The Disaster Deficit Index (DDI)

This index measures the economic loss that a particular country could suffer when a catastrophic event takes place, and the implications in terms of resources needed to address the situation. Construction of the DDI requires undertaking a forecast based on historical and scientific evidence, as well as measuring the value of infrastructure and other goods and services that are likely to be affected. In order to do this, we must define an arbitrary reference point in terms of the severity or periodicity of dangerous phenomena. Objective modeling must take into account existing information and knowledge gaps and restrictions. The DDI captures the relationship between the demand for contingent resources to cover the losses caused by the Maximum Considered Event (MCE),[3] and the public sector's economic resilience (that is, the availability of internal and external funds for restoring affected inventories).

$$DDI = \frac{MCE\ Loss}{Economic\ Resilience}$$

Estimating Probable Losses

Potential losses were calculated using a model that takes into account different hazards (which are calculated in probabilistic form according to historical data on the intensity of past phenomena) and the actual physical vulnerability of the elements exposed to such phenomena. This analytical and predictive model is not based on historical measures of losses (deaths and number of people affected), but rather on the intensity of the phenomena. Actuarial requirements imply that we must avoid making estimates of risk based on previous damage statistics over short time periods. Modeling must be done by inference, by evaluating the likelihood of high-impact, low-probability events, as well as the vulnerability of infrastructure and other elements that are exposed to hazard (see Cardona *et al*., 2004a, 2004b and 2005, for additional details of the technical bases of the models used).

MCE has been defined with an arbitrary return period (we used three scenarios) as the worst situation, which requires feasible corrective or prospective planning actions to mitigate it in order to reduce potential negative effects for each country or subnational unit under study. The economic loss or demand for contingent resources (the numerator of the index) is obtained from modeling the potential impact of the MCE for three return periods: 50, 100 and 500[4] years, whose probability during any 10 years exposure period is 18 percent, 10 percent and 2 percent, respectively.

A particularly useful indicator for risk assessment is the expected annual loss, L_y^P, which is defined as the expected loss value in any one year. It is also known as the pure or technical premium. This value is equivalent to the annual average investment or saving that a country would have to make in order to approximately cover losses associated with future major events.

Resources Potentially Available to the Government

Economic resilience (the denominator of the index) represents internal and external re-

[3] This model follows the insurance industry in establishing a reference point (the Probable Maximum Loss, PML) for calculating potential losses (ASTM, 1999; Ordaz, 2002).

[4] Most existing construction codes are based on the maximum possible intensity of events in approximately a 500 year time period. Particularly important infrastructure are designed for maximum intensity events of several thousand years. However, the majority of buildings and public works constructed in the twentieth century have not been designed to withstand such events.

sources that were available to the government when the evaluation was undertaken. However, access to these resources has limitations and costs that must be taken into account. Seven constraints are explicitly taken into consideration in this study:

- *Insurance and reinsurance payments* for insured government-owned goods and infrastructure;
- *Disaster reserve funds*;
- Public, private, national or international *aid and donations*;
- *New taxes*;
- *Budgetary reallocations*, which usually corresponds to the margin of discretional expenses available to the government;
- *External credit* that the country could obtain from multilateral organizations and in the external capital market; and
- *Internal credit* the country may obtain from commercial banks as well as the central bank.

The DDI captures the relationship between the demand for contingent economic resources to cover the economic losses that the public sector must assume, and the nation's economic resilience, that is, its ability of generate internal and external funds to replace the affected infrastructure and goods. A DDI greater than 1.0 reflects the country's inability to cope with extreme disasters even by going into as much debt as possible. The greater the DDI, the greater the gap between losses and the country's ability to face them. Government responsibility was restricted to the sum of losses associated with public sector buildings and housing for the lowest income population.

The left side of figure 1 shows the DDI in 2000 calculated for an MCE with 500 years of return period (2 percent probability of occurrence in ten years). The right side of the figure shows the maximum loss, *L*, for the government during the same period.

With the exception of Costa Rica (CRI) all countries have a DDI greater than 1.0. Bolivia (BOL), with a DDI of 5.7, is in the most critical situation and could face a loss of US$2.84 billion.

