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climate change in Latin America and the Caribbean:
Methodological issues in modelling the macro-
economic impacts of climate change in the Caribbean
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**REPORT OF THE FOURTH EXPERT GROUP MEETING OF THE PROJECT
UNDERSTANDING THE POTENTIAL ECONOMIC IMPACT OF CLIMATE CHANGE
IN LATIN AMERICA AND THE CARIBBEAN:
METHODOLOGICAL ISSUES IN MODELLING THE MACROECONOMIC
IMPACTS OF CLIMATE CHANGE IN THE CARIBBEAN**

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A. DECISIONS AND RECOMMENDATIONS

1. The following decisions and recommendations were accepted:

(a) Three key recommendations were made with respect to the methodological issues involved in modeling climate change. First, it was suggested that further attempts at modelling should employ the existing models from the various sectors, build upon those sectoral models to construct national country-specific models, and then all national models should be utilized to create a regional model. Second, it was proposed that countries move towards a flexible, dynamic and more integrated modeling framework for countries in the region and for the Caribbean region as a whole. Third, there was general agreement that the region required an integrated regional assessment model.

(b) Arising from the sector-specific discussion of modelling climate change, there were several recommendations:

- Agriculture: in order to improve the performance of the models employed there should be an attempt to collect additional data on the non-climatic and climatic variables, information at the level of the farm and GIS data including soil type.
- Coastal and marine: it is critical that annual data on climatic and non-climatic variables and GIS data be collected to adequately assess this sector.
- Energy: studies on this sector should employ models that would adequately capture both the use of energy in promoting economic growth and reduction in emissions.
- Health: examination of the impact of climate change on this sector would be enhanced by the employment of GIS, geo-referenced and rainfall data.
- Tourism: while there were no pressing data needs, there was an urgent requirement to incorporate both demand and supply of tourism, global feedback effects and the influence of non-hotel establishments in the modeling framework.
- Water: the analysis of this sector required more than just data on precipitation to adequately assess the sector and there was an appeal for a regional level water policy.

B. ATTENDANCE AND ORGANIZATION OF WORK

1. Place and date

2. The fourth expert group meeting under the initiative: Understanding the potential economic impacts of climate change in Latin America and the Caribbean: methodological issues in modelling the macroeconomic impacts of climate change in the Caribbean was convened by the Economic Commission for Latin America (ECLAC) subregional headquarters for the Caribbean on 5 and 6 December 2011 in Port of Spain.

2. Attendance

3. The list of participants appears at annex I.

3. Agenda

4. The meeting adopted the following agenda:
1. Opening of the meeting
 2. Adoption of the agenda
 3. Review of ECLAC's experience in economic modelling of climate change in the Caribbean.
 4. Methodological issues in macroeconomic modelling – frameworks for embedding climate change effects in macroeconomic models
 5. Policy implications of macroeconomic modelling – applying model results to specific issues
 6. Modelling sectoral impacts – special challenges related to the agriculture, coastal and marine and energy sectors
 7. Modelling sectoral impacts – special challenges related to the health, tourism and water sectors
 8. Towards a regional approach to macroeconomic modelling of climate change in the Caribbean
 9. Conclusions and recommendations
 10. Closure

C. SUMMARY OF PROCEEDINGS

1. Opening of meeting

5. Welcome and opening remarks were delivered by Diane Quarless, Director, ECLAC subregional headquarters for the Caribbean. She affirmed the continued efforts of ECLAC in undertaking assessments and analyses on the impact of climate change in the Caribbean subregion. She acknowledged the assistance and support of ECLAC's many regional and international collaborators and partners in undertaking the 26 climate change studies in the subregion. The Director indicated that the response to the challenge of climate change required in-depth and robust analyses of climate variables, so as to support optimum decision-making by governments in designing policy for the future. She noted that the issue of climate change was especially important for the Caribbean due to the unique vulnerabilities and challenges of the subregion. She concluded by challenging the participants to reflect on how some of the social impacts of climate change could be incorporated into the modelling framework and how a regional response to climate change might be modelled.

2. Adoption of the agenda

6. The provisional agenda was adopted.

3. Review of ECLAC's experience in economic modelling of climate change in the Caribbean

7. This agenda item reviewed ECLAC experiences to date in modelling the impact of climate change on the macro-economy of the Caribbean.

8. The Coordinator of the Sustainable Development Unit at ECLAC subregional headquarters for the Caribbean delivered a summary of findings on the economics of climate change in the Caribbean. She provided a brief explanation of the Providing Regional Climates for Impacts Studies (PRECIS) climate change projections for temperature and precipitation for the Caribbean followed by a background on the

sectors and countries chosen for analysis. The results obtained in each sector in each country were summarized and presented. She concluded by highlighting some of the challenges experienced in conducting the studies.

9. The Economic Affairs Officer, Sustainable Development Unit, ECLAC subregional headquarters for the Caribbean, undertook a review of the models employed in the economic analysis of the impact of climate change in the Caribbean. He first specified the general assumptions made and the climate change scenarios used in conducting the analyses. He proceeded by explaining the broad modelling techniques employed and then examined the various sectors and the models applied in each of the sectors studied. He concluded by emphasizing the challenges experienced in the modelling process.

Discussion

10. The moderator observed that most of the work already done on climate change in the region employed a partial equilibrium framework, except for one. He pointed out that the research done so far had not dealt with the intersectoral effects of climate change and that each sector was basically examined as a single unit. He raised the issue of whether research in the subregion should be moving towards employment of one of the general equilibrium frameworks and speculated as to the challenges the subregion was likely to face by adopting such a framework.

11. Another concern that arose dealt with the matter of developing Caribbean-specific scenarios and the syncing of those scenarios with the Intergovernmental Panel on Climate Change (IPCC) scenarios. The moderator mentioned that most of the climate variables were simply added on to the standard theoretically-informed models and he wondered if that was the appropriate way to deal with such variables. Another matter raised was the issue of the aggregation of the sector-specific studies for the Caribbean. The use of demand models without the appropriate supply relationship was also mentioned. In addition to those concerns, another question was introduced regarding the variability of datasets from country to country and the subsequent aggregation of such datasets to produce regional assessments.

12. As the discussion continued, it was mentioned that there should be caution regarding the sole concentration on the broad macroeconomic effects (for example, increases or decreases of GDP) of climate change, rather than distributional effects of such change, which omitted key information and might serve to provide misleading information about the impacts of climate change.

13. The Coordinator, Statistics Unit, ECLAC subregional headquarters for the Caribbean, pointed to the problem of data availability in the Caribbean. He emphasized that accurate, timely and relevant statistics and indicators were crucial for modelling and decision-making, but that the subregion faced serious deficits in environmental data. He offered some possible solutions, as follows:

- The providers of data should consult with the users of such data
- Statistical development depended crucially on investment at the national level – national resources – and governments therefore needed to invest in the development of statistical resources in the subregion
- The users of environmental data should guide the statisticians in the area of such data collection as to their specific needs

14. One participant highlighted the importance of focusing on the distributional aspects of climate change. He stated that there was a need to focus on macro-founded micro models rather than the micro-founded macro models. He cautioned that while there was a desire for Caribbean-specific scenarios, the development of such models should take into consideration the needs of the Caribbean and there must be coordination among the countries in developing those scenarios. He stressed that while distributed lag

models were useful, there were certain limitations associated with them and that structural breaks tended to be a problem when employing those models. He suggested that use of Bayesian models might be more useful.

15. It was suggested that the models applied so far had served to provide an inventory and that from those partial equilibrium models, general equilibrium models might be constructed to serve the region. A country-level general equilibrium model should incorporate the existing partial equilibrium models, and then there should be movement towards a regional model.

16. Finally, it was pointed out that the probability of losses to the subregion's capital stock was not factored into research on forecasting and macroeconomic modelling and those losses affected economic growth, and, so, it was important that those issues be included in discussions on climate change.

7. Methodological issues in macroeconomic modelling – frameworks for embedding climate change effects in macroeconomic models

17. The agenda item reviewed the global and regional experiences in modelling climate change impacts.

18. The representative of the Ca'Foscari University and IEFÉ, Venice, Italy, first outlined the overall approach employed in his research on modelling climate change and some of the results obtained. Most of the modeling exercises were based on the Computable General Equilibrium (CGE) framework and there was some evolution towards an Integrated Assessment Model (IAM). He explained that the modelling exercises were occasionally dynamic in nature instead of comparative static, with the basic idea being to embed results from specific micro-sectoral studies. He described a typical simulation exercise as being one that examined macroeconomic performance with and without climate change impacts. After displaying some of the results obtained, he pointed out the general issues and challenges of the modelling processes undertaken. He ended his presentation by identifying some of the sector-specific problems faced in modelling climate change using CGE models.

19. The representative of the International Monetary Fund stated that in general CGE models had their role in helping to clarify the effects of climate change but from the present standpoint as a region, there was a need to build on existing models. He underscored the fact that CGE models are based on the assumption that markets clear, and advised caution in applying such models to the Caribbean. He emphasized that CGE models had their role, and that there was a need for the subregion to be more proactive with its policies. He pointed out that for the estimates to be built into the macroeconomic models at the national level and for analysis and policy recommendations to be incorporated and implemented by countries in the region, there must be a certain level of national ownership. He recommended that the century forecasts being undertaken should be broken down into smaller time segments, so as to build them into the macroeconomic models. He concluded by saying that while CGE models were suitable for climate change analysis, the subregion did not, as yet, have the technical capacity or the data information to build a model at the national or regional level from ground level, and that the subregion should consider employing the existing models as a start and move forward from that point.

20. The representative of the Massachusetts Institute of Technology (MIT) stated that most climate change modelling had focused on the cost of abatement options. He concentrated on two approaches, namely the integrated assessment and uncoupled analysis approaches. He then discussed climate change estimates and pointed out that there had been little work done in downscaling results to individual islands. He provided information on the MIT Joint Program Outlook (<http://globalchange.mit.edu/>) and Climate Interactive (<http://climateinteractive.org>). He concluded by touching on the issue of parameterizing

economic shocks by focusing on food production, sea level rise, health effects, increased carbon dioxide concentration in sea water, extreme weather events and tourism effects.

Discussion

21. Participants observed that the problem of downscaling had not been solved, and that a higher degree of resolution was needed for modelling. The presenter, in responding to an earlier comment by a discussant, indicated that it was not absolutely correct to say that CGE models worked better in markets that attained equilibrium, but that they could be adapted to deal with characteristics common to markets in the Caribbean. The discussant agreed and added that if there were already existing country-specific sectoral models, then all that was required was a modification of macro models to provide a regional model. The concerns related to intersectoral spillover, distributional impacts, technological change and structural shifts in relation to CGE frameworks were discussed and it was mentioned that the CGE modelling framework could capture certain sectoral spillovers.

22. The discussion focused on non-market values and how they could be factored into the models. While those values were not incorporated into models, at that time, it was deemed necessary to incorporate them in the modelling frameworks in the future since some sectors were dependent on the maintenance of those resources.

8. Policy implications of macroeconomic modelling - applying model results to specific issues

23. The agenda item considered emerging policy issues (energy and food security, poverty, social impact analysis, vulnerability) related to the impacts of climate change in the Caribbean

24. The representative of the Department of Economic and Social Affairs (DESA) focused on policy issues in climate change macro modelling. He mentioned that climate change mitigation and the challenge with regard to energy represented a paradigm shift. He expressed the opinion that the initial development phases would be affected by an intensive, but inefficient, investment in energy and that the pressure on energy prices would continue. The presentation continued with an analysis of the limits of the conventional models: IAM, CGE, partial equilibrium, simulation and cost minimization models. The presenter then focused on the United Nations Global Policy Model, and provided an explanation of the analytical structure of the model. He continued by showing how the model was used in an empirical analysis by providing some results of the analysis. He concluded the presentation by providing policy options generated by the modelling process.

25. The representative of the Centre for Environmental Studies in Cuba stated that many small islands relied on limited resources and that there was a need to capture and determine how they would change through climate change and the subsequent impact on sectors in the society. He was of the opinion that some measures (for example, mitigation strategies) needed to be examined more closely since change and advances were likely to occur. He postulated that the subregion could possibly undertake a bottom-up analysis with environmental services and a top-down approach with economic assessments and thereby improve its model and produce a more practical way to approach climate change.

26. Based on the presentation, the Economic Affairs Officer, ECLAC subregional headquarters for the Caribbean, initiated his discussion by stating that there must be further clarification on the incentive mechanism for countries given that countries in the region were at different stages in terms of their sectoral development. He enquired as to whether there was an attempt by any of the countries in the region to pursue coordination. He turned his attention to the partial equilibrium models being used at that time and mentioned that despite the unease with use of those models, they were used a great deal in

certain areas since they allowed a more intuitive interpretation of results. He also enquired as to whether the partial equilibrium framework was at the boundary or, at most, at the upper limits or what could be done with the models.

27. The presenter stated that nuclear technology might well be an option eventually for the region, since at each time in history there had been some degree of myopia. He noted that climate change was a long-term problem and that, when the issue of coordination among countries was discussed, there should be an enquiry about how the gains made would be distributed to those that were involved in the coordination process. With regard to the limits of partial versus general equilibrium models, it appeared that the challenges being faced at that time called for a breakthrough in the modelling process and a need to ensure that inter-sectoral linkages were appropriately taken into account and modelled. It must be borne in mind that when CGE models were used, it meant that strong assumptions were made on the functioning of the economy.

Discussion:

28. There was a request for more details on the model to be presented. The presenter responded by indicating that the model he presented was based on national accounts and he directed participants to two relevant websites: one for more details on the model (http://www.un.org/en/development/desa/policy/publications/un_gpm.shtml) and the other for accessing datasets (<http://www.wocat.net/en/network/activities/initiatives/initiative-detail/article/tancat.html>).

29. The discussion concentrated on the model presented and CGE modelling for the Caribbean. It was stated that CGE models were not necessarily better than the partial models and that a more robust model structure, which was tied to the specific needs of the country, might be more suited to the region. There was reference to a need for more theoretical work to build models unique to the region. In response to further questions on the model described, the presenter stated that the model was a regional one, with several national components, and was employed at the country group level. He further added that coordination was built into the model and that benefits were distributed according to the coordination process. Bearing in mind the realities of the Caribbean, it was mentioned that while the model assumed cooperation among countries, the Caribbean subregion did not have a good history of cooperation at the regional level.

30. There was some concern about the issue of preconditions not being explicitly addressed in the model, to which the presenter indicated that it was expected that some conditions would hold, as the subregion moved from the theoretical to practical application of the model. In conclusion, he stated that a national model had limitations and that addressing the structural implications of climate change was a regional concern.

31. The summary discussions noted that CGE had featured heavily in the discussions and that there was a need to note the positives of such a modelling process but it must be borne the unique characteristics of the Caribbean subregion with regard to data deficiencies. It was mentioned that an emerging issue appeared to be the distributional aspects of climate change and that it had to be considered in the deliberations.

9. Modelling sectoral impacts – special challenges related to the agriculture, coastal and marine and energy sectors

32. This agenda item examined specific sectoral issues in modelling the impact of climate change in the Caribbean.

33. There were two major objectives of the presentation, Modelling the impacts of climate change at the sectoral level - focus on the macroeconomy. The first was to review the recent approaches to modelling the impact of climate change in the Caribbean, and the second to outline the future directions and needs of the region. The presenter summarized the modelling approaches as being regression (the major modelling technique), CGE, and simulation. He proceeded to review each of those techniques and the studies that employed the specific techniques. He then discussed the issue of downscaling climate projections to the Caribbean in the context of the small islands and emphasized the fact that more precise evaluations of the impact of climate change required further downscaling. He concluded his presentation by proposing that the way forward for modelling the impact of climate change in the region required an integrated regional assessment model.

34. Discussions were focused on the agriculture sector and the discussant stated that one of the main challenges in analyzing the agricultural sector was the lack of data for non-climatic variables used in agricultural models. She revealed that adequate data at the farm level were not collected and the data received by practitioners were basically insufficient farm level data aggregated to the national level. Due to that deficiency, it was not possible to capture the distributional impacts among crops. Turning her attention to water and the huge impact it had on agriculture, she suggested that those two sectors should be brought together in analyzing the impact on climate change on the agriculture sector. As an example, she pointed out that data on the amount of land under irrigation was not available in the region. With regards to spatial data, she said that there was a need to gather data on soil type. Turning towards a subsector in the agriculture sector, the discussant mentioned that the impact of climate change on fisheries could not be measured correctly since data on sea surface temperature was not collected. In addition to those concerns, she pointed out that countries were sometimes unwilling or hesitant to provide data on agricultural output. She brought her discussion to a close by indicating that she was in full support of the regional integrated model proposed, but suggested that more simulations should be done and there should be some amount of dynamism introduced in the models.

35. The discussant on the coastal and marine sectors and revealed that data for that sector were not available on an annual basis, and so it precluded the use of regression models. Simulation models were generally used to analyze the sector with values being placed on the resources. He disclosed that the values he obtained were wide in estimations and dated and, therefore, impact on the sector was measured using downscaled data obtained from country-specific statistical offices. He revealed that in analyzing the sector, there was a link to the tourism sector, but not to the trade sector, which was necessary. He suggested that there was a need to undertake sensitivity analysis and examine one factor at a time. Another issue raised was related to GIS data and the lack of availability of such data in some countries. Similar to the first discussant, he indicated that there were no projections for sea surface temperature other than those presented under IPCC scenarios. As a key climate variable in analyzing that sector, there was neither historical nor forecasted data on that variable. He supported the call for a regional model.

36. With respect to the energy sector, the representative of the University of Havana noted that the sector was an exception due to its sectoral relationship to climate change. On the one hand, there was need for economic growth, which consumed energy (Caribbean countries consumed more than 90% of energy from non-renewable sources) and, on the other, there were the policy objectives of the energy, which included reducing CO₂ emissions. For those reasons, simulation models could be employed to illustrate several scenarios regarding less emissions and higher social and economic development. A

study on the energy sector must consider a range of policies that could reduce energy use and total emissions. With regard to modelling, while a regression-based approach could be used, it should be supplemented with Artificial Neural Networks (ANN) to capture non-linearity, asymmetries and enable a more accurate forecast of variables. The discussant closed his discussion by stating that integrated assessment and scenario planning models and ANN could be the best options for assessing the economic and social impacts of climate change on the energy sector.

Discussion

37. The discussion started with participants raising several questions and issues, including the use of an indicator besides GDP that could be used to examine the impact of climate change and the key concern as to whether national assessments should be undertaken and then an aggregation be done to obtain a result for the region. The presenter responded by saying that a range of potential indicators could be employed if an integrated assessment model was used and that GDP was still fairly useful since governments utilized fiscal measure. He stated that if there was a modular type of framework, different countries could use different sub-models and then add it to a regional 'module'. Another recommendation was that there should be an examination of the similarities and disparities found in the studies already conducted. It was emphasized that even when there was methodological coherence, there might still be problems encountered from aggregating similar sectors across countries. There was a need to construct into the country level model a mechanism for continual update of the model as new data and information emerged. On the same issue, there was the suggestion that the approach did not matter, since it could not be an exact fit in any event, but that there should be a widespread awareness of what climate change was all about. There was the pressing need to be able to mitigate and provide adaptation strategies, so the livelihood of citizens could be maintained or improved. The meeting was reminded that there were country specifics that needed to be taken into consideration in the modelling process and there should be a national focus so that the regional aspect could benefit from the country specifics and vice versa. It was recommended that an exogenous adaptation facet be built into the model. Discussion on that issue was concluded with the presenter adding that a good model should encompass adaptation options and that the modelling framework had to be simple and flexible enough to adapt to changes in variables (for example, technological changes).

38. Another important issue raised was whether it was suitable to rely on results emanating from variations or problems in the short term to put forward long-term solutions. In reply, the presenter suggested that if one had an idea of the underlying cycle of the variables, then it should reduce the problems associated with using short-term variations to produce long-term results.

39. In response to a question on thresholds for rainfall, the presenter responded by advising that identification of such thresholds required historic accounts and homogenous approaches.

40. A recommendation was made that three recent publications be reviewed by participants. Those publications were available at - (<http://www.ipcc-wg2.gov/SREX/>), (<http://www.ipcc-wg3.de/publications/special-reports/srren>) and (<http://srren.ipcc-wg3.de/report>).

7. Modelling sectoral impacts – special challenges related to the health, tourism and water sectors.

41. This agenda item continued to examine specific sectoral issues in modelling the impact of climate change in the Caribbean.

