MACROECONOMIC EFFECTS OF NATURAL DISASTERS IN LATIN AMERICA AND THE CARIBBEAN

1. Introduction

The countries of Latin America and the Caribbean are frequently affected by natural disasters of different origin and intensity. While the average amount of losses imposed by these disasters has been estimated at over US$ 1,500 million per year [1] --a very impressive amount in itself-- the corresponding effects on the economic performance of the countries and on the living conditions of their population can be even more dramatic.

In that respect, it must be realized that most of the economies of the Latin America and Caribbean countries are relatively small and non-diversified. Thus, they are very vulnerable to the effects of natural disasters, particularly those located in more disaster-prone areas, such as small islands located along the usual path of tropical storms and countries located in very seismic or volcanic areas.

Furthermore, depending on its economic position prior to the disaster, a country may find itself unable to undertake the required programme and projects for rehabilitation and reconstruction, and require international cooperation --both technical and financial-- for their implementation.

The international community --via multi-lateral lending and technical cooperation organizations and/or bi-lateral assistance programs of donor countries-- is always willing to support these undertakings, and requires detailed and reliable information concerning the magnitude of the damages. Potential donors expect a precise determination of the most affected sectors and areas, the identification of the post-emergency projects and plans that require financial and technical cooperation, and the determination of the country's capacity to handle its share of the burden in the rehabilitation and reconstruction efforts.

Since 1972 the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) has been assisting member states located within its geographical jurisdiction in the assessment of damages caused by natural disasters. A damage assessment methodology has been developed and tested [2] to estimate the extent of the damages, their economic impacts

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[1] See Roberto Jovel, Natural disasters and their economic and social impact, CEPAL Review No. 38, Santiago, 1989.

[2] See ECLAC, Manual para la estimación de los efectos socio-económicos de los desastres naturales, Santiago, 1991.

and the requirements for rehabilitation and reconstruction, based on the country's post-disaster execution capacity.

The ECLAC methodology facilitates the systematic definition of international cooperation requirements in a relatively short period of time --that does not exceed 1 to 2 months-- and requires information that can be collected in the days immediately after the disaster strikes and its comparison to macroeconomic data and forecasts available before the disaster.

This paper describes briefly the methodology developed by ECLAC to assess the macroeconomic effects of natural disasters. It does not deal with the procedures to estimate individual sector damages. It also describes the results of applying the methodology to selected cases of disasters that have occurred recently in the Latín America and Caribbean region, and enables comparisons of effects caused by different types of disasters in different sizes of economies. More detailed methodological information can be obtained in the ECLAC manual on the subject.

2. Description of the methodology

a) Definitions

To facilitate understanding of the methodology, a definition of terms to be used throughout the paper is presented. It refers to direct and indirect damages and to secondary effects.

Direct damage refers to all damage to fixed assets, capital and inventories of finished and semi-finished goods, raw materials, and spare parts.

Direct damage essentially involves damage to property which occurs simultaneously with the natural phenomenon that causes the disaster. It includes total or partial destruction of physical infrastructure, buildings, machinery and equipment, transport and storage facilities, furniture, damage to farmland and soils, irrigation and drainage works, dams, etc. In the particular case of agriculture, the destruction of crops ready to harvest is considered as direct damage.

Essentially, direct damage refers to physical destruction, whether complete or partial, that occurs simultaneously or immediately after the disaster.

Indirect damage refers to damage to the flow of goods that will not be produced and of services that will not be provided after the disaster strikes, for a period of time beginning immediately after the disaster and of a duration which may last several months or years depending on the type and characteristics of the disaster.

Indirect damages are measured in monetary --not physical-- terms and may include inter alia the following:

(i) increased operational expenditures in a given sector due to the destruction of physical infrastructure or inventories, and increased costs for the provision of services;

(ii) additional costs incurred in a given sector or activity due to the need to use alternative means of production or for the provision of a service, such as higher transportation costs when using longer deviations;

(iii) losses of income as a result of the non-provision of services in utilities and losses of personal income in the case of individuals losing --totally or partially-- their means of livelihood;

(iv) unexpected expenditures related to meeting "new" needs arising from the disaster, such as the costs of vaccination campaigns to avoid epidemics;

(v) production or income losses in activities located either "downstream" or "upstream" of activities directly affected by the disaster, such as in the case when the destruction of an industry results in the cutback of activities of a supplier who has no alternative markets or customers who have no other suppliers; and

(vi) investments incurred to respond to the need to relocate fixed assets or activities to safer areas after a disaster has demonstrated such need.

