Picked up 1-13-87

U.S. House of Representatives
Committee on Energy and Commerce
Room 2125, Rayburn House Office Building
Washington, DC 20515

January 2, 1987

Honorable George P. Shultz
Secretary
Department of State
2201 C Street, N.W.
Washington, D.C. 20520

Honorable Lee M. Thomas
Administrator
Environmental Protection Agency
Waterside Mall -- West Tower
401 M Street, S. W.
Washington, D. C. 20460

Dear Secretary Shultz and Administrator Thomas:

I commend your agencies and representatives for their effective efforts last month in Geneva, Switzerland, to obtain a protocol to the Ozone Layer Convention of 1985 which would apply worldwide. I believe a protocol is the right approach. I understand it is also supported by industry and environmentalists in the United States, although I note that the European CFC Producers in an October 1986 statement are not as supportive of a protocol as the U.S. industry. I am disappointed to learn that a number of countries were not represented at Geneva and that some Nations, like the European Economic Community and Japan, are less supportive of the protocol approach. Hopefully, with patience and education, these countries will also agree to a meaningful protocol that includes adequate trade provisions, particularly in light of the recently announced trade deficit of $19.1 billion for November 1986.

There are, however, several matters that concern me regarding this effort that are discussed in the attached 'Enclosure.' I request your reply by February 13, 1987. I am sending a copy of this letter and enclosure to the Defense Department (DOD), the Department of Energy (DOE), and the National Oceanic and Atmospheric Administration (NOAA) which also are concerned with these matters and asking them by this letter to cooperate with your agencies in preparing a reply.

I am also in receipt of Assistant Secretary of State J. Edward Fox's December 23 reply to my letters concerning the participation of the Committee staff as observers to the Geneva negotiations and in all meetings of the U.S. delegation. I appreciate Mr. Fox's comment that the U.S. delegation undertook to "consult closely and continuously with observers as the discussions proceed and the U.S. position evolves." I applaud that and request that it continue. However, on at least two occasions, one here in Washington, D. C. and one in Geneva, the Congressional staff observers were excluded from delegation meetings. That was not consistent with my request. Subsequent to the second occasion, the head of the U.S. delegation, Mr. Richard Benedick, did seek to avoid such further instances. Thus, I presume that the matter has been resolved in favor of opening all such future meetings to our staff.

Please keep our Committee appraised of all matters relating to the development of this protocol in a timely fashion.

With best wishes.

Sincerely,

JOHN D. DINGELL
CHAIRMAN

Enclosures

cc: Honorable Norman F. Lent, Ranking Minority Member
Subcommittee on Oversight and Investigations

Honorable Henry A. Waxman, Chairman
Subcommittee on Health and the Environment

Honorable Edward R. Madigan, Ranking Minority Member
Subcommittee on Health and the Environment

Honorable Caspar W. Weinberger, Secretary
Department of Defense

Honorable John S. Herrington, Secretary
Department of Energy

Honorable Anthony J. Calio, Administrator
National Oceanic Atmospheric Administration
Department of Commerce

Honorable J. Edward Fox, Assistant Secretary
Legislation and Intergovernmental Affairs
Department of State

Mr. Richard Benedick
Deputy Assistant Secretary of State
OES/E, Department of State

Committee on Energy and Commerce Enclosure for
the Department of State and the Environmental Protection Agency
Re: Ozone Layer Protocol and Related Matters

January 2, 1987

1. Please provide a table showing all CFC producing countries, the estimated annual production, and the annual exports by such countries of that production. Please include in the table the identity of each firm producing (by country) the CFCs and, if known, the specific CFCs being produced. Please also indicate which producing and nonproducing countries do not ban the use of aerosols.

2.(a) Please provide a reasonably comprehensive statement of the status of the scientific understanding available today about the risks to human health and the environment, particularly the stratospheric ozone, from continued or expanded global emissions of fully-halogenated alkanes, including a discussion of the life of the compounds. Please identify the relevant compounds and the problems they offer.

(b) The U.S. statement of November 5, 1986 expressing the "U.S. Views" for a protocol said:

> Considerable evidence exists, both in theory and from models, linking these chemicals to depletion of ozone. However, remaining scientific uncertainties prevent any conclusive statement concerning safe levels of emissions.

In replying to (a) above, please summarize that "evidence" and the "uncertainties" and explain the status of efforts worldwide and in the U.S. to resolve the uncertainties.

(c) In its policy statement of September 16, 1986, the Alliance for Responsible CFC Policy said:

> Based on the theory, current scientific understanding, and reasonable assumptions about future emissions of substances that may modify the ozone layer, no significant modification of the ozone layer is expected during the next few decades, therefore, there is no imminent threat to human health and the environment from current CFC use or emission.

A reading of a more recent research report by the World Resources Institute seems to take a different view, while recognizing that the "urgency of the issue has fluctuated widely." What are your views on this issue of imminent threat and urgency, taking into consideration the long atmosphere lifetimes of the

compounds? Do you agree with the Alliance?

(d) The December 5, 1986 edition of The Christian Science Monitor indicates that some scientists, such as one from Cornel and two from NASA, have questioned some conclusions, including a recent EPA study. One observes that "chemical process can't explain all the facts" such as "seasonal ozone redistribution." The other challenges a recent EPA study on the "rise in skin cancer rates" if CFCs are not curbed. Please comment on those challenges and indicate their significance. Was the EPA study released prior to peer review as the Cornel scientist states? If yes, please explain why. What is the status of the study?

3. Enclosed is a document prepared, but not used and thus I understand it has no official standing, by scientific advisors at Geneva. Nevertheless, it appears helpful. Please review it and if you desire, provide a revised version or make comments on it where you think they are warranted for any reason.

4. The U.S. "Views" of last November called for a "prudent protocol" which, as a "first step," should require a "near-term freeze on the emissions of all fully-halogenated alkanes (i.e., CFC 11, 12, 113, and Halon 1211 and 1301) at or near current levels." Such levels are established in the draft protocol as those that do "not exceed" each Party's "1986 level."

(a) Please explain why the above CFCs were included in the freeze and indicate the current uses and user industries of each. The enclosed paper also lists CFC 22 as a substance meeting the criteria for potential impact on the ozone. Why is that substance and CFC 114 not on the U.S. list?

(b) What is the Defense Department's view on including the Halons in the protocol? Why should they be included?

(c) Please explain the term "emissions" and explain how the U.S. expects it would be applied meaningfully in the U.S. and in other countries, particularly in nonproducing countries. The November 25 draft U.S. protocol refers to annual "bulk" exports and imports. Please explain how this term works in the case of motor vehicles with air-conditioners imported to the U.S. from such countries as Sweden, Japan, and West Germany? Would they be counted by the U.S. or these other Nations?

(d) As noted in the Geneva meeting, "no country disputed need to control CFC 11 and 12, and many want to include 113 (Japan opposed)." To what extent is Japan a producer of CFC 113 and is all that production now on line? Why is Japan opposed to a protocol that covers CFC 113? Is Japan phasing out other solvents in favor of CFC 113 and going to tighter systems? Is that occurring in the U. S.?

(e) Will the U.S. proposed freeze at 1986 production, not capacity, levels allow some countries without a ban on aerosols to have an advantage over other countries, like the U.S. which has a ban? With such a freeze, could those countries later adopt an aerosol ban and increase production of other CFCs, like 113, and still be within the freeze? If yes, please explain why that approach is sound from health and environment, trade and competition standpoints.

5. The European CFC producers' October 1986 statement indicate that as a "first step" a protocol "might include" a "global limit to the production of CFCs 11 and 12." As the State Department's telegram points out, the European Communities offered a proposal to freeze CFCs 11 and 12 at 1986 production, not capacity, levels. The Alliance's policy statement indicates that it "supports international resolution of the issue" without saying what substances should be covered or what limits should be established, although the related press release calls for a global limit on the future rate of growth of fully halogenated CFC production capacity which leaves a great deal of "wiggle-room" I believe. Would the U.S. agree to a protocol that only places limits on CFC 11 and 12 at current production levels and relies on future actions to provide for more limits and substances in order to have some agreement?

6. The November 5, 1986 U.S. Views also calls for a "long-term scheduled phase-out of emissions of these chemicals." The "phase-out" would have such "characteristics" as to:

(d) provide adequate time for shifting away from ozone-depleting chemicals to avoid social and economic disruption, while at the same time give a strong incentive for the rapid development and employment of emission controls, recycling, and benign substitute chemicals (i.e., a technology-forcing approach);

(e) take into full consideration scientific uncertainties and promote future improvements in understanding by instituting a requirement for reassessing the goal and timing of emission limits if changes in science suggest such action is warranted;

(f) address all fully-halogenated alkanes, so that the principal anthropogenic sources of atmospheric chlorine and bromine are included;

(g) allow flexibility for industrial planning by allowing trade-offs among these chemicals based on their relative ozone-depleting effects;

(h) allow flexibility for limited continued use of those chemicals which are of highest social value and for which no substitutes presently exist; and

(i) create incentives to participate in the protocol by regulating relevant trade between parties and non-parties.

The draft protocol of November 25, 1986 calls for global reductions of 20, 50, and 95 percent from the 1986 levels over an unspecified period following the effective date of the protocol which could be several years after its adoption. I understand that these percentages (which depending on the reasonableness of the related timeframes) are suggestions by the U.S. and not firm. On the other hand, the World Resources Institute press release of November 30, 1986 states that CFC emissions "could be reduced by one third in the U.S. and worldwide by using 'safe' CFCs, banning aerosols, and recycling CFCs."

A December 4, 1986 contract report to EPA on CFC substitutes which "has not been peer reviewed" discusses the new substitutes being considered today. Some of that discussion follows:

Mobile Air Conditioning

FC-134a appears to be a good candidate for substitution of CFