garment products to air shipments, suggesting some success in production cost control and a strategy to overcome the distance advantages of rivals in the Western Hemisphere. Interestingly, the greatest allocation to air shipments come from South America (Table 3-1), particularly Colombia, Argentina, Brazil, Ecuador, and Peru. In Colombia, textile producers are not near the country's ports, so the added costs for land transport make air shipments a viable alternative.[8] Producers from Ecuador and Peru have to overcome the disadvantage of Panama Canal transits for most of their shipments, which are destined for U.S. Gulf and East coast markets. The tolls for Canal transits today are equivalent to about $100 per container. Brazil and Argentina use air shipments to overcome the market proximity advantages of Central American and Caribbean rivals. Other CAFTA and non-CAFTA countries in the Caribbean, such as the Dominican Republic, share similar distance-to-market advantages.

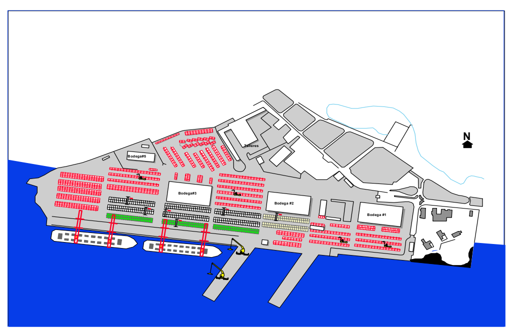
Manufacturers need shipping reliability and quick access to markets because of the unique retail-related dynamics of garments. As Nathan (2003) points out, the price of a particular garment one week after Christmas can be 50 percent cheaper than the garment one week before Christmas. When a vessel calls a port in Costa Rica, the port will need to not only avoid delays in serving the vessel, but also minimize vessel berth time and cargo dwell times.

PORT OF CARTAGENA, COLOMBIA

In November 2003, the Port of Cartagena (Figure 3-1), located on Colombia's Atlantic coast, celebrated the tenth anniversary of its privatization. In the late 1980s, Colombia recognized the value of economic liberalization and began its "Apertura" movement. One of the country's first priorities was to drastically reduce tariffs. Nominal average tariffs dropped almost 40 percent to about 10 percent and the sectoral dispersion of "protection" rates also dropped from an average effective rate of about 70 percent to just 22 percent. Colombia's bold trade liberalization became a model for much of the rest of Latin America and, despite some internal industry opposition, the momentum of the Apertura movement could not be reversed.

Figure 3-1

Port of Cartagena: A Modern Port Operating at Global Standards



SOURCE: Sociedad Portuaria Regional de Cartagena

Colombia realized that trade reform itself would be at risk unless structural constraints on trade were also addressed. Infrastructure assets, particularly ports—notorious for low productivity, poor efficiency, inadequate security, and extremely high costs—were targeted for reform. Carriers viewed the situation as untenable, and in 1990 imposed a penalty surcharge of $2.50 per ton in Colombian ports, in effect erecting a tariff barrier to free trade. Colombia's ports were thus obstacles to the achievements envisioned for the Apertura movement. It was not by coincidence, therefore, that Colombia's very first law of 1991 addressed the liquidation of the government's port agency and created a public–private partnership for port operations that

8 Hinterland transport in Colombia can be $1,000 or more per container depending on plant location.

is today a model for port reform around the world. Private entities were awarded concessions to operate Colombia's ports in 1994 and, as indicated by their recent conference celebrating privatization, ten years make a great difference.

Since the private operator, Sociedad Portuaria Regional de Cartagena (SPRC), assumed control of a terminal formerly run by the government agency COLPUERTOS in 1994, cargo growth has grown from about 93,000 to nearly 400,000 TEUs per year. More important, more than $150 million in investments have been made, costs per move have decreased dramatically, productivity has increased to more than 50 moves per ship-hour, and berth utilization rates have decreased to the point that vessels no longer have to wait for a berth (Table 3-2).

Table 3-2
Port of Cartagena Performance Improvements since Private Concessioning in 1994

Performance Measure	Pre-reform (1993)	Post-reform (2003)
Containership waiting time	10 days	0
Containership turnaround time	72 hours	7 hours
Gross productivity/hour	7 moves/ship hour	52 moves/ship hour
Berth occupancy	90 percent	50 percent
Cost per move	$984	$224
Bulk cargo productivity	500 tons/vessel/day	3,900–4,500 tons/vessel/day
Hours worked per day	16	24
Cargo dwell time	30+ days	2 days
Port costs	$984/per move	$222/per move

SOURCE: Kent, Paul E. and Hochstein, Anatoly, "Port reform and privatization in conditions of limited competition: the experience in Colombia, Costa Rica, and Nicaragua", Maritime Policy and Management, *1998, vol. 25, no. 4, p. 313 and Sociedad Portuaria Regional de Cartagena.*

PUERTO LIMÓN, COSTA RICA

In contrast to Cartagena's rags to riches tale is that of Puerto Limón (Figure 3-2). Puerto Limón is Costa Rica's Atlantic gateway port for containerized cargoes and the country's leading port in container volume. As the Atlantic coast gateway port for Costa Rica, the port serves markets to the U.S. Gulf and east coasts as well as to Europe, primarily for textiles, bananas, and coffee. The port also serves as a cruise ship port of call, with more than 100 calls per year, catering to ecotourism-related activities for passengers.

