Economic Considerations
on the
Panama Canal Watershed Expansion

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EXECUTIVE SUMMARY

The Panama Canal Watershed Expansion, and the associated plan to expand the canal itself, are motivated by a desire to take advantage of projected growth in global maritime trade and to ensure adequate water supplies for Panama's population. However, these initiatives involve substantial social, environmental, and economic risks. This report presents economic considerations, and finds that projected gains may not outweigh probable costs of this project. We recommend that public dialogue include further clarification of costs and benefits of this project, as well as an investigation of its potential to crowd out needed social investments by the public sector.

Global shipping trends suggest increasing demand for canal services. Private sector investment of $600 million in container handling facilities at both ends of the canal indicates strong expectations that the canal will play an important role in the rapidly growing container shipping segment. Global fleet characteristics are changing as average ship sizes increase: about 60 percent of ships on order are of post-Panamax dimensions. However, global Panamax capacity is also growing by 6-8 percent per year, contradicting arguments that the canal will become obsolete without larger locks.

A single transit through the Panama Canal consumes about 52 million gallons, or about one half of total daily residential water consumption in Panama. Each day of canal operations uses about ten days of total urban water needs. Currently, each gallon used in canal transits generates the same revenue per gallon as paid by residential users, about $0.20 per m^3. Water prices are often higher in other countries at comparable and lower levels of economic development, which suggests that urban consumers in Panama could conceivably outbid the canal for water. In 30 years, when the population will have doubled, the most cost-effective way to meet urban water needs may indeed be to restrict the number of canal transits.

Trends in global shipping and water demand in Panama warrant examination of options to expand canal capacity and augment water supply. However, analysis of financial considerations suggests that revenue gains from expansion may not offset the costs of building, maintaining and financing the new infrastructure. Current budget estimates for the expansion plan range from $5 billion to over $8 billion. Loans to finance a budget of this magnitude would more than double Panama's present debt burden. The interest payments alone on this amount of debt could easily overwhelm any revenue gains. Simple calculations suggest that, with a budget of $6 billion and interest rate of 7 percent, a doubling of the 1999 net revenues of $315 million would fall short of required payments of principal and interest. Consequently, the expanded canal would leave with no additional – and possibly less – government revenue to invest in the economy or otherwise benefit the Panamanian population. The debt burden would restrict Panama's capacity to borrow internationally for other purposes, such as other economic development projects or for social services. Any investment project requires that other uses of resources be sacrificed. To evaluate the sacrifice required to pursue the PCWE project, the Panamanian people need far more access to details regarding the plan than have been released to date.

INTRODUCTION AND BACKGROUND

Revenues from Panama Canal operations contribute about 10 percent of service income in the Panamanian economy, or about 8 percent of GDP.[1] Including other activities indirectly generated by Canal operations, some observers estimate that the Panama Canal generates as much as one fifth of Panama's economic activity.[2] Panama's ports are the leading handlers of container traffic in the Americas, and the canal itself straddles 144 global shipping routes.[3] As global shipping, and particularly the container cargo sector, continue to expand, there may be an opportunity for Panama to benefit , by building infrastructure to handle more and larger vessels.. Although expansion of canal capacity is a primary concern of the Panama Canal Authority (ACP), the focus of rhetoric has shifted to water issues, arguing that an increase in reservoir capacity is vital to avoid a conflict between water needs for canal operations and urban consumption. Analysis used by government to justify expansion plans suggests that current trends may produce such a conflict by about 2015.

Current Planning

Ongoing operations aim to expand canal capacity 20 percent by the end of 2002. This involves widening the Gaillard Cut (or Culebra Cut), which currently permits only single passage of Panamax ships. The widening project should allow simultaneous two-way passage of Panamax ships and thus increase average daily canal passages from about 39 ships to as many as 47 ships, at a cost of $1 billion.[4]

The proposed Panama Canal Watershed Expansion Plan (PCWE) intends to supplement water supply and further expand canal capacity. The basic components of the plan are:[5]

- Construction of high dams on the Coclé del Norte, Caño Sucio, and Indio rivers, and water transfer to the Panama Canal watershed;
- Construction of hydropower installations on the Coclé del Norte and Indio rivers, with installed capacity of 150 and 25 megawatts respectively;
- Construction of a third set of locks, able to accommodate post-Panamax sized vessels;
- Widening and deepening of the canal.

One of the motivations for this plan is that, even with the widening of the Gaillard Cut, the canal's capacity constraint could be reached between 2010 and 2012. The timeline of the expansion plan would run until about 2030, and the cost may total anywhere from $5 billion to $8 billion or more.[6]

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[1] World Bank, 2000b.

[2] Carter, 1999.

[3] Bounds, 2000c.

[4] Bounds, 2000c; Griffiths, 2000; Financial Times, 2000.

[5] Technically, the watershed expansion and canal expansion are presented as separate plans. However, the purpose of watershed expansion is clearly to provide water needed for canal expansion, so this report treats these two components as one package, referred to as the PCWE.

[6] Estimates of the total cost vary. The range cited includes figures from Bounds (2000a), Bounds (2000b). Clarkson (2000a), ACP (2000) and others. Note that this figure does not include the $1 billion budget for widening the Gaillard Cut, which will not be addressed in this report.

Although the plan was reportedly selected from among 60 different proposals submitted to government, the actual feasibility requires further clarification. Ambiguities revolve around:

- Precise costs of the four components listed above;
- Environmental costs of flooding the regions in question for the reservoirs;
- Social costs imposed on people due to be displaced by the reservoirs;
- Projected revenues and operating costs added by the expansion.

The intended dimensions of an expanded canal also remain unclear: so-called Capesize ships typically have a beam between 45m and 46m, substantially larger than the Panamax beam of 32.2m. Current draft allowance of the canal is 39.5 feet; to accommodate increasing ship sizes, draft allowance may have to increase to as much as 45-49 feet. Current canal dimensions can accommodate ships of up to 65,000 deadweight tons (DWT). Expansion plans intend to extend capacity to ships of 150,000 DWT, but the engineering requirements of such an increase have yet to be clarified.

The PCWE may appear attractive as a means to relieve capacity constraints, adapt to the evolution of global fleet characteristics, and ensure water supplies. However, these benefits must be set against construction costs, environmental and social costs, as well as the considerable opportunity cost of financing. This study will concentrate on economic aspects relating to the PCWE. The following section summarizes current trends in global shipping and use of Panama Canal services. Trends in cargo container services and shipbuilding suggest that demand for use of the Panama Canal is robust and increasing. Next, the discussion turns to water use by canal operations and other sectors in Panama. Although demand for water is clearly increasing, it is not clear that the PCWE is the only way to alleviate potential water allocation difficulties. Finally, this report examines some financial implications of the plan. The large budgetary requirements of the PCWE raise two critical questions: can canal expansion pay for itself, and can Panama afford to take on this much additional debt? This report finds that, under a broad range of plausible conditions, the PCWE may not be financially viable. Therefore the conclusions indicate a need for greater access to planning details and information, essential for more refined analyses that will provide answers to these questions.

GLOBAL SHIPPING AND THE PANAMA CANAL

Shipbuilding trends suggest strong projected growth in world shipping, implying concomitant expansion in demand for Panama Canal services. Building berths around the world are nearly filled to capacity through 2003. While the global shipbuilding sector delivers vessels as fast as they can build them, global capacity is likely to expand on the order of 10 percent per year. Much of this increase is taking place in the high-capacity segment of the sector, as indicated by the preponderance of post-Panamax vessels in shipbuilding orders: about 60 percent of all ships ordered since January 1999.[7] The proportion of these that will fall under the projected 150,000 DWT limit remains unclear. Nevertheless, there exists a clear motivation for considering the option of expanding canal capacity.

Container Shipping

The most dynamic segment of the shipping industry corresponds to containerized cargo.[8] The global ocean-going cargo fleet comprises about 25,000 ships, or about 4.1 million TEUs.[9] Container ships comprise 6.9 percent of world fleet tonnage, but comprise the fastest growing segment of the shipping industry, averaging nearly 10 percent per year since the mid-1980s compared to less than 5 percent in the next fastest growing categories, specialized tankers and auto carriers.[10] Container capacity has nearly quadrupled in the last 15 years, and continued rapid growth is expected. Table 1 below reports recent capacity increases and future expansion already evidenced in building orders.

TABLE 1 GROWTH IN GLOBAL CONTAINER SHIPPING FLEET						
Year	1997	1998	1999	2000	2001	2002
Capacity Expansion (%)	11	13	12	9.8	9.2	7.5

Source: Fairplay, 2000a.

As of mid-2000, the order book included 154 post-Panamax sized vessels with a total capacity of 927,000 TEU, representing about 18 percent of the existing world fleet. By the end of 2000, 31 of these should have entered service. Of 167 deliveries anticipated in 2001, 58 are larger than 5,000 TEU. Deliveries for 2002 include 44 ships larger than 5,000 TEU, and 36 ships between 4,000 and 5,000 thousand TEU; thus, 80 percent of 2002 deliveries expected thus far are post-Panamax sized. Table 2 illustrates the surge in post-Panamax building in the latter half of the 1990's.

TABLE 2 POST-PANAMAX BUILDING			
Building year	1985-89	1990-94	1995-99	2000-02[*]
Number built	5	9	23	154

* The figure for 2000-02 reflects a lower bound based on existing orders.
Source: Fairplay, 2000a.

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[7] Bounds, 2000b.

[8] Fairplay, 2000a.

[9] A TEU is a twenty-foot equivalent unit, reflecting a standardized measure of container volume (20 ft x 8.3 ft x 8.3 ft). Panamax vessels fall in the 3,000-3,999 TEU range, post-Panamax vessels fall in the 4,000 TEU and over range.

[10] Fairplay, 2000a.

Projected growth in demand for container shipping is about 8.5-9 percent per year over the next three years.[11] East-west trade appears to be growing faster than the world average, reinforcing industry demand for post-Panamax vessels. In 2001, trans-Pacific and Europe-Asia services should see a 350,000 TEU expansion, driven by entry of post-Panamax vessels that will displace many smaller ships to the trans-Atlantic and Asia-US East Coast routes.[12]

Retirement of older vessels implies a general increase in average size of container vessels. Older vessels predate the Panamax and post-Panamax building era, and the ships built to replace them are typically much larger, reflecting the growth in global trade over the 25-year average service life of a typical cargo container ship. Therefore, as this service life draws to a close for ships built during the shipbuilding boom of the 1970s, average ship sizes will increase. Nonetheless the current shipbuilding boom could be shortlived according to experts who note a recent slowdown in investments in new vessels. Expert Martin Stopford concludes that "…the delivery cycle will peak in 2003/4, after which we will see lower levels of shipbuilding output".[13] Jiro Hitotsuyanagi, a maritime economics specialist at the University of Panama, also expresses a lack of confidence about the shipbuilding market and demand growth for Panama Canal services.[14]

Demand for Panama Canal Services

The canal has handled about 4 percent of global maritime trade throughout the 1990s, despite robust growth in global shipping.[15] The constancy of this share could suggest that continued growth in world trade and in container shipping in particular will expand demand for canal services. Over 1999, Panamax-capacity in global dry-bulk shipping grew by 6 percent.[16] Between the end of 2000 and the end of 2001 Panamax capacity will grow by 8 percent, as current Panamax capacity on the order books represents 21.5 percent of the global fleet.[17] The increasingly dominant role of container shipping is reflected in cargo passing through the Panama Canal and the explosive development of container handling facilities at both ends of the waterway. About two thirds of Panama's port activities comprise the transfer of containers between ships (transshipment), and ports clearly anticipate significant growth given investments in expansion of port facilities: over the past 5 years, private port operators have invested on the order of $600 million in transshipment infrastructure development.[18] Modernization of the trans-isthmian railroad will contribute to transshipment options, and rail may carry as many as 500,000 containers per year between the coasts by 2003. In 1998, operations at Colon handled 1.12 million TEUs, more than any other Latin American port save Buenos Aires. Manzanillo alone handled nearly 1 million TEUs in 2000.[19]

These figures give rise to arguments both for and against expansion complete with the third set of locks. On the one hand they indicate that demand is strong and users will welcome new infrastructure. On the other, they demonstrate that there is a brisk demand for canal services as

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[11] Fairplay, 2000a. The Fairplay shipping market information service uses the following rule of thumb: growth in container shipping demand is about 3 percent above growth in world trade which in turn is about 3 percent above growth in world GDP.
[12] Fairplay, 2000a.
[13] Stopford, 2000, p.7-8
[14] Hitotsuyanagi, 2000.
[15] ACP, 2000.
[16] Fairplay, 2000b.
[17] Clarkson Research, 2000b.
[18] Bounds, 2000b.
[19] Bounds, 2000d.

they exist now, without the PCWE project. The figures do not answer the question of whether growth in demand for transport via the Canal is strong enough to pay for the expansion.