42. The presenter stated that understanding the economic and social impacts of climate change was critical. He proposed a framework for modelling the macroeconomic impact of climate change in the region which comprised the climate change scenarios, the regional and country studies, and national macroeconomic model, a national macroeconomic assessment, climate change mitigation and adaptation strategies. He highlighted some of the problems and issues encountered with macroeconomic forecasting modelling. He stressed that insufficient data was still a major issue and that it was related to other factors (for example, the timeliness of current output and the absence of forward-looking indicators). He concluded by stating that the social dimension could not be addressed in the current structure of models and that there was a need to incorporate such impacts as it related to climate change.

43. The discussant informed the meeting that the impact of climate change on the health sector was examined from the demand side through infection from selected diseases. She added that health should not be examined in isolation but rather should be studied in conjunction with water, sanitation, and the percentage of persons gaining accessibility to good quality water. She emphasized that GIS and geo-referenced data and rainfall data would be important for assessing the health sector.

44. As explained by the discussant, modelling the impact of climate change on tourism generally included one climatic variable, that is, temperature. However, his estimation involved the use of a traditional tourism demand model augmented by the tourism climatic index. Included in the analysis on the supply side was coral reefs and sea level rise (divided into three components). He concluded by emphasizing that, to date, partial equilibrium frameworks had been used to model tourism demand and that future study of the sector should consider, global feedback effects, the integration of adaptation options, the use of a general equilibrium framework to incorporate both, demand and supply. There should be an attempt to model the effects on non-hotel establishments in the tourism industry.

45. The discussant reviewed the facts and uncertainties associated with climate change and the hydrological cycle. He pointed out that a plethora of models and software was needed to assess the water sector. He suggested that the results from climate change models using precipitation data were not adequate to assess the water sector and that an advanced water policy was essential for the region. He concluded by recommending some modelling frameworks and tools for assessing the water sector.

Discussion

46. The first question posed in the session dealt with the issue of how to link the water models with the macro models. No definite solution was offered, but one participant stated that there was a lack of economic culture when dealing with water scarcity. One of the discussants indicated that the water model was within a good framework and that avoidance of the problems could be avoided by obtaining the data from the tourists. It was emphasized that water markets did not operate in the typical way and the real issue involved curtailing demand since increases in demand brought decreases in yield.

47. Following that discussion, the issue of the tourism climate index was raised. The main concern with the index was that the variables entered the model linearly and did not interact when, in fact, they might be quadratic in nature. The presenter on the tourism sector indicated that the water model was a good framework and one of the ways that problems associated with the tourism climate index could be avoided was to obtain data directly from the tourist.

48. The discussion turned to the health sector analysis and a question was posed regarding the issue of migrate diseases and if they were considered in the analysis. The presenter indicated that due to the grouping of diseases according to symptoms in the collection process, it was difficult to separate foreign diseases from national ones.

49. With regard to the water sector, two comments were made. The first was related to water pricing and the fact that pricing would only change if there was a policy shift. The second was in reference to curtailing demand since it resulted in yield decreases.

50. A question was raised regarding the flexibility of the model in allowing for simulative policy responses. The presenter pointed out that similar to most macro models there was a policy response in the form of mitigation effects. It was added that the model did not explicitly provide mitigation and adaptation strategies, but that they were inferred from other circumstances. Further, it was explained that the model delivered the impacts and effects, but there was choice in the mix of policy. In response to a concern raised on the width of the shock that could be captured in the model, it was explained that macro models were not built to make distance projections and when the time frame exceeded 5-10 years, a trend was received. It was, therefore, essential that the model be kept updated as much as possible.

8. Towards a regional approach to macroeconomic modelling of climate change in the Caribbean

51. This agenda item comprised a panel discussion which examined general equilibrium tools, methods and implications for the Caribbean, as well as regional adaptation strategies, and alternative approaches.

52. The presenter explained that the early modelling strategies in the Eastern Caribbean were simple and focused on the real and monetary sectors and there was a general lack of resources and knowledge of the features of Caribbean economies. From the early 1990s, the models employed in the Caribbean became a little more sophisticated, disaggregated and the focus was on the monetary, real, balance of payment and government sectors – the models lacked the inclusion of social and environmental impacts. At present, certain Caribbean countries employed an accounting macro-type model, with a few behavioral elements. The models had been extended to examine other facets in the economy and could be used to undertake simulation analysis, some elements of regression analysis; it had a GE- type framework and allowed the examination of feedback elements. The model, which was developed in 1993 in Barbados, had various modules, was well-grounded in Caribbean theory and had strong theoretical underpinnings. The impact of climate change could be incorporated into the model and that model was being recommended for exploring climate change in the Caribbean. It could be extended to the other Caribbean islands and could be tweaked to accommodate flexible exchange rates.

53. The presenter provided a national overview of Cuba and the main foreseeable impacts of climate change in Cuba. He outlined the national response and gave a brief summary of the existing policies and programmes. He mentioned that there were still some outstanding issues that needed to be dealt with regarding a new economic policy which was expected to increase energy demand. He outlined the relationship among sectors, including climate change variables and offered some practical and methodological points of view on sectoral modelling and some of the models and tools that were utilized. He ended by discussing how adaptation and mitigation actions should be featured in the model.

54. The presenter reported that macroeconomic modelling in Guyana utilized partial equilibrium analysis in the main and were generally sectoral in nature. He stated, further, that in the context of Guyana, GE models were seen as inappropriate due to data limitations and that markets in Guyana were imperfect and very shallow, with long lags. He stated that modelling in Guyana would necessarily have to be very eclectic. He mentioned that there were models being used at present which had been very useful in predicting the near to medium term. He suggested that there was a need to modify and update the existing model to take into consideration climate change. In the Guyanese context, incorporating aspects of climate change into a macro econometric model might be very difficult due to existing adaptation measures. He addressed the national to regional modelling concern by stating that there were a number of weaknesses that needed to be taken into account and that the existing models should be utilized

as a start and then incorporated into a larger model. He further stated that the regional model would need to mimic models existing outside the region, and the existing models would then be used to make it region-specific. Given the adaptation and mitigating efforts that had been undertaken, the models would have to be revised regularly.

Discussion

55. The discussion in this session began with questions on the incorporation of temperature, precipitation and other environmental variables into the modelling framework, the role of technology and cost minimization in climate change and how could risk be incorporated in the model. It was emphasized that one macro model could perform all tasks, however, once it could be identified that temperature and rainfall affected a particular sector, then it could be built into the particular sector model. It was stressed that in modelling, since all processes began in the real sector then once an impact was noticed in that sector then it could be included in the model. Further, it was mentioned that it was possible for risk to be captured.

56. Further questions were raised on the technical details of the model, specifically regarding the substitution effects among the provinces and whether the various macro accounts used in the model were available at the province level. It was advised that even though national models were being used, there was still a need for a regional model to look at the broad issues in the region such as, debt and climate change. It was suggested that maybe there could be a regional framework that could tackle all of the regional-level issues (fiscal issues, climate change) and then feed back to the specific countries.

57. A cogent issue regarding social inclusion and provision for the gender dimension in those models was also raised. The response was that those items would be included in the model.

58. It was noted that the models presented might be able to tackle distributional issues and various impacts, but the concern remained as to how micro the analysis could be with the models. One response to that issue indicated that the climate change models should be included in the sectoral models and not the regional model. There was the need to start building the model from the bottom up and that different options should be used in the modelling process to determine the best approach. It was mentioned that the distribution issue was not considered in modelling in Cuba at that time.

59. It was also mentioned that surveys could be done to obtain information to inform policy, since while from a monetary perspective all levels of data were readily available, data for other sectors could prove to be more difficult to acquire.

60. The discussion turned to social and environmental issues and whether those were considered in existing models. One response indicated that social issues were not included explicitly in the model but that there was always the 'adjustment' factor where expert opinion was used to determine the impact of a 'shock'. That was supported with the statement that there were no variables omitted from the model since they were implicitly included in the sectoral-type estimates, which were then encompassed in the national model. It was emphasized that there was a pressing need to have a flexible framework that took into consideration adaptation measures the subregion moves into the future.

9. Conclusions and recommendations

61. At the conclusion of the meeting, it was stated that the two-day discussion was a remarkable experience and that the expertise and intellectuality of the participants were quite extraordinary. There were two challenges that were identified: the need to build on existing models and the need to examine methodologies that permitted more satisfactory outcomes and those that allowed integrated approaches.

The presenter closed by emphasizing that it was a team effort and that subregion's resources should be utilized in addition to the expertise of extraregional colleagues.

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