The summation of direct and indirect damages represents the total --material and monetary-- damage inflicted by a disaster. Care must be exercised when assessing disaster damage to include both types of damage in the estimations, since it is very frequent that indirect damages may exceed the amount of direct damages, and they may cripple a weak economy and render it unable to meet by itself the resulting rehabilitation and reconstruction requirements.

Secondary effects refer to the impact of the disaster on the overall economic performance of a country as measured through the most significant macroeconomic variables. The estimation of changes in these variables due to the disaster complements that of direct and indirect damages, although they can not be mathematically added to express the total amount of damage inflicted by a disaster.

A disaster's main secondary effects are those which have an impact on:

(i) the overall and sectoral **gross domestic product** (GDP);

(ii) the **balance of trade** and the **balance of payments**;

(iii) the **level of indebtedness and of monetary reserves**;

(iv) the state of **public finances**; and

(v) the amount of **gross capital investment.**

Depending on the nature of the disaster, the secondary effects of **inflation, in employment and household income** may also be of relevance.

Gross domestic product can be reduced by the anticipated decline in the output of sectors that sustained direct and indirect damages; it can grow, however, due to the surge in the construction sector as a result of rehabilitation and reconstruction activities. The balance of trade and the balance of payments can be affected due to export shrinkage resulting from diminished output, and by increased import requirements to face unmet internal demands and the requirements of rehabilitation and reconstruction. Public sector spending grows to meet the needs of the emergency and rehabilitation phases and tax revenues may shrink because of reduced output and diminished exports, which may combine to create or increase fiscal budget deficits. Reconstruction efforts may involve acquiring or increasing foreign or local indebtedness.

Simultaneously prices may go up because of shortages or speculation, thus creating or worsening inflationary pressures on the economy. Moreover, depending on the economic position of the country prior to the disaster and if the secondary effects are sufficiently large, it is possible that the country's international reserves and its ability to meet external commitments can be jeopardized.

This paper presents a description of ECLAC's methodology to assess the secondary effects of a natural disaster. It assumes that all direct and indirect sectoral damages have been evaluated beforehand, although it describes the requirements of information for sectoral damages when appropriate. Interested parties can consult the ECLAC damage assessment manual to obtain details on the sectoral assessment methodology.

Nevertheless, it must be indicated that to enable the assessment of secondary effects, sectoral evaluations of damages must include estimates of foreseeable losses in output (of goods and services) during the period required to rehabilitate farmlands, industrial production and physical and social infrastructure. They must also include estimations of indirect effects on household employment and income, exports and exports, gross investment, taxation, etc, for each sector affected. In addition, it is essential that an estimation be made of the period of recovery for each sector or activity during which the indirect effects are to be present.

b) Estimation of macroeconomic effects

The estimation of the effects of natural disasters on the economic position of a country is based on a comparison between the economic performance anticipated before the disaster

The sectoral damage or losses to be used in the macroeconomic assessment must include:

(i) products and services which, owing to the destruction of infrastructure and machinery, will no longer be produced; or

(ii) income that will no longer be received, estimated on the basis of salaries, wages and profits that will not be forthcoming while production plants are being rehabilitated;[3] or

(iii) in the special case of the "housing rental" sector --included in the national accounts-- losses are to be estimated as the result of multiplying the number of houses destroyed or damaged by the average monthly rent during the estimated rehabilitation and reconstruction period.

In each sector indirect losses must include both the volume (or units) of losses in future production of goods and services during the estimated period for recovery of full or previous productive capacity, and the price of these goods and services expressed in terms of producer prices or, in the case of services, consumer prices.

The gross amounts thus estimated must be converted into value added to enable its incorporation into the projected GDP. To this effect national account information relating gross values to value added ones for leading economic sectors and branches of activity are utilized. Usually, a recent input/output matrix relating these values is available.

As indicated previously, the anticipated expansion of the construction sector as a result of the rehabilitation and reconstruction plan and activities will have a positive bearing in GDP, and must be estimated. In this respect, the annual growth of the sector must be calculated on the basis of the known capacity of the sector and of the expected amounts of investment for rehabilitation and reconstruction.

Sectoral-loss value added data and construction sector expansion information are superimposed on the anticipated sectoral estimates of GDP for the year in which the disaster occurs, and for subsequent years if the data is available and the type and magnitude of the disaster so warrants it.

An estimation of post-disaster GDP is thus generated. Global and sectoral economic setbacks due to the effects of the disaster can be easily identified from a comparison of the new GDP estimation and the pre-disaster projection for the same year. Trends in economic growth can be determined by comparing the newly estimated GDP and real GDP figures for previous years.

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[3] For the cases of small businesses in which a wide variety of goods and services is produced, this method of estimation is more feasible and reliable than the one described under (i).

Effects on the external sector. The effects on the external sector of a country affected by a natural disaster include those that affect the balance of payments current account and, in some cases, the external financial requirements of reconstruction. These effects would be felt not only in the year during which the disaster occurred but in a longer time frame until the country's productive capacity is fully restored.

It is essential for the assessment process to obtain the most reliable and up-to-date information concerning the balance of payments situation for the whole economy and its projection for the year in which the disaster occurred --and the following years if possible. This should be complemented with other basic data on external indebtedness, debt servicing levels and international monetary reserves before the disaster struck.

The resulting current account of the balance of payments during the year of the disaster is estimated on the basis of both the envisaged account before the disaster and the following calculations based on the indirect damages for each affected sector:

(i) reductions in the export of goods and services, be it due to the destruction of their means of production or to its re-orientation towards internal markets. Losses in services refer to cases when a country has been affected in its tourism reception capacity, its shipping fleet or its engineering export capacity;

(ii) increases in imports of goods required for the rehabilitation phase, including fuel and food to replace insufficient internal production, as well as that portion of construction materials required for the reconstruction of destroyed assets;

(iii) donations in kind and in cash received to attend the emergency phase;

(iv) insurance and re-insurance payments from abroad to cover damages and destruction of assets; and

(v) possible reductions in interest payments to foreign creditors that may be agreed upon as a result of the disaster, and possible increases in payments related to new short-term loans requested to attend the emergency or for immediate rehabilitation of essential services.

The projection thus made will enable the determination of the possible occurrence or increase of a current account deficit in the balance of payments in the year of the disaster. Should the requirements for imports and/or the reduced export levels remain for a longer time period, a chronic deficit may occur as a result of the disaster

The resulting capital account of the balance of payments must be estimated superimposing --on the before-the-disaster projection-- the information related to the medium- and long-term foreign financing requirements for the priority investment projects that are to be included in the reconstruction plans that will follow in the, say, next five years following the disaster.

It should also include the additional foreign financing required to compensate the possible chronic deterioration of the current account balance as determined above. These additional foreign financing requirements will have to be made compatible with prior foreign debts commitments and with the level of international reserves that the country may have. A change in the conditions governing foreign financing and debt servicing may have to be negotiated.

Effects on public finances. Using as a base the before-the-disaster fiscal budget, the following secondary effects are to be superimposed to determine the disaster's effects on public finances:

(i) reductions in tax revenue due to decreases in the production of goods and services, household income and consumption expenditures;

(ii) increased current expenditures to attend the emergency phase of the disaster; and

(iii) increased capital investments requirements for the rehabilitation and reconstruction program.

The first two types of secondary effects are usually felt during the same calendar or fiscal year, while the increased capital investment is usually spread over a number of years.

The reductions in tax revenues are estimated as part of the sectoral evaluation of indirect damages, based on the projections of production of goods and services. Further estimations of reductions in tax revenues should be made based on the expected reductions in household income and consumption expenditures. There are cases when governments may decide to reduce the level of taxes on exports, to foster or expedite recovery of production levels; these reduced tax revenues should also be entered into the equation. A similar case occurs when national or local governments can not collect property taxes on destroyed housing and business buildings.

Expenditures incurred by national governments to meet the unforeseen needs during the period immediately following the disaster, including the provision of temporary shelter and most immediate rehabilitation needs, should be determined during the assessment.

The result is a revised current account of the fiscal budget which shows the effects of the disaster. From it, resulting fiscal deficits and the possible non-compliance with agreed upon fiscal restraint targets may be identified.

In regard to the capital investment expenditures for rehabilitation and reconstruction, a preliminary program is prepared during the damage assessment mission. The following items must be taken into consideration:

(i) estimates of total investment required to rehabilitate and reconstruct infrastructure and to restore production; and

(ii) the known delivery capacity of the construction sector in the affected country or region(s).

An annual capital investment program for rehabilitation and reconstruction is thus prepared, to be superimposed on the program envisaged before the disaster had occurred. Should the new requirements be a sizable percentage or fraction of the capital investment envisaged under normal conditions, a revision of the country's overall investment program would be in order. Some already programmed development projects may have to be postponed or discarded, unless additional financing can be obtained as new priorities are forced upon by the disaster. Furthermore, if the additional financing is to come from foreign sources an additional analysis is to be made concerning the balance of payments and the country's ability to maintain an increased level of debt servicing.

Effects on inflation. Contrary to other macroeconomic effects, the resulting impact on consumer prices can not be quantitatively measured or estimated immediately after the disaster. A qualitative assessment can be made, however, based on the disaster-imposed short-term constraints on the local supply of manufactured goods and agricultural products, including the effect on the marketing channels and transport systems. It must be borne in mind that a lowering of consumer prices may occur whenever imported products are cheaper than domestic supplies.

Effects on employment. A disaster has both short and medium-term effects on employment and household income. Estimates of the short-term effects can be made on the basis of available data for the relations between employment and sectoral production, once the latter's losses as a result of the disaster have been estimated. Estimates of work-months to be generated in the medium term by the rehabilitation and reconstruction activities following the disaster can be made based on the existing ratios between labor requirements and construction investment levels. Both estimates must be combined to show the total effect of the disaster on this important social and economic variable.

3. Application of methodology to selected cases of natural disasters in Latin America and the Caribbean

The following is a summary of the macroeconomic effects of three selected disasters in the Latin America and Caribbean region,[4] as estimated using the ECLAC methodology and data obtained immediately after the disasters occurred.

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[4] No details of the type and material extent of losses are given here as they can be found in other reports; only macroeconomic effects are to be described and discussed.

The 1985 Mexico City earthquake.[5] Total losses originated by this earthquake were estimated by ECLAC at US$ 4,335 million, of which US$ 3,790 million refer to direct damage and destruction to physical infrastructure and inventories and US$ 545 million to losses in production and income.

No reduction in the growth of GDP was expected to result due to the indirect losses posed by the disaster. However, the external sector position was expected to suffer considerably generating an estimated trade imbalance of US$ 8,580 million. This expected deterioration derived from a reduction in exports --including especially the tourism services sector--; an increase in imports of goods and services for the rehabilitation and reconstruction program and projects; in spite of an inflow of re-insurance payments. The deficit in the balance of payments was thus expected to increase by more than 5% in the three years immediately after the disaster.

In addition, the position of public sector finances was expected to deteriorate by an estimated US$ 1,900 million as a result of the disaster. It involved US$ 2,025 million of increased expenditures connected to the emergency phase, including the demolition of partially damaged structures and the removal of ruble, and the investment for rehabilitation and reconstruction of damaged and destroyed assets. It also involved, on the plus side, a net increase of US$ 125 million in tax revenues to be collected as a result of increased construction activity. The public sector deficit was thus expected to increase by an average 10% in the three years following the disaster, with respect to the previous year.

In spite of the deficit, it was felt that the required reconstruction effort could be borne without major difficulty, particularly if the expenditure involved were spread over a period of several years. Even though the loss of US$ 4 billion in absolute terms was considerable --and of course the losses of life were irreplaceable-- the value of the losses represented an equivalent of only 2.7% of the forecasted GDP for Mexico in 1985, 13.5% of the expected gross capital formation for the year, or 11% of total Mexican Federal Government expenditure.

Difficulties were nevertheless foreseen for the reconstruction efforts since the effects of the disaster could not be considered as an isolated phenomenon. The earthquake had occurred at a time when the Mexican economy was struggling against a particularly difficult set of circumstances: public expenditure austerity was being applied, banks were short of liquidity, and external financing restrictions were looming.

The analysis of macroeconomic effects of the disaster was instrumental in revealing to the authorities that the cost of reconstruction --which could not be postponed-- required a revision of some of the most sensitive areas of economic policy, such as public expenditure, credit policies, the price structure and the balance of payments. Thanks to this, discussions could be started then to define how to face the new financial requirements while trying to

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[5] See ECLAC, Damage caused by the Mexican earthquake and its repercussions upon the country's economy, (LC/G.1367), October 1985.

maintain a stabilization programme and continue servicing the public external debt in the light of the increased import requirements for reconstruction.

The 1986 San Salvador earthquake.[6] Total damage inflicted by this disaster were estimated by ECLAC at US$ 940 million; direct losses of capital and inventories amounted to US$ 710 million and indirect losses to US$ 230 million.