Located about 115 km from San Jose, the port handled just over 610,000 TEUs in 2002. The port is essentially a monopoly, though several private companies compete for vessel stevedoring (ship-to-shore movements of cargo). Because of extraordinarily high berth utilization rates for the dedicated container berth (approaching 90 percent or more), a container ship can expect to wait 12 hours for a berth, raising the costs for the vessel operator calling the port.[9] The vast majority of shippers using Limón have no other option because of high hinterland transport costs and extensive transport time required. Costa Rica has had very

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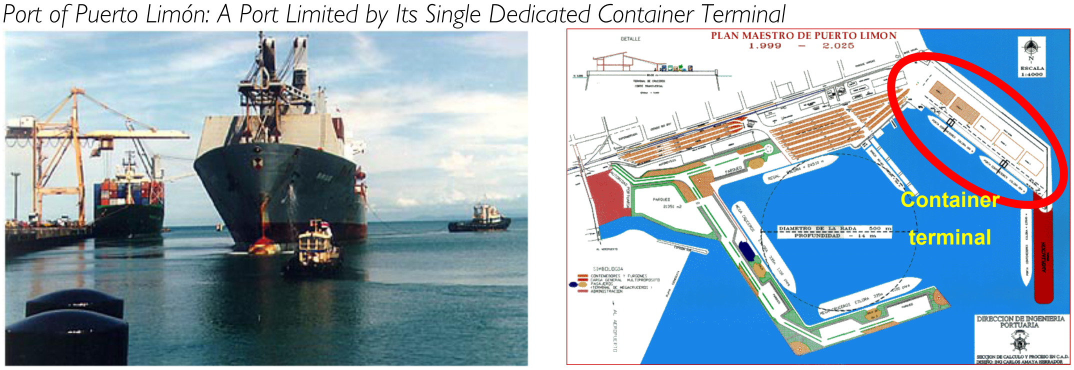
[9] Note that a 90 percent berth utilization rate means that a ship only has a one in ten chance that a berth will be available when it arrives. Because of the relatively high operational costs of a containership, "optimal" utilization is usually in the range of 60 percent, suggesting a high probability that a berth is available when the vessel arrives.

limited progress in port privatization. Because of the strength of the labor unions on Costa Rica's Atlantic coast (and hence forceful opposition against privatization), the government decided to start first with the privatization of port facilities at the Port of Caldera, on Costa Rica's Pacific coast. There, union-port relations were considered less problematic, and the government proceeded with the development of a privatization program consisting of five transactions. However, the government's unrealistic requirements for investments from potential concessionaires discouraged interest in the transactions, and ultimately only one bid was awarded. After delays due to a legal requirement to make labor severance payments before the transaction is signed, the transaction was finalized in mid-2004.

Figure 3-2

Port of Puerto Limón: A Port Limited by Its Single Dedicated Container Terminal



SOURCE: Junta de Administración Portuaria y Desarrollo Económico (Agency for Port Administration and Economic Development), Costa Rica.

The congestion problem in Puerto Limón is caused for the most part by an insufficient number of berths and insufficient yard storage for container handling. The dedicated container terminal today can serve only one ship at a time because of larger ships that are calling there, and its on-dock storage capacity is estimated to be only about 500 TEUs. Construction of additional berthage and storage in other facilities in Moín, a port complex about 12 km away and managed by the same government entity, has been delayed because of the port's inability to continue financing the project. Though the port is experiencing berth congestion, the Customs operation is relatively efficient; Customs clearance typically requires between 24 and 48 hours (compared to 3-5 days in the United States).

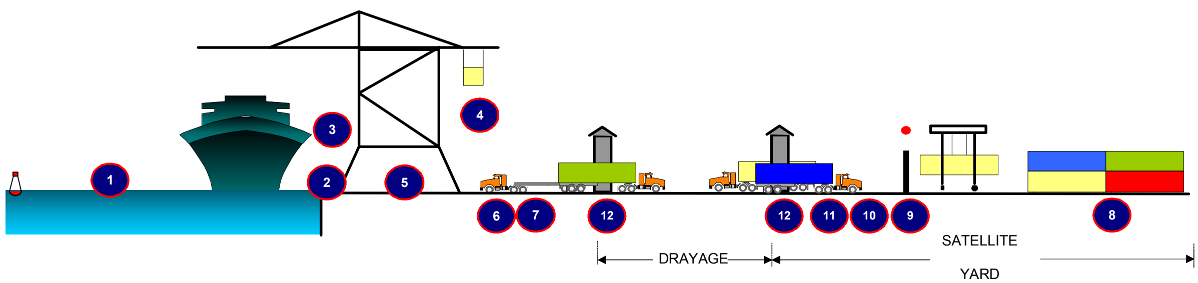
From an operational point of view, efficiency losses are really tied to berth congestion and inadequate storage. Because of the small storage yard, containers are drayed immediately from the berth to a satellite yard, which can take up to 45 minutes. This "stretches" the handling chain and hence requires more equipment to move the containers to storage than what is normally required to achieve the same berth productivity enjoyed by terminals where larger storage yards are close to berths. Because the port cannot afford additional handling equipment, carriers suffer from lower berth productivity, incurring additional costs from a longer port of call.

Why are the port's finances so bad? The port's mission, as defined in the law, is to serve both as a port authority and an economic development agency. Both activities are financed through port tariffs; in fulfilling its economic development role, the port believes it should be an employment generator; hence, excessive workforce levels relative to the port's scale and scope of operation are the norm. Because of this situation, as well as lobbying from port users who complain about high costs, the country's economic regulator has refused to approve the port's petitions for tariff increases. The combination of obligatory wage increases for unionized labor, excessive workforce levels, stagnant growth in cargo volume, inefficient handling systems, and the port's continuing inability to get approval for tariff increases from the country's economic regulator have caused the port's tenuous financial condition: the port lost $3 million in 2002 and losses for 2003 are estimated to be $4 million. Some have predicted that if conditions do not change, the port will be in bankruptcy within the next 3 to 5 years.

As noted in Figure 2-1, ships and cargo acquire services through 12 nodes in a port operation. We revised Figure 2-1 to reflect the drayage and satellite yard operation (Figure 3-3). We shall now follow a container processed in Puerto Limón:

Figure 3-3

Nodes in Puerto Limón's Port Logistics Chain Where Cargo is Exchanged



- After the port receives a pilot and tug services to assist the vessel to the berth, the vessel is tied to the berth (step 2), following which a member of the Drug Enforcement Administration and a member of the health department board the ship; inspection can take from 30 minutes to 1 hour (step 3).
- The port sends one or two gangs (groups of workers) to discharge the containers (step 4).
- The crane charge for loading or discharging is $47 per move plus $36 per move for stevedoring labor (step 5). When the port's two cranes are used, productivity is about 38 moves per ship-hour. This is relatively slow, and caused by lack of storage capacity within the terminal and staging the container with a truck chassis for drayage to the satellite yard. By comparison, Cartagena has a berth productivity rate of 52 moves per ship-hour when two gantry cranes are used. Because of the lower productivity rate in Limón, ships spend more time at berth and incur higher berth charges.
- After each container is discharged, the container seal is inspected (step 6) before movement out of the terminal and checked once again upon arrival to the satellite yard (step 12).
- The container is placed on a chassis and dispatched to the satellite yard (step 7).
- Upon arrival to the satellite yard, the container is moved to storage (step 8), for which a yard handling charge is applied ($22 per move). Because Customs processing is relatively quick, shippers do not incur a storage fee unless they choose to keep the container there longer than the free period (5 days), for which a charge is then applied.
- Customs officials, who do not work 24 hours per day, clear the container (step 9). If the container arrives after Customs work hours, then clearance takes place the next day.

- Some cargoes may require fumigation (step 10). When Customs and other inspection agencies release the container, it is placed on a chassis. Gate processing occurs (step 11), the charge for which is included in the satellite operator's yard handling charge, and the container then exits the port (step 12).

4. MODELING RELATIVE COSTS OF THE TWO PORTS

As noted earlier, we can compare the costs of the efficient port (Cartagena) with the costs of the inefficient one (Puerto Limón). We do this by developing a port cost spreadsheet model and sailing a "model" vessel through the port's tariff and the charges applied by non-port entities (e.g., tug services, line handling). A model vessel is necessary because larger ships, enjoying economies of scale, have a lower cost per move (when all of the vessel and cargo charges are applied) than a smaller ship. So the model vessel provides for an equitable comparison in the two ports. For our model vessel we chose a carrier service common to both ports: New Caribbean Service (NCS). NCS ships typically have a capacity of 2,000 TEUs.

Spreadsheet models incorporating the charges applied to the vessel or cargo were developed for each port (Tables 4-1 and 4-2). Because actual charges may deviate from the tariff and "advertised" charges of non-port service providers, we verified the charges through interviews and a review of ship and shipper invoices. Recall that charges are either applied to the ship or to the cargo. The shipper gets the bills for the cargo, and the carrier company gets the bill for services rendered to the ship.

To ensure equitable comparisons of costs of services provided in each vessel call, we assume the same cargo volume (352 containers or 520 TEUs) and the same mix of containers (e.g., imports, exports, empty containers, full containers, 20 footers, and 40 footers). Because tariff structures differ in different ports, the spreadsheets look different. For example, pilotage fees for Cartagena are treated as a separate charge ("Private Pilotage" in Table 4-1), while for Puerto Limón pilotage fees are incorporated in "Vessel Wharfage" (Table 4-2). In addition, productivity rates at the berth are governed by the efficiency of the integration between the discharge operation and the transfer to the equipment moving the container to storage. Hence, gross productivity rates for Cartagena and Puerto Limón, both of which use two gantry cranes, are 52 and 38 moves per hour, respectively. Storage fees for Cartagena and Puerto Limón are not displayed because containers rarely stay beyond the free storage period.

Table 4-1

Port of Cartagena Port Cost Calculation ($US)

Port **Cartagena (SPRC - Sociedad Portuaria Regional de Cartagena)**
Service **NCS**

Vessel Characteristics / Cargo Assumptions			Cargo Composition: Imports		Exports		Transshipment	
LOA	M	204	Full 20'	70	Full 20'	65	Full 20'	7
GRT	TM	28,000	Full 40'	65	Full 40'	60	Full 40'	6
NRT	TM	13,181	Empty 20'	25	Empty 20'	15	Empty 20'	2
Cargo per Box	TM	14	Empty 40'	20	Empty 40'	15	Empty 40'	2
Port Productivity			Total Containers			352	Total TEU	520
Time B/A Berth Work		0.5	Full Cont. Imp/Exp			260	Full TEUs Imp/Exp	385
Gross Vessel Prod (Moves/hr)		52	Ratio Imp-Exp/Total			74%	Ratio TEU/Cont.	1.5

Item	Tariff Code	Concept	Unit	Unit Cost	Qty	Total Cost	Average Cost per Cont.	Average Cost per TEU
Charges related to the VESSEL								
1	10100	Dockage	M-LOA*hr	0.57	1,483	845	2.40	1.63
2	22100	Pilotage - Wharfage	Maneuver	10.00	2	20	0.06	0.04
3	23100	Tuggage - Wharfage	Maneuver	30.00	2	60	0.17	0.12
4	--	Private Pilotage	Maneuver	600.00	2	1,200	3.41	2.31
5	--	Private Tuggage	Maneuver	600.00	2	1,200	3.41	2.31
6	--	Nav. Aid & Insp	NRT	0.15	13,181	1,977	5.62	3.80
7	--	Private Line Handling	Maneuver	100.00	2	200	0.57	0.38
8						-	-	-
9							-	-
10							-	-
		Total				5,502	15.63	10.58
Charges Related to the CARGO (Containers)								
11	--	Gantry Crane	Hr	650.00	14	8,800	25.00	16.92
12	20210	Imp/Exp Wharfage (Shipper)	Full 20-ft	75.00	135	10,125	28.76	19.47
13	20211	Imp/Exp Wharfage (Shipper)	Full 40-ft	105.00	125	13,125	37.29	25.24
14	20240	Imp/Exp Wharfage (Carrier)	Empty box	-	75	-	-	-
15	20250	Transship Wharfage (Carrier)	Full box	28.50	13	371	1.05	0.71
16	20250	Transship Wharfage (Carrier)	Empty box	16.00	4	64	0.18	0.12
17	21210	Imp/Exp Berth Wharfage (Op.)	Full box	18.00	260	4,680	13.30	9.00
18	21230	Imp/Exp Berth Wharfage (Op.)	Empty box	6.00	75	450	1.28	0.87
19	21250	Transship Wharfage (Op.)	Box	5.00	17	85	0.24	0.16
20	24200	Imp/Exp Land Wharfage (Op.)	Box	2.00	335	670	1.90	1.29
21	--	Private Stevedore	Box	56.00	352	19,712	56.00	37.91
22	--	Yard Handling	Box	56.00	260	14,560	41.36	28.00
23							-	-
24							-	-
25							-	-
		Total				72,642	206.37	139.70
				T O T A L		**78,144**	**222**	**150**
						Total Cost	**Average Cost per Cont.**	**Average Cost per TEU**

Note:
LOA – Length overall of the vessel
GRT – Gross registered tons
NRT – Net registered tons
M – Meters
TM – Metric tons

Table 4-2

Puerto Limón's Port Cost Calculation (in $US)

Port **Limon/Moin**
Service **NCS**

			Cargo Composition					
Vessel Characteristics / Cargo Assumptions			Imports		Exports		Transshipment	
LOA	M	204	Full 20'	70	Full 20'	65	Full 20'	7
GRT	TM	28,000	Full 40'	65	Full 40'	60	Full 40'	6
NRT	TM	13,181	Empty 20'	25	Empty 20'	15	Empty 20'	2
Cargo per Box	TM	14	Empty 40'	20	Empty 40'	15	Empty 40'	2
Port Productivity			Total Containers	352	Total TEU			520
Time B/A Berth Work		2	Full Cont. Imp/Exp	260	Full TEUs Imp/Exp			385
Gross Vessel Prod (Moves/hr)		38	Ratio Imp-Exp/Total	74%	Ratio TEU/Cont.			1.5

Item	Tariff Code	Concept	Unit	Unit Cost	Qty	Total Cost	Average Cost per Cont.	Average Cost per TEU
Charges related to the VESSEL								
1	1.1	Vessl Wharfage - Fix	UND	538.00	1	538	1.53	1.03
2	1.3	Vessel Wharfage - Variable	$/GRT	0.13	28,000	3,640	10.34	7.00
3	2.1	Dockage	M-LOA*hr	1.17	1,483	1,735	4.93	3.34
4	7	Tug - Entry	Maneuver	4,770.00	2	9,540	27.10	18.35
5	7	Tug - Exit	Maneuver	4,770.00	1	4,770	13.55	9.17
6	13	Launch	Trip	34.50	2	69	0.20	0.13
7						-	-	-
8						-	-	-
9							-	-
10							-	-
		Total				20,292	57.65	39.02
Charges Related to the CARGO (Containers)								
11	11.3	Mobilization - Gantry Crane	Box	47.00	352	16,544	47.00	31.82
12	11.5	Loading/Unloading on Berth	Box	9.25	352	3,256	9.25	6.26
13	4.1	Wharfage Full Box	MT	0.95	3,822	3,631	10.32	6.98
14	4.3	Wharfage Empty Box	Unit	3.25	79	257	0.73	0.49
15	11.6	Yard Handling	Box	22.00	352	7,744	22.00	14.89
16	--	Private Stevedore	Box	36.00	352	12,672	36.00	24.37
17							-	-
18							-	-
19							-	-
20							-	-
21							-	-
22							-	-
23							-	-
24							-	-
25							-	-
		Total				44,104	125.29	84.81
				TOTAL		64,396	183	124
						Total Cost	Average Cost per Cont.	Average Cost per TEU

Note:
LOA – Length overall of the vessel
GRT – Gross registered tons
NRT – Net registered tons
M – Meters
TM – Metric tons

GETTING RESULTS

Figure 4-1 summarizes the results of the port cost spreadsheet models. The total cost to the ship calling to Puerto Limón is nearly $15,000 more than a call to Cartagena. But for the cargo, total charges in Cartagena are nearly $30,000 more than in Puerto Limón, equivalent to $36 more per container than in Puerto Limón.[10] The total charges from calling Cartagena and Puerto Limón are $78,943 and $64,396, respectively, with Cartagena (the efficient port) $14,547 higher than Puerto Limón (the inefficient port).

Running the model ship through the tariff allows us to capture all of the charges associated with calling the port, including all of the elements of inefficiency, such as berth waiting time[11] and berth productivity. In Puerto Limón, the vessel is forced to wait two hours before the gang starts working the cargo and after the loading/discharge operation is complete. In Cartagena, this total time is only 30 minutes. Additionally, crane productivity in Cartagena (52 moves per ship hour), because of the efficiency of its yard operation (versus the drayage/satellite yard operation in Puerto Limón), is 37% faster than Puerto Limón (38 moves per ship hour).

Vessel waiting time and slower berth productivity means additional dockage cost to the vessel. The dockage charge (essentially a "parking" fee) is a function of vessel length and time spent at the berth. Therefore, the longer a vessel stays at berth, the higher the total dockage charge will be. So it stands to reason that if we can reduce the vessel waiting time at the berth, as well as increase berth productivity, we can reduce the vessel's cost. In this case, however, the cost impact of reducing the time a vessel spends at the berth is only nominal with respect to the total average cost per container; matching berth efficiency in Puerto Limón with that of Cartagena reduces the total average cost per container only $3 (Table 4-3). However, the relative impact on the vessel is substantially greater; dockage cost is reduced from $2,688 to $1,735.

Reducing vessel waiting time and increasing berth productivity also affects berth availability. In this case, improving berth efficiency to match the performance of Cartagena reduces the vessel's time at berth by four hours. This increases berth availability at the port and ultimately reduces congestion.[12]

The analysis to this point shows that Puerto Limón, although being inefficient at the berth, still shows a cheaper cost. How can this be? Well, as we show next, there is more to cost than the charges imposed directly by the ports. We shall now see where else Puerto Limón's berth inefficiency has an impact.

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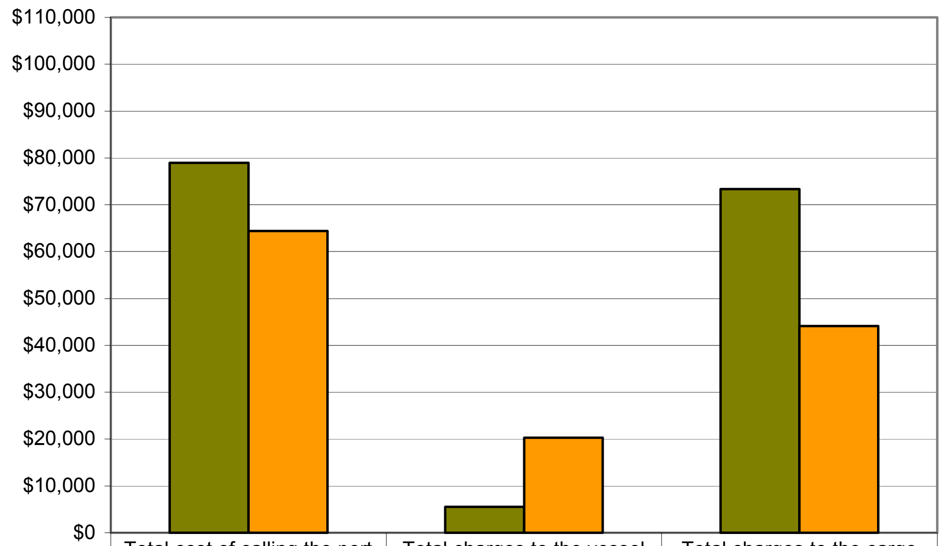
[10] The main reason for such a large disparity in costs to the ship lies in Cartagena's strategy to attract carriers. Cartagena has intense competition with other terminal operators in close proximity to the port. This has driven the reallocation of costs, with greater burdens on the shipper.

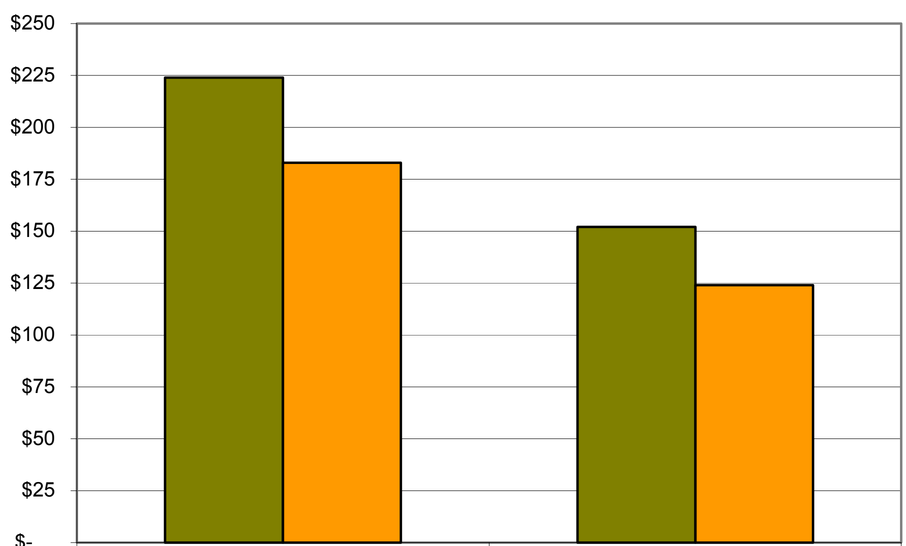
[11] Berth waiting time refers to the time the vessel waits for the services it needs. It is calculated as the difference in the time between the last line tied in at the berth and the time the first gang starts working plus the difference between the time the gang completes its work and the last line is untied. Our spreadsheets identify this as "Time B/A Berth Work." In Cartagena, berth waiting time is 0.5 hours; in Puerto Limón, 2.0 hours.

[12] The time required for handling our model ship in Puerto Limón is 11.3 hours, thus allowing only 2.1 calls per day. Achieving the same berth efficiency enjoyed at Cartagena would reduce the berth time to 7.3 hours, allowing for 3.3 calls per day.

Figure 4-1
Puerto Limón's Apparent Cost Advantage



	Total cost of calling the port	Total charges to the vessel	Total charges to the cargo
Cartagena	$78,943	$5,568	$73,375
Puerto Limón	$64,396	$20,292	$44,104



	Average cost per container	Average cost per TEU
Cartagena	$224	$152
Puerto Limón	$183	$124

Table 4-3

Impact of Reducing Vessel Berth Waiting Time Puerto Limón

Vessel Characteristics / Cargo Assumptions			Cargo Composition: Imports		Exports		Transshipment	
LOA	M	204	Full 20'	70	Full 20'	65	Full 20'	7
GRT	TM	28,000	Full 40'	65	Full 40'	60	Full 40'	6
NRT	TM	13,181	Empty 20'	25	Empty 20'	15	Empty 20'	2
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Port Productivity			Total Containers			352	Total TEU	520
Time B/A Berth Work		0.5	Full Cont. Imp/Exp			260	Full TEUs Imp/Exp	385
Gross Vessel Prod (Moves/hr)		52	Ratio Imp-Exp/Total			74%	Ratio TEU/Cont.	1.5

Item	Tariff Code	Concept	Unit	Unit Cost	Qty	Total Cost	Average Cost per Cont.	Average Cost per TEU
Charges related to the VESSEL								
		Dockage	M-LOA*hr	1.17	1,483	1,735	4.93	3.34
		Total				20,292	57.65	39.02
			T O T A L			**64,396**	**183**	**124**

MORE COSTS

Though we have calculated the cost impact of inefficiencies within Puerto Limón's terminal, our models do not reflect the indirect costs associated with the experience of calling there. For example, the extended time the ship is at berth waiting for the gang to appear implies vessel operational costs as well as container inventory costs.

The U.S. Army Corps of Engineers (2003) publishes data on deep draft vessel capital and operating costs for a variety of vessel types and sizes. Costs include debt service, crew, supplies, maintenance and repair, insurance, overhead, and fuel. Because of fuel consumption, costs are higher when a ship is sailing. Thus, the Corps of Engineers distinguishes total costs as "sea" (sailing) and "port" (idle). For our model NCS vessel, the total hourly cost in port is $647. When calling Limón a ship typically has to wait 12 hours for berth availability. Combined with berth waiting time (1.5 hours), the container ship is subjected to a delay of 13.5 hours. The ship thus incurs an extraordinary cost of $8,735 because of the waiting time differential vis a vis Cartagena ($647 * 13.5). Applied to the total loaded/discharge volume of 352 containers and 520 TEUs, this amounts to $24.81 and $16.79 per container and TEU, respectively.

In addition to the extraordinary cost associated with vessel waiting is the added container inventory cost. The standard industry estimate is about $2.80 per container or $1.87 per TEU per day. The total inventory cost is applied to the extraordinary time the vessel spends at the berth (1.5 hours) plus the time associated with the vessel waiting for berth availability (12 hours), relative to operational performance in Cartagena. The inventory cost at the berth applies to all containers loaded and discharged (352 containers or 520 TEUs).

The products in the container also incur an inventory cost. Hummels (2001) determined that merchandise incurs an inventory cost of 0.8 of one percent per day. The *Journal of Commerce* PIERS data indicate an average product value of $26,919 per TEU or $40,378 per container. Applying the Hummels multiplier then yields total inventory costs of $121 per TEU or $182 per container.[13]

Table 4-3 shows the total cost per container and per TEU of calling Puerto Limón and Cartagena. As noted, our cost models capture inefficiencies in the port logistics chain. To these costs, we add the vessel waiting, container inventory costs, and inventory costs on the goods carried in the containers to generate a total cost

[13] In the analysis that follows, we'll have to remove this product inventory cost here because we will re-introduce it when assessing the impact of inefficiencies on Costa Rica's trade flows.

of calling Puerto Limón and Cartagena. We can derive the cost of inefficiencies by subtracting the Puerto Limón total cost from Cartagena's (Table 4-4). We can see that the price advantage Puerto Limón has by virtue of its tariff is lost because of the cost of inefficiencies. Whereas Puerto Limón had cost advantages of $41 and $28 dollars per container and per TEU, respectively, these advantages are lost because of the port's inefficiencies; the cost advantage converts to a disadvantage of $166.89 and $110.84 per container and TEU, respectively. In effect, the cost of inefficiency is the tax on doing business in Puerto Limón.

Table 4-4
Calculating Total Costs and the Cost of Inefficiencies in Puerto Limón ($US)

	Puerto Limón		Cartagena	
	Container	TEU	Container	TEU
Cost from port cost model	183	124	224	152
Added vessel cost from berth waiting	24.81	16.79	--	--
Container inventory cost	1.58	1.05	--	--
Inventory cost on the goods	181.50	121.00		
Total cost	390.89	262.84	224.00	152.00
Cost differential from inefficiency	$166.89	$110.84		
TOTAL VESSEL COSTS				
From port charges	$20,292		$5,568	
From vessel and berth waiting	$8,734		--	
Total	$29,026		$5,568	

SOURCE: *Calculations by Nathan Associates Inc.*

The total cost to the ship is also important. The delays a ship incurs in Puerto Limón increases the cost of calling the port by about $8,700, raising the total cost to the carrier to $29,026. This means that a ship calling Puerto Limón pays about $23,500 more than the same ship calling Cartagena. A ship pays these extraordinarily high costs in Puerto Limón simply because there is no other port that can realistically serve the Costa Rican market. The added cost of calling Puerto Limón is reflected in the freight rates the carrier charges to shippers. The notoriously high freight rates of Central America can be explained in part by the cost of inefficiencies imposed on carriers.

Now, we shall estimate the impact of these inefficiencies on trade and welfare.

5. MODELING THE TRADE AND WELFARE IMPACT

To estimate the impact of improvements in port efficiency, we employ the Global Trade Analysis Project (GTAP) model,[14] a computable general equilibrium model of the world economy. The model defines a framework for enabling a multicountry, multisector analysis of the impact of policy decisions. Goods are differentiated by country of origin, and each country maximizes its utility subject to the prevailing market prices and its endowments of capital and labor.

Data for the analysis are drawn from several sources. For the model itself, we rely on Version 6.0, pre-release 1 of the GTAP database.[15] The GTAP database covers 85 regions and 57 sectors for the base year of 2001. Because no social accounting matrix of the Costa Rican economy is readily available, we instead rely on a broader model of Central America and impute the impact on Costa Rica. We aggregate this database to four regions (Central America,[16] NAFTA, EU, and Rest of World) and 31 sectors.

Trade data for Costa Rica are listed in Table 5-1 and are drawn from the United Nations Comtrade Database for 2001. Costa Rican imports are those reported by Costa Rica, while exports are those reported by Costa Rica's trade partners. The data are originally aggregated at the HS6 level and are then concorded to the sectoral aggregation of the model. Measures of GDP and population are drawn from the World Bank's World Development Indicators. These figures are presented in Table 5-2.

CALCULATING THE BARRIER

To model the impact of improvement in port efficiency, it is first necessary to establish the impact of such changes in efficiency on the economy as modeled. Drawing on the work of Hummels (2000), we consider each day's delay in shipment of manufactured goods as the equivalent effect of a 0.8 percent *ad valorem* tariff. We also take into consideration the additional measured cost differential incurred for all goods, that is, the total cost of inefficiency minus the product inventory cost. On average, this adds $18.00 per TEU in shipping costs.

Following Hertel *et al.* (2001), we model this barrier as a shift in the technical efficiency of trade. As such, the shortening of travel time (through improvements in port efficiency) acts to increase the "efficiency" of the traded good. This allows the model to treat the improvement in shipment as the removal of a deadweight loss. The alternative of treating the barrier as an actual tariff has the undesirable effect of generating tariff revenue that must be dealt with in the model.

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[14] The GTAP model is maintained and published by the Global Trade Analysis Project at Purdue University. See http://www.gtap.org for more details.

[15] The GTAP database is published by the Global Trade Analysis Project at Purdue University. See http://www.gtap.org for details.

[16] The Central American aggregate consists of Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama.

Table 5-1
Costa Rican Imports and Exports, 2001 (current US$)

Sector	Imports	Exports
Crops	402,415	1,855,374
Animal products	16,174	6,336
Forestry	3,717	77,455
Fishing	2,512	45,157
Oil, gas and minerals	105,748	2,729
Processed food	494,958	613,584
Textiles	407,840	147,583
Wearing Apparel	453,617	692,815
Leather products	106,271	30,178
Wood and paper	716,802	144,452
Petroleum, chemical, mineral products	2,253,937	500,194
Metals, metal products	638,547	119,031
Transport equipment	560,249	8,194
Electronic equipment	2,625,246	1,296,479
Machinery and equipment	1,618,150	600,678
Other manufactures	124,676	51,016
Total	10,530,859	6,191,255

SOURCE: *UN Comtrade Database.*

Table 5-2
GDP and Population for Costa Rica, 2000-2002

Statistic	2000	2001	2002
GDP (current US$)	15,957,090,000	16,381,890,000	16,886,570,000
Total Population	3,810,000	3,873,000	3,941,750

SOURCE: *World Bank World Development Indicators.*

Given the estimated time differential between Puerto Limón and Cartagena of 13.5 hours and direct costs of $18.00 per TEU, we arrive at an estimated tariff equivalent as follows:

$$t = (13.5/24) \times 0.8 + (\$18/26{,}919 \times 100) = 0.517$$

That is, the excess delay in Puerto Limón is the equivalent of a 0.517 percent tariff on both exports and imports of manufactured goods. For all other goods, we consider only the direct costs of $18.00 per TEU, equivalent to a 0.067 percent tariff on both exports and imports of other goods. Because we cannot separately identify goods transported by ship from those transported by other modes, we apply the tariff to all goods to derive an order of magnitude estimate. Hummels' result of 0.8 percent inventory cost per day is only robust for manufactured goods.

SIMULATION

We simulate an improvement in efficiency in Puerto Limón by shocking the parameter *ams*[17] within the model by 0.517 percent for manufactured goods and by 0.066 percent for other goods. That is, we simulate an improvement across the entire Central American aggregate region. The proportionate results of this improvement in efficiency are reported in Table 5-3. The simulation indicates that welfare across the aggregate region will increase by 0.47 percent. Applying this result to Costa Rica's GDP in 2001, we estimate a net welfare impact on Costa Rica of $76.5 million on an annual basis.

CONCLUSIONS

Carriers rationalize their calls based on the cost of doing business at a particular port. If costs or inefficiencies are not acceptable, carriers that have choices will use another port to serve the same trade. When we add the $8,734 berth waiting time cost to the total cost assessed the ship in our Puerto Limón cost model, we have a total ship cost of $29,029. In comparing this with the $5,568 ship cost in Cartagena, we can see that a ship calling Puerto Limón incurs a "penalty" of nearly $23,500. We conclude, therefore, that Central America's high freight rates cannot be attributable solely to low cargo volumes.

This is a very important point. Most ports in Central America (with the exception of Panama) have not undergone reform or privatization. Competition-induced efficiencies are lacking, and many ports operate under restrictive labor practices whose tradition in gang size ignores the technology revolution of containerization. As noted earlier, Puerto Limón is "caught between a rock and a hard place." The port can improve efficiencies by expanding capacity, but does not have the financial wherewithal to do so. The port's dual mission as an economic developer and a port agency discourages it from rationalizing its workforce. Given the strength of labor unions, there is great resistance to reducing the workforce, and for the same reason Costa Rica has been unable to proceed with privatization. Because port users justifiably complain about the high costs of using the port given problems with inefficiencies, the economic regulator is disinclined to approve tariff increases.

The costs of inefficiencies presented here are conservative. To compensate for delays in Central America's ports, vessels sail at higher speeds or carriers add a ship to their itineraries. If vessel waiting time were reduced by a mere 15 minutes in each port on an itinerary, fuel costs could be reduced by several million dollars each year for a fleet deployed in a service pattern. Savings would be even greater if a carrier could remove a vessel from deployment on the service pattern, made possible by reducing vessel turnaround time (or vessel berthing time).

Port inefficiencies cause not only higher carrier costs, but also higher shipper costs than are suggested by container costs. Shippers incur inventory costs on goods delayed because the vessel cannot find an available berth. On exports that are tightly contested (which is virtually all of Costa Rica's exports that rely on maritime transport, such as textiles, bananas, and coffee), inventory costs can take a country out of the market entirely. One has to wonder what will happen in Costa Rica with the termination of the textile quotas. As we showed in our analysis, in fact, the textile sector is one that stands to benefit significantly from efficiency improvements.

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[17] The parameter ams (i.r.s) was introduced into version 6.0 of the GTAP model to allow for adjustments attributable to efficiency improvements that reduce the effective price of goods and services imports. Shocks to ams(i,r,s) represent the negative of the rate of decay on imports of commodity or service i from region r imported by region s. When ams(i,r,s) is shocked by 20%, then 20% more of the product becomes available to domestic consumers -- given the same level of exports from the source country. In order to ensure that producers still receive the same revenue on their sales, effective import prices (pms) fall by 20%.

Table 5-3

Impact of Reducing Costa Rican Delivery Time by 13.5 Hours and Removing $18/TEU Cost Differential

Sector	2001 Imports	Simulated Change	Percent	2001 Exports	Simulated Change	Percent
Crops	402,415	2,455	0.61	1,855,374	-14,843	-0.80
Animal Products	16,174	76	0.47	6,336	-25	-0.40
Forestry	3,717	22	0.58	77,455	-744	-0.96
Fishing	2,512	5	0.21	45,157	23	0.05
Oil, gas, and minerals	105,748	-613	-0.58	2,729	-13	-0.47
Processed food	494,958	6,830	1.38	613,584	-15,217	-2.48
Textiles*	407,840	3,120	0.77	147,583	2,351	1.59
Wearing apparel*	453,617	1,796	0.40	692,815	5,799	0.84
Leather products*	106,271	345	0.324	30,178	54	0.18
Wood and paper*	716,802	7,612	1.06	144,452	806	0.56
Petroleum, chemical, mineral products*	2,253,937	16,025	0.71	500,194	3,151	0.63
Metals and metal products*	638,547	5,402	0.85	119,031	568	0.48
Transport equipment*	560,249	2,773	0.50	7,375	230	2.82
Electronic equipment*	2,625,246	26,935	1.026	1,296,479	37,338	2.88
Machinery and equipment*	1,618,150	11,360	0.702	600,678	6,379	1.06
Other manufactures*	124,676	2,120	1.701	51,016	1,308	2.57
Total (based on value)	10,530,859	87,932		6,191,255	52,342	
Percent (based on value)		0.83			0.85	

NOTE: *All measures in thousands of U.S. dollars, 2001 base year.*

SOURCE: *Calculations by Nathan Associates Inc.*

Carriers and shippers using Central America's ports will continue to be penalized until needed reforms are undertaken. Central American exporters, consumers, and eventually the economies carry the weight of these penalties. If the Central American countries that just signed the CAFTA are to benefit from that agreement, they must devise a course of port reform and an approach to port privatization that induces competition. The contribution that the resulting improved efficiencies can have on trade and welfare, with an increase of 0.47 percent, is relatively substantial.

6. IMPLICATIONS FOR USAID

Our analysis and findings have important implications for USAID as it works to help countries increase their competitiveness in global market. First, any attempt to reform trade policies should be accompanied by complementary improvements in infrastructure at the ports. As the experience of Costa Rica shows, persistent weaknesses in trade infrastructure can seriously undermine the effectiveness of trade policy reform. Such weaknesses and the inefficiencies associated with them can also undermine the intended benefits of trade preferences that developing countries enjoy in the U.S. and European markets. Improving port efficiencies can lower total transaction costs and thereby improve the competitiveness of a country's trade.

Second, such assistance need not concentrate solely or even largely on physical infrastructure. For example, while some of Puerto Limon's problems can be traced to inadequate infrastructure and an inability to finance improvements, a carefully formulated port privatization program that leverages investment and promotes competition in port services can resolve these problems. Assistance in formulating privatization strategies as part of a trade reform program can greatly alleviate port inefficiencies while discouraging monopolistic behavior.

Third, while addressing infrastructure constraints and pursuing related policy reforms USAID and other donors need to be aware of the dynamics of a country's political economy. Such dynamics can facilitate or obstruct policy reforms. In Costa Rica, for example, labor union resistance in Puerto Limón has delayed a privatization program. Any port reform effort will have to consider labor mitigation as a means for overcoming resistance.

Finally, improving the port performance of its trading partners will enhance U.S. export competitiveness. Ninety-five percent of U.S. trade (70 percent by value) is handled through ports. Greater awareness of the importance of port efficiency will help countries press for needed port sector reforms. USAID may wish to address port performance in trade capacity-building projects and support preparation of additional case studies for other regions.

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