Figure 1. DDI and Probable Maximum Loss in 500 Years

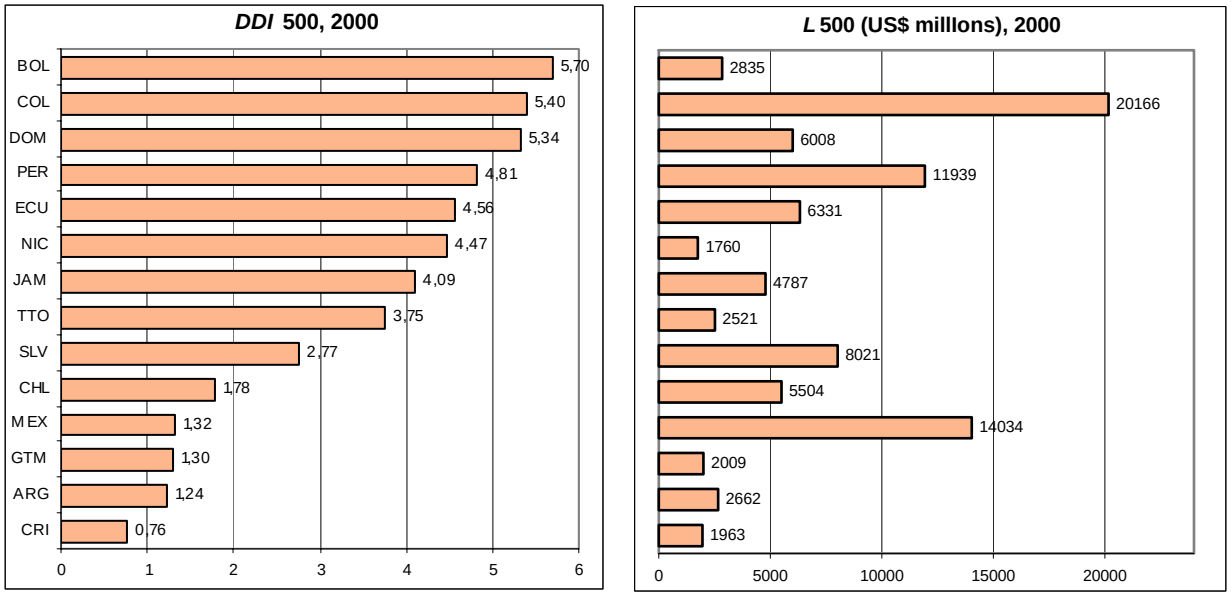


Figure 2 shows the Disaster Deficit Index and potential losses when faced with an event with 100 years of return period (5 percent probability of occurrence in ten years). In this case, access to reconstruction resources is critical for eight of the fourteen countries studied. The DDI for the other six countries is below 1.0. However, the impact for Mexico (MEX) could be very high even though its index is less than one.

Figure 3 shows the DDI and potential losses when faced with an event with 50 years of return period (18 percent probability of occurrence in ten years). In four of the countries studied, the macroeconomic impact would be considerable if this high probability event should occur. The potential losses are particularly high even though some countries have a greater economic resilience.

Figure 2. DDI and Probable Maximum Loss in 100 Years

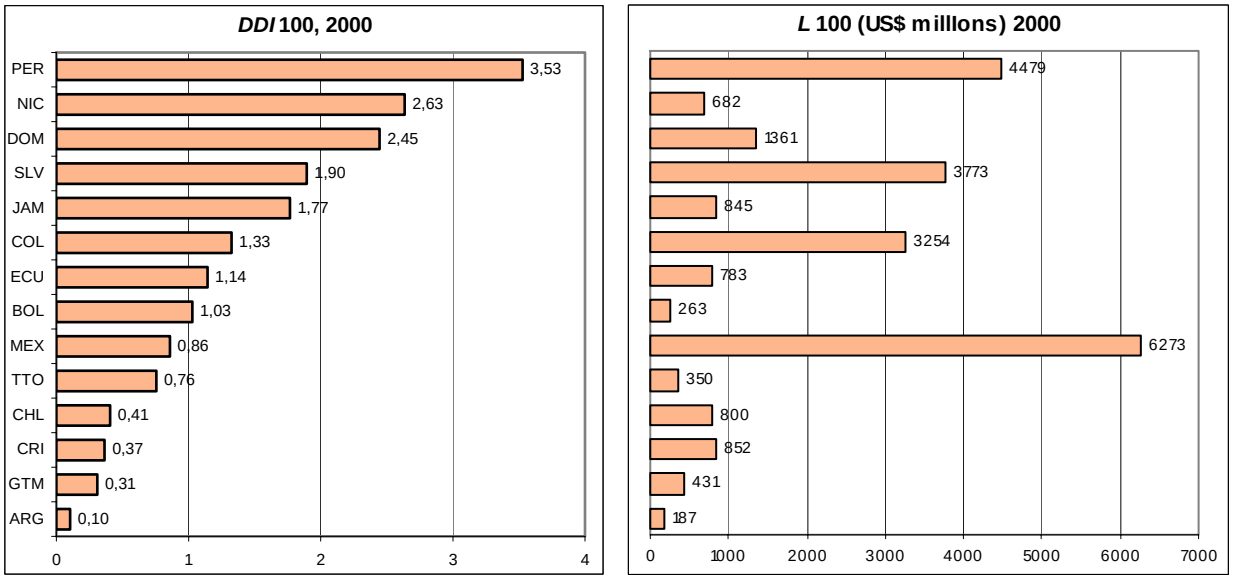
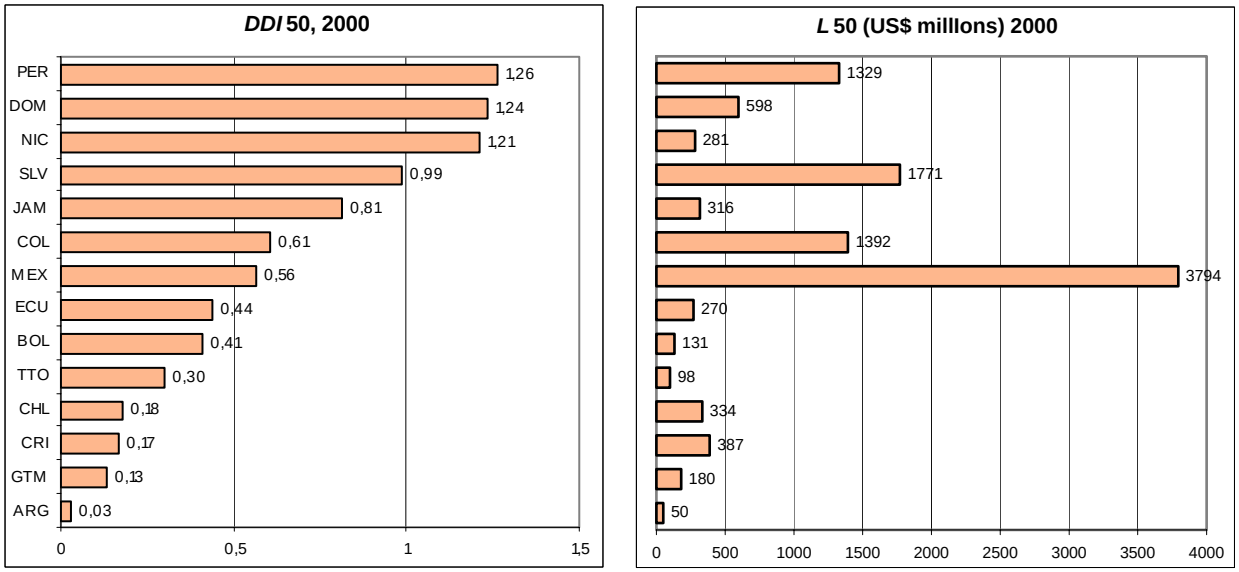


Figure 3. DDI and Probable Maximum Loss in 50 Years



To help place the Disaster Deficit Index in context, we've developed a complementary indicator, DDI', to illustrate the portion of a country's annual Capital Expenditure (CE) that corresponds to the expected annual loss or the pure risk premium. That is, DDI' shows the percentage of the annual investment budget that would be needed to pay for future disasters. The left side of figure 4 shows the DDI'_{CE} for 2000. The right side shows the annual expected loss, *Ly*.

El Salvador (SLV) shows the highest DDI' relative to capital expenditures. The annual cost of future disasters represents 32 percent of capital investment. Trinidad and Tobago (TTO) follows in importance with 9.2 percent. Only four countries have values below 5 percent of the investment budget. These indicators provide a simple way of measuring a country's fiscal exposure and potential deficit (or contingency liabilities) in case of an extreme disaster. They allow national decisionmakers to measure the budgetary implications of such an event and highlight the importance of including this type of information in financial and budgetary processes (Freeman *et al*., 2002b). These results substantiate the need to identify and propose effective policies and actions such as, for example, using insurance and reinsurance (transfer mechanisms) to protect government resources or establishing reserves based on adequate loss estimation criteria. Other such actions include contracting contingency credits and, in particular, the need to invest in structural (retrofitting) and nonstructural prevention and mitigation to reduce potential damage and losses as well as the potential economic impact of disasters.

Figure 4. DDI' and Annual Probable Loss