About 92 percent of the current global shipping fleet can pass through the canal, but the shipping orders discussed in the previous section indicate that this proportion may fall over the coming years. It is unclear how low this proportion may go, though the absolute growth in Panamax shipping capacity makes it difficult to imagine a decline sufficient to render the existing Canal obsolete. Principal goods shipped through the canal are corn, soybeans, wheat, chemicals, petrochemicals, containerized cargo and bananas.[20] US destinations and points of origin account for about two thirds of canal traffic, as about 12 percent of US maritime trade passes through the canal, including 40 percent of all grain exports.[21] The majority of traffic, about one third, moves between the US east coast and the Far East.[22]

Between 13,000 and 14,000 vessels traverse the Panama Canal per year. Current traffic, of which about one third are by Panamax-sized ships, runs near total capacity of 39 passages-per-day. Upon completion of the $1 billion Gaillard Cut widening effort, capacity may rise to about 47 passages-per-day.[23] Maersk Sealand, the world's leading container carrier and canal's largest customer, expects 30 percent growth in its canal traffic over the year 2000 alone.[24]

Officials cite a 20 percent increase in capacity resulting from the PCWE, but it is not clear whether this refers to ship passages or tonnage.[25] Although the number of transits would probably show moderate growth, tonnage (the current basis of tolls) – could show a more than proportionate increase due to expanding average ship sizes. Some observers expect total canal traffic to double in the next 20 years, and cargo tonnage to quadruple[26], but it is unclear how the 20 percent capacity expansion envisioned in the PCWE could accommodate a doubling of traffic or a quadrupling of tonnage. These ambiguities prevent confident estimation of revenue potential.

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[20] Griffiths, 2000.

[21] Santoli, 1999.

[22] www.pancanal.com.

[23] Financial Times, 2000.

[24] Bounds, 2000c.

[25] – ACP, 2000. Some confusion surrounds these projected capacity increases. Widening of the Gaillard Cut should permit a 20 percent increase in transits, but capacity increases resulting from the PCWE remain shrouded in ambiguity.

[26] Wilson, 1999.

DEMAND FOR WATER

Each lock of the Panama Canal, 110 feet wide and 1,000 feet long, holds about 8,800,000 cubic feet, or 66 million gallons, of water. A single ship transit releases about 52 million gallons of water into the oceans. This enormous dependence on water is met by the reservoirs of Gatun and Madden Lakes. Panama's population currently stands at about 2.8 million people; the population is projected to double in approximately 30 years, so water demand may be assumed to at least double over the same period. Tourism and industrial demand will add another 10 percent to demand growth over this period.[27] Panama City, Colon, Araijan and Chorera account for about 1.4 million people, and the Panama Canal watershed supplies about 95 percent of these metro-regions' water needs. Although urban areas enjoy almost 100 percent coverage in drinking water supply, coverage in rural areas is only about 66 percent. Table 3 summarizes water consumption by urban areas and canal transits.

TABLE 3 WATER CONSUMPTION	
Gallons for one canal transit	52,000,000
Canal operations (gallons per day)	2,705,153,294
Canal operations (gallons per year)	987,380,952,381
Metro-population	1,400,000
Residential (gallons per day)	117,534,247
Residential (gallons per year)	42,900,000,000
Other urban (gallons per year)[28]	59,242,857,143
Total Urban (gallons per year)[29]	102,142,857,143
Hydroelectric (gallons per year)	459,642,857,143
Other (gallons per year)	153,214,285,714
Annual Total (gallons)	**1,702,380,952,381**
Canal share of total (percent)	0.58
Urban share of total (percent)	0.06
Canal consumption/urban consumption	9.7

Sources: ANAM, 1999c and author's calculations.

Table 3 indicates that daily water use in canal operations consumes the equivalent of nearly 10 days of urban water consumption. A single transit consumes almost one half the total daily residential water consumption. If one transit through the current lock system requires 52 million gallons, a passage through the larger locks proposed in the PCWE presumably will require even more water. As stated earlier, proposed dimensions of the new lock system have yet to be made clear, but to accommodate post-Panamax vessels the new locks would have to be both wider and

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[27] ACP, 2000, p.15

[28] Includes commercial, industrial, and public sector water consumption.

[29] Direct urban water consumption reflects only a portion of total flows, due to substantial leakage and waste in the delivery system. High water losses of more than 45 percent in urban systems suggest an important potential source of water savings (www.cepis.org)

deeper than the current locks, suggesting substantially larger water needs.[30] Assuming a total increase in canal water use of 40 percent, and a doubling of urban consumption, canal and urban consumption under the PCWE would exceed 1.5 trillion gallons of water per year, imposing average claims on the total reservoir system of more than 4 billion gallons per day. These trends would raise water requirements by about 31 percent by 2030. Total requirements will be even higher due to increased water consumption by rural consumers, the tourism sector, and industry.

Total canal revenues per gallon consumed by shipping are \$0.00077 (\$0.20 per m^3).[31] Urban consumers pay about the same, but water users pay more in several countries that are substantially poorer than Panama (see Table 4). That raises the possibility that urban consumers in Panama may outbid the canal for water use when these two sources of demand exceed existing reservoir regenerative capacity. From a public policy perspective, these prices imply that the opportunity cost of water consumed in canal transits may exceed per-gallon-revenues by orders of magnitude when supplies fall below combined urban and canal demand. Therefore foregoing a small number of transits to supply urban water needs would be economically and fiscally justified, potentially alleviating the need for the PCWE from a water-supply perspective.

TABLE 4 RESIDENTIAL WATER PRICES AND PER CAPITA INCOME, SELECTED COUNTRIES		
Country	Water Charge (1996\$ per m^3)	GNP per capita (1999\$)
Tanzania	0.06-0.24	\$240
Madagascar	0.33-1.25	\$250
Uganda	0.38-0.59	\$320
Sudan	0.08-0.10	\$330
Pakistan	0.06-0.10	\$470
Algeria	0.06-0.27	\$1,550
Namibia	0.22-0.45	\$1,890
Tunisia	0.10-0.53	\$2,100
Panama	0.20	\$3,070
Botswana	0.28-1.48	\$3,240
Brazil	0.40	\$4,420
Average	0.20-0.54	

Sources: Dinar and Subramanian, 1997; World Bank, 2000a.

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[30] An increase in lock sizes to accommodate ships of 150,000 DWT, compared to the current maximum of 65,000 DWT, would clearly result in a substantial increase in water needs per transit.
[31] Heckadon-Moreno et al. (1999)

FINANCIAL CONSIDERATIONS

- The preceding sections have presented evidence of robust growth in global shipping, increasing demand for Panama Canal transits, and mounting pressure on water supplies. The PCWE envisions a response to these trends that revolves around development of three reservoirs that will enable the operation of larger locks and expand water supplies to urban consumers. Nonetheless, it remains unclear whether these benefits justify the potential price tag of more than $6 billion.

Costs of Panama Canal Watershed Expansion

A major impediment to open, productive public discussion of the PCWE is the lack of data regarding the budget for the plan, particularly itemized cost schedules for the PCWE. At a minimum, the costs must be broken down into: specific construction costs for dams, locks, and power generation and transmission facilities; costs of supplementary facilities such as new tugboat and train purchases, water conveyance mechanisms between the new reservoirs and the canal system and new access roads; and projected recurrent maintenance and operating expenditures. Table 5 reports the most comprehensive budget data made available for this report, but leaves several questions unanswered.

TABLE 5 PCWE PLAN COSTS (millions of dollars)				
	2010	2020	2030	TOTAL
Hydroelectric Projects				
Río Indio dam	250			250
Coclé del Norte dam	850			850
Lock System				
Locks	1,500			1,500
Feeder channels	500			500
Canal Expansion				
Canal entrances	425		380	805
Gatún Lake Channel, Culebra Cut	150	700	650	1,500
Bridges (2)	400			400
Other equipment and structures	250			250
TOTAL	4,325	700	1,030	6,055

Source: ACP, 2000.

Several potentially significant cost categories are left unspecified, including installation of access roads and transmission lines, and acquisition of tugboats and locomotives (the amount entered for 'other equipment and structures' is unlikely to suffice for these major expense items). Moreover, the Panama Canal Authority has yet to provide information regarding projected maintenance and operating costs; projected revenues must be sufficient to cover operating costs as well as debt finance for the PCWE to break even. The need for more comprehensive public disclosure is particularly pressing given that a 1993 study predicted expansion costs on the order of $10 billion.[32] Finally, the budget supplied by the Panama Canal Authority in Table 5 does not include interest during construction, crucial in the determination of whether the PCWE is viable. Debt Finance Issues

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[32] Bounds, 2000a.

Bounds (2000d) quotes Asaf Ashar, director of the US National Ports and Waterways Institute, as stating that revenues will pay for a $4 billion upgrade within 10 years. However, the higher budget cited by the Panama Canal Authority (see Table 5) and various measures of Panama's indebtedness would seem to contradict Mr. Ashar's confidence, and point to the need for deeper analysis (see Table 6). Former Minister of Housing Quijano, participant in several studies concerning canal expansion, believes revenues will pay for the project within 30 years of completion.[33] Without more concrete information on PCWE costs, disbursement schedules, and the like, this report can only offer a rudimentary assessment of these claims. Nevertheless, this assessment identifies potential difficulties in Panama's ability to shoulder the additional debt.

TABLE 6 DEBT INDICATORS FOR PANAMA (1998, 1999)		
	1998	1999[*]
	($ millions)	
Total stock of external debt	5,313	5,632
Total debt service	606	633
Principal	302	314
Interest	303	319
	(percent)	
Total debt/GDP	68.7	76.6
Total debt service/exports	15.5	14.2
Debt service/central government receipts	34.3	47.6
Principal	17.1	23.7
Interest	17.2	23.9

*Source: IMF, 2000; World Bank, 2000a. * through September.*

Despite annual debt service payments in excess of $600 million, the stock of external debt has risen by more than $300 million per year in 1998 and 1999. Growth in the debt burden raised the debt to GDP ratio to 76.6 percent. Official government policy intends to reverse this trend, as indicated in a letter of intent submitted to the IMF in June of 2000: "In keeping with the overriding importance the Administration attaches to fiscal consolidation, the principal goal of fiscal policy will be a substantial, progressive decline in the debt to GDP ratio…"[34] The addition of $6 billion or more to current total debt outstanding may pose a significant obstacle to accomplishment of this goal.[35] The debt-crisis that afflicted many developing countries in the 1980s illustrated the ramifications of an excessive debt-burden. Forced cuts in government expenditure reduced social spending, while fiscal imbalance fueled inflation. Falling real incomes and macro-economic instability stifled domestic savings and foreign investment, such that few resources flowed towards the promotion of economic growth and development. Several countries used debt-equity swaps to reduce external debt and promote foreign investment. Should Panama embark on the PCWE, double its level of indebtedness, and fall in arrears on principal or interest payments, the foremost target for such debt-equity arrangements would be the Canal itself, which is not permitted under Panamanian law.

A comparison of Panama's present value of debt to GDP ratio to other countries confirms that the additional debt burden implied by the PCWE could be problematic. In 1998, Panama's ratio

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[33] Barroso, 2000.
[34] Gelonch et al., 2000.
[35] World Bank, 2000a.

of present value of debt to GDP of .73 was the 28th highest in the world (see Appendix B).[36] Everything else equal, the debt burden of the PCWE would raise Panama to 10th or 11th place, joining a group of countries known for economic stagnation and instability such as Sierra Leone, the Democratic Republic of Congo, and Indonesia. Of course, the precise ranking will depend on trends in GDP growth over the period in question, and the timing of incremental increases in total debt as the PCWE proceeds. Nevertheless, there is little doubt that this indicator, already cause for concern and a central preoccupation of government policy, would deteriorate even further.

In Table 6 the debt service ratio (total debt service/exports) fell from 15.5 percent to 14.2 percent between 1998 and 1999. Government commitments cited above notwithstanding, preliminary indications for 2000 suggest an increase in this ratio to about 16.7 percent, approaching the 20 percent mark generally considered an upper limit for sustainable debt management.[37] The increase in debt implied by the PCWE would raise the debt service ratio to at least 21-26 percent, assuming advantageous interest rates and servicing only of interest. The current average interest rate on debt is near 6 percent, dominated by the advantageous terms on Brady bonds, which comprise nearly 40 percent of the total debt burden.[38] The debt service ratio would climb even higher in the likely event that new debt would carry higher average interest rates than the current burden, or if service included payments on principal. Thus, debt service could consume as much as a third or more of Panama's total export earnings due to the PCWE.

In 1999 canal revenues totaled $765 million, of which toll payments comprised $560 million. The remainder was revenue from water and power sales to urban users.[39] Operating and maintenance costs for that year were around $450 million.[40] Thus, net income from Panama Canal operations amounts to about $315 million in total. If the PCWE costs $6 billion and doubles net revenues, an annual interest rate no higher than three percent would be required for loan payments to be less than net revenues. If net revenues were to increase threefold, an interest rate of nine percent or lower would be needed for net revenues to exceed payments. Such scenarios may be unrealistic, considering that municipal water supply income would grow only incrementally, and the new power stations are not expected to generate significant amounts of electricity once the third set of locks is in full operation. Removing the income from these two sources, 1999 net revenues would be a mere $110 million. Under these conditions, the private sector would be hesitant to issue the needed credit or take an equity stake in the project. This stylized scenario subsumes a host of considerations: the cost of capital, trends in canal usage, the evolution of toll fee structures, etc. The following sections explore the implications of some of these factors.

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[36] World Development Indicators (World Bank): http://www.worldbank.org/data/dataquery.html.
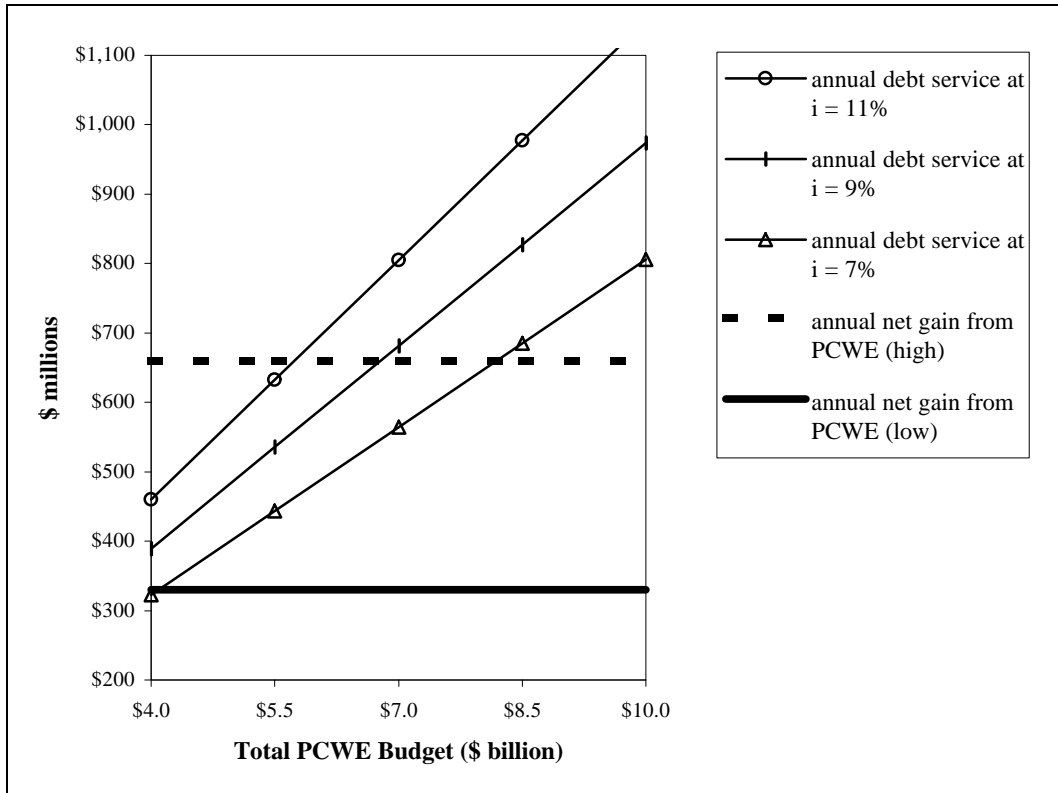
[37] N. Hope, former head of World Bank debt division, pers com, Nov. 2000.

[38] IMF, 2000.

[39] Bounds, 2000a; Financial Times, 2000.

[40] Carter, 1999; Griffiths, 2000; and www.orbi.net. About $150 million are spent on round-the-clock dredging, and about $100 million on other maintenance activities (Griffiths, 2000).

FIGURE 1
DEBT SERVICE PAYMENTS AS A FUNCTION OF
TOTAL BUDGET AND INTEREST RATES

Budget, Interest Rate, and Debt Service

Figure 1 summarizes the relationships between some key variables: total budget, benefits in the form of additional annual net revenues, and costs in the form of debt service payments as a function of the interest rate. The figure assumes total debt is repaid over 30 years from completion, and that payments are made during the construction period to offset interest accrual.[41] The 'low' and 'high' scenarios constitute *additional* net income attributable to the PCWE (doubling and tripling current net income, respectively).

In Figure 1, the PCWE is only viable if the annual debt service requirement determined by the total PCWE budget and interest rate lies below the horizontal line representing gains in annual net income. If the 'low' scenario prevails, and the budget and interest rate result in interest payments above the bold horizontal line, the cost of debt service exceeds the income gain from the expansion plan and the project results in a financial loss. The simple analysis reflected in Figure 1 shows that, under certain conditions, profitability requirements may render the PCWE plan unviable. These requirements become even more stringent when considering the expectation that a substantial portion of additional revenues be used to the direct benefit of the Panamanian people, rather than in debt service payments.

How does Figure 1 relate to the budget presented by the Panama Canal Authority, reported in Table 5? Borrowing $4.3 billion in 2010, at an interest rate of 7 percent, would carry interest

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[41] An alternative approach would add interest accrual over the course of construction to the construction budget.

costs of just over $300 million in the first year, *nearly the equivalent of current net income from canal operations*, many years before the expansion project would begin to generate additional revenue. Maintaining interest payments during construction would consume as much as 90 percent of net revenue from canal operations, before the expansion generates any revenue gains. If payments were made during construction to offset interest accrual, debt service payments after completion would need to be $488 million per year to pay off the debt in 30 years. In the absence of interest payments, annual interest costs would rise to nearly $400 million within five years of beginning construction. By 2030, accrued interest and additional loans in 2020 and 2030 could raise annual payments to more than $1 billion per year.[42] Of course, higher interest rates would require considerably larger payments.

Debt Service During Construction

The preceding section indicates the important role of payments on debt during construction, prior to revenue increases deriving from the expansion. In 1999, average tolls per vessel amounted to about $39,000 (see Appendix A). Table 7 reports the number of transits required to cover operating costs and debt service to offset interest accrual during construction, based on 1999 canal performance.

TABLE 7 AVERAGE DAILY TRANSITS REQUIRED TO OFFSET INTEREST ACCRUAL, ASSUMING AVERAGE REVENUE PER TRANSIT OF $39,000			
Total Budget	Interest Rate = 7%	Interest Rate = 9%	Interest Rate = 11%
$ 4.0 billion	51	57	63
$ 5.5 billion	60	66	74
$ 7.0 billion	68	76	86
$ 8.5 billion	77	85	97
$ 10.0 billion	85	95	109

Table 7 suggests that, subject to 1999 parameters for operating costs and average tolls per transit, the current average of 39 transits per day falls far short of requirements to prevent accumulation of interest during construction. Panamanian officials have indicated a belief that, since the PCWE will benefit the global community, increases in tolls might be justified so that global trade contributes to project financing. Assuming 47 transits per day (the projected capacity increase after the widening of the Gaillard Cut), Table 8 reports required revenues per transit to offset interest accrual during construction.

TABLE 8 AVERAGE REVENUE PER TRANSIT REQUIRED TO OFFSET INTEREST ACCRUAL, ASSUMING AVERAGE OF 47 DAILY TRANSITS			
Total Budget	interest rate = 7%	interest rate = 9%	interest rate = 11%
$ 4.0 billion	$42,553	$47,217	$51,880
$ 5.5 billion	$49,600	$55,086	$61,498
$ 7.0 billion	$56,646	$62,955	$71,116
$ 8.5 billion	$63,692	$70,825	$80,734
$ 10.0 billion	$70,738	$78,694	$90,353

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[42] The $1 billion figure assumes no payments are made until completion of the PCWE; i.e., until the expansion project begins to generate revenue.

Tables 7 and 8 indicate that debt service would require increases in traffic and/or toll fees, well before the expansion achieves increased revenues. These calculations assume that net revenue is entirely used to pay interest on debt, leaving nothing for investment in the economy. To be of any benefit to the country, traffic and toll increases will have to be even greater than those suggested in Tables 7 and 8. Revenues per transit may increase over time due to inflation, growing average ship size, and real increases in toll fees. The ability to raise toll fees is limited, however, as excessive increases will enhance the competitiveness of alternative routes.

Debt Service: Contribution from Hydropower Sales

Proponents of the PCWE emphasize the potential for dams associated with the project to pay for themselves with hydropower revenues. Recent data from Panama's wholesale electricity market permits a broad characterization of these revenues. Monthly averages of electricity spot prices in 1999 and the first half of 2000 ranged from $28 to $55 per megawatt-hour (Mwh). Electricity contract data varied within a narrower range from around $37 to $49 per Mwh.[43] Average monthly prices from the wholesale electricity market supplied by the *Empresa de Transmisión Eléctrica* – ETESA – showed a low of $32.29, a high of $63.76 and a mean of $49.46 over the same time period.[44]

Installed capacity of the two plants, on the Rio Colcé del Norte and the Rio Indio, would total 175 megawatts, so maximum annual production of these two stations, operating at full capacity, amounts to 1,533,000 Mwh. However, routine maintenance, water shortages, demand fluctuations, transmission interruptions, and other uses of reservoirs reduces actual delivery for all hydro dams. For example, at times water used for canal operation may reduce water available for electricity generation. Therefore it is customary to apply a plant factor to adjust for time the stations are idle. Table 8 presents revenue estimates based on high and low prices and plant factors. These calculations are gross of operation and maintenance expenses. Allowing for operating costs of $11 million (1 percent of capital cost) we can optimistically interpolate net operating revenue in the range of about $50 million per year. Our high net revenue estimate, shown in Table 8, would be $56 million and the low would be around $12 million. At a low 7 percent interest and a fifteen-year amortization covering the period of significant hydropower revenues, annual payments on the dams would be $121 million per year. Even spreading payments over thirty years would improve the situation only moderately, yielding an annual payment of $89 million. Therefore, unless electricity rates to Panama's consumers and businesses skyrocket, no credible case can be made that hydropower alone will pay for the dams. Once water is diverted to Lake Gatun for Canal operation, little can be expected in the way of electricity generation.

TABLE 8 REVENUE ESTIMATES FROM PROPOSED COCLÉ DEL NORTE AND RIO INDIO STATIONS		
	Low Revenue Scenario	High Revenue Scenario
Electricity Price	$30/Mwh	$55/Mwh
Plant Factor	.5	.8
Gross Revenue	$22,995,000	$67,452,000
Net Revenue	$11,995,000	$56,452,000

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[43] pers. comm. Juan Banes, *Ente Regulador de los Servicios Públicos,* 11/00.
[44] pers. comm. Victor González, ETESA, 11/00.

These calculations raise several questions that require clarification before determining the viability of the PCWE: income expected from water provision to urban consumers; anticipated changes in toll fee structures; precise capacity specifications of the expanded canal; expected interruptions in canal service during construction; and details on projected maintenance and operating costs (of the canal as well as electricity and water distribution systems). However, the simple analyses presented above suggest a strong possibility that the cost of capital may exceed revenue gains.

DISCUSSION

Under certain conditions, the Panama Canal Watershed Expansion plan may provide a viable means for increasing urban water supplies and exploiting growth in global maritime trade. However, under conditions we consider realistic, the PCWE plan appears financially infeasible and questionable from a macroeconomic perspective. Due to information constraints, the analyses that have yielded this conclusion are necessarily limited to rough calculations. Provision of additional planning details by the government would allow more precise analysis and informed discussion.

Environmental Costs: deforestation and flooding of natural areas

A full accounting of environmental, social and cultural costs of the PCWE is outside the scope of this report. Hughes (2001, in preparation) examines these issues in some detail. Here we merely point out general categories of so-called external costs likely to be imposed by the project. These costs raise the overall cost of the project, therefore requiring that the project generate more revenues to compensate for the damage.

About 70 percent of Panama's forests have been destroyed, and logging, mining, and slash-and-burn farming continue to deforest about 25,000 hectares per year. [45] Panama's forests are shrinking at a faster rate than in any other country in Central America, and forest cover has dwindled to no more than 20 percent of the Panama Canal watershed. [46] Deforestation and agricultural conversion facilitate surface runoff, causing erosion and sedimentation that reduce lake storage capacity and clog dams as well as the canal itself. [47] By 1996, Lakes Gatun and Madden had suffered estimated losses of 8 and 6 percent of their original capacity, respectively. [48] Therefore, from the perspective of water provision, the costs and benefits of the PCWE must be compared to the costs, benefits, and urgency of enhanced protection of the integrity of existing reservoirs.

The PCWE would impose a direct environmental cost by flooding a substantial area (448 km^2). [49] The area directly flooded grossly underestimates the full extent of damage, however. A large number of islands and narrow, steep peninsulas would be created in and around the lakes. Further, transmission lines, aqueducts and access roads would all have substantial impacts. A portion of the area to be flooded comprises land that has already been subjected to agricultural conversion. Although possibly tempering direct ecological costs of flooding, this feature exacerbates the social and distributional consequences for the rural poor by destroying their production base, their homes, and assets of spiritual importance, such as cemeteries and churches. Moreover, clearing of new forest areas for homesteads on which to resettle people would add significantly to the total environmental bill. Finally, transportation of equipment, spoil removal, and other building activities could inflict substantial ecological harm, and access roads to construction sites could facilitate waves of migration that have contributed to deforestation in the past.

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[45] Strieker, 1997; Carter, 1999. Recen estimates by Hughes (2001, in press) put this figure much higher.
[46] Mitchell, 1998.
[47] Mitchell, 1998.
[48] ANAM, 1999b.
[49] Urrutia and Elton, 1999.

Distributional Impacts

The area that would be flooded under the PCWE plan is home to at least 8,500-9,000 people according to the Panama Canal Authority.[50] Field surveys carried out in 2000 by Hughes (2001, in preparation) suggest that the total number of people living in the area is much higher. In addition to the financial costs of relocating these people, considerations of equity and social justice merit further attention before embarking on this plan. Panama features extreme income inequality, as a small segment of the population controls the vast preponderance of wealth in the country; the wealthiest 20 percent of the population claims over half of total national income.[51] With a Gini coefficient of .58, Panama ranks high among countries with the worst income distributions in the region (see Appendix C).[52] About 37 percent of the population lives below the poverty line.[53] Therefore the distributional impacts of the PCWE should figure prominently among issues considered in the decision-making process for the project. Although the project will generate some employment, displacement of at least 8,500-9,000 people by the new reservoirs places a substantial burden on a significant number of rural poor, some of whom were previously displaced by the construction of the Bayano Dam.

There is a further, sometimes overlooked distributional impact involved in granting the use of water resources to a specific entity such as the Canal Authority. Water now used exclusively by residents of the Coclé del Norte and Rio Indio watersheds, would be transferred, free of charge, to ACP, mostly for use in shipping. The value of that resource would accrue, therefore to shipping companies, and to the central government, to the extent the government manages to derive new net revenues from the project.

Government statements describe the Canal as a national asset, owned by all Panamanians as shareholders.[54] As canal revenues accrue to the government, the degree to which this national asset benefits the population depends directly on policy-driven decisions regarding public expenditure in the central budget. For this reason, the distribution of benefits largely is an issue not so much of economics but one of politics, which lies beyond the scope of this report. However, the analyses in preceding sections suggest that, after operating expenses and debt service, there may be few benefits left for distribution. Therefore, a convincing argument for the expansion plan requires a comparison to the costs and benefits relating to other socio-economic investments in the economy that more directly address the needs of the broader population, in such areas as health, education, and agricultural.

Part of the appeal of large-scale infrastructure projects to policy makers lies in the belief that such investments generate substantial spillover effects throughout the economy. However, there are reasons to be less optimistic regarding this so-called multiplier effect in the case of the PCWE. Given the large projected impact of the PCWE budget on the national debt burden, there is a strong likelihood that debt service obligations will compromise Panama's ability to support socio-economic development spending. Doubling the country's debt-burden would limit Panama's access to further funds in international credit markets, and claim an enormous share of government revenue. This crowding-out effect would severely constrain investment, and could

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[50] Belisle, 1999; Lapper, 2000. Since 1947, the population in the Panama Canal watershed region has grown from about 37,000 people to over 150,000 people, most of who live below the poverty line (Mitchell, 1998). That number is expected to double over the next decade (Carter, 1999).
[51] World Bank, 2000a.
[52] ANAM, 1999a.
[53] Gelonch et al., 2000.
[54] Delawsky, 1999.

conceivably exacerbate income inequality, unless it is overcome by multiplier effects. However, the current structure of income distribution in Panama suggests that the vast preponderance of benefits from the PCWE would accrue to a small minority. During construction, engineering and building firms would benefit. Once the project is in operation, multiplier effects would benefit shipping, insurance, banking, and other industries that currently revolve around the canal, but there is little to suggest any further trickle down to the rest of the population. The people of Panama need to know far more details about the PCWE before they can decide whether these risks are justified by the potential benefits. These concerns are all the more pressing given the uncertainties inherent in long-term projections of global shipping trends, canal use, and rural, industrial, and residential water needs.

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		APPENDIX A: SELECTED PANAMA CANAL USAGE STATISTICS				
	Transits	Tonnes	Tolls	Transits/Day	Tonnes/Transit	Tolls/Transit
1983	11,707	145,590,759	$287,791,023	32	12,436	$24,582
1984	11,230	140,470,818	$289,155,035	31	12,509	$25,748
1985	11,515	138,643,243	$300,807,914	32	12,040	$26,123
1986	11,926	139,810,493	$322,734,202	33	11,723	$27,061
1987	12,230	148,690,380	$329,858,775	34	12,158	$26,971
1988	12,234	156,482,641	$339,319,326	34	12,791	$27,735
1989	11,989	151,636,113	$329,696,838	33	12,648	$27,499
1990	11,941	157,072,978	$355,557,957	33	13,154	$29,776
1991	12,572	162,695,886	$374,624,737	34	12,941	$29,798
1992	12,454	159,272,618	$368,662,504	34	12,789	$29,601
1993	12,086	157,703,910	$400,884,033	33	13,048	$33,169
1994	12,337	170,538,437	$419,218,757	34	13,823	$33,980
1995	13,459	190,303,065	$462,754,053	37	14,139	$34,382
1996	13,536	198,067,990	$486,688,265	37	14,633	$35,955
1997	13,158	189,800,000	$493,700,000	36	14,425	$37,521
1998	14,243	192,184,654	$545,700,000	39	13,493	$38,314
1999	14,337	195,978,357	$560,000,000	39	13,669	$39,060
2000	13,653	193,721,862		37	14,189	

Sources: www.pancanal.com; IMF, 2000; www.orbis.com.

	APPENDIX B: COUNTRY RANKINGS BY RATIO OF NET PRESENT VALUE OF DEBT TO GDP, 1998					
	Country	Debt/GDP		Country	Debt/GDP		Country	Debt/GDP

	Country	Debt/GDP		Country	Debt/GDP		Country	Debt/GDP
1	Sao Tome and Principe	3.53	44	Mauritius	0.63	87	Rwanda	0.34
2	Guinea-Bissau	3.38	45	Cambodia	0.61	88	Maldives	0.32
3	Nicaragua	2.47	46	Samoa	0.61	89	Burkina Faso	0.32
4	Congo, Rep.	2.43	47	Hungary	0.60	90	Dominica	0.32
5	Congo, Dem. Rep.	1.75	48	Honduras	0.60	91	Colombia	0.31
6	Zambia	1.65	49	Russian Federation	0.60	92	Nepal	0.31
7	Indonesia	1.54	50	Jamaica	0.59	93	Seychelles	0.31
8	Angola	1.53	51	Moldova	0.59	94	St. Kitts and Nevis	0.31
9	Guyana	1.50	52	Senegal	0.58	95	Croatia	0.31
10	Sudan	1.48	53	Bolivia	0.58	96	Armenia	0.30
11	Mauritania	1.42	54	Lesotho	0.56	97	Egypt, Arab Rep.	0.30
12	Ethiopia	1.33	55	Equatorial Guinea	0.55	98	Ukraine	0.29
13	St. Vincent & the Gr.	1.24	56	Central African Republic	0.55	99	Cape Verde	0.28
14	Sierra Leone	1.23	57	Niger	0.54	100	Brazil	0.28
15	Syrian Arab Republic	1.20	58	Ghana	0.54	101	Poland	0.28
16	Cote d'Ivoire	1.16	59	Peru	0.54	102	El Salvador	0.27
17	Jordan	1.07	60	Tunisia	0.53	103	Barbados	0.27
18	Gabon	0.94	61	Morocco	0.52	104	Dominican Republic	0.26
19	Cameroon	0.92	62	Yemen, Rep.	0.52	105	St. Lucia	0.26
20	Lao PDR	0.89	63	Kyrgyz Republic	0.51	106	Romania	0.25
21	Madagascar	0.88	64	Argentina	0.50	107	Paraguay	0.25
22	Mali	0.83	65	Turkey	0.50	108	Georgia	0.25
23	Malawi	0.81	66	Tajikistan	0.49	109	Kazakhstan	0.25
24	Turkmenistan	0.79	67	Chile	0.48	110	Tonga	0.24
25	Bulgaria	0.77	68	Mongolia	0.46	111	Bangladesh	0.24
26	Thailand	0.76	69	Grenada	0.46	112	Oman	0.23
27	Vietnam	0.76	70	Benin	0.45	113	Guatemala	0.23
28	**PANAMA**	**0.73**	71	Slovak Republic	0.45	114	Solomon Islands	0.22
29	Ecuador	0.72	72	Belize	0.45	115	Albania	0.20
30	Nigeria	0.71	73	Kenya	0.45	116	India	0.20
31	Burundi	0.71	74	Czech Republic	0.45	117	Bhutan	0.18
32	Mozambique	0.70	75	Korea, Rep.	0.43	118	South Africa	0.18
33	Tanzania	0.70	76	Pakistan	0.41	119	Uzbekistan	0.18
34	Philippines	0.70	77	Sri Lanka	0.40	120	Lithuania	0.17
35	Comoros	0.68	78	Venezuala	0.40	121	Swaziland	0.16
36	Togo	0.67	79	Lebanon	0.39	122	Haiti	0.15
37	Guinea	0.66	80	Mexico	0.38	123	Vanuatu	0.15
38	Malaysia	0.65	81	Chad	0.37	124	China	0.14
39	Zimbabwe	0.65	82	Costa Rica	0.36	125	Azerbaijan	0.13
40	Papua New Guinea	0.65	83	Uruguay	0.36	126	Eritrea	0.13
41	Gambia, The	0.64	84	Djibouti	0.36	127	Estonia	0.12
42	Macedonia, FYR	0.64	85	Uganda	0.35	128	Iran, Islamic Rep.	0.12
43	Algeria	0.63	86	Trinidad and Tobago	0.34	129	Fiji	0.12

Source: World Development Indicators (World Bank): http://www.worldbank.org/data/dataquery.html.

	APPENDIX C: MOST RECENT ESTIMATES OF GINI COEFFICIENTS, LATIN AMERICA		
	Country	Year	Gini Coefficient
1	Brazil	1995	60.1
2	Guatemala	1989	59.6
3	Paraguay	1995	59.1
4	**Panama**	**1997**	**58.0**
5	Colombia	1995	57.2
6	Chile	1994	56.5
7	Honduras	1996	53.7
8	Dominican Republic	1989	50.5
9	Mexico	1992	50.3
10	Nicaragua	1993	50.3
11	El Salvador	1995	49.9
12	Costa Rica	1996	47.0
13	Venezuela	1995	46.8
14	Ecuador	1994	46.6
15	Peru	1994	44.9
16	Jamaica	1991	41.1

Source: World Bank: World Development Report, several years.