While those losses are only one fourth of those calculated for the Mexican case, they were estimated to have a much larger economic impact in this small country since the damages were equivalent to nearly 24% of GDP and to about 40% of the national foreign debt at the time. Furthermore, the secondary effects on the macroeconomic aggregates were expected to be felt for several years after the disaster.

The expected growth rate of GDP was expected to fall by 2% in the year of the disaster, due to decreased production in the sectors of commerce and industry.

Public sector finances were foreseen to be severely affected by an estimated amount of US$ 935 million in the five years following the disaster, including an increase of US$ 975 million in public outlays to face the requirements of the emergency, rehabilitation and reconstruction phases, and despite a net increase of US$ 40 million in tax revenues. This meant a net increase of 24% in the public sector deficit.

For that 5-year period the external sector position was expected to suffer a US$ 350 million deterioration as a result of increased imports for rehabilitation and reconstruction (US$ 450 million), despite disaster-related reinsurance payments and relief assistance. The net anticipated result was nearly doubling the current account balance of payments deficit.

Shortages in construction materials combined with the increased demand for rehabilitation and reconstruction were anticipated to affect consumer prices, resulting in annual inflation rates above the previous years' values.

The analysis revealed that not only the San Salvador earthquake had a very negative effect on the main macroeconomic aggregates of the country, but also that the country lacked the capacity to face the challenges of reconstruction concurrently with facing the pre-disaster social problems such as housing shortages and high unemployment rates. In view of that, the country's government decided to elicit international cooperation --both financial and technical-- to ensure the successful outcome of the rehabilitation and reconstruction program to follow.

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[6] See ECLAC, The 1986 San Salvador earthquake: damage, repercussions and assistance required, (LC/G.1443; LC/MEX/L.39/Rev.1), December 1986.

The 1987 earthquake in Ecuador.[7] Total damages imposed by this earthquake were estimated by ECLAC at US$ 1,000 million. Direct losses represented US$ 185 million; indirect losses were calculated at US$ 815 million.

The estimated amount of total losses was significant: it was the equivalent of about one-tenth of GDP at that time. However, indirect damages were more important since anticipated production losses amounted to the equivalent of 7% of GDP and 33% of expected exports for 1987.

It was estimated that GDP in 1987 would decrease by 2.7% --instead of growing by 2.8% as estimated prior to the disaster-- as a result of a fall of 37% in value added due almost exclusively in the oil-production sector. Minor reductions in the agricultural and domestic trade sectors were also foreseen.

It was estimated that the economy's external sector would suffer an important negative impact. The balance of payments was to be affected by an estimated drop of US$ 554 million in the export of crude oil and by-products, and by the need to import US$ 135 million worth of goods required both to meet internal fuel demand and to initiate the reconstruction of damaged infrastructure. A further US$ 20 million were estimated to be required to transport foreign crude oil acquired or borrowed from friendly nations in order to comply with sales contracted in the international market.

Furthermore, it was foreseen that the position of public sector finances would worsen. It was expected that public expenditures to meet rehabilitation and reconstruction requirements would have to increase, and that current income from the export of oil products and tax revenues from decreased economic activities would decline. While before the quake the fiscal deficit was expected to decrease, when compared to 1986, it was foreseen that it would certainly increase by nearly 40 per cent due to the disaster.

The analysis conducted revealed the vulnerability of the oil-producing and export activities of Ecuador's economy, at a time when the government was making important but still not totally successful efforts to stabilize it. The analysis also revealed that the country's capacity to undertake by itself the required investment for reconstruction was seriously compromised due to the anticipated effects on both the public sector finances and the external sector position. It could be foreseen, however, that due to the nature and relatively limited amount of the damage done to infrastructure, reconstruction and restoration of the country's production and export capacities could be achieved with relative ease, provided that international cooperation could be obtained on a timely basis.

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[7] See ECLAC, The natural disaster of March 1987 in Ecuador and its impact on social and economic development, (LC/G.1465), May 1987.

4. Conclusion

The examples described above show some of the possible different practical uses of applying the methodology developed by ECLAC to assess the macroeconomic effects of natural disasters.

By resorting to this methodology, governments of countries affected by these phenomena have been able not only to determine the extent to which a disaster may require them to modify economic policies, but to assess whether they are in position to face by themselves the requirements for rehabilitation and reconstruction.

From the perspective of the international donor community, the methodology provides a tool to ascertain the extent and the type of cooperation it may render to the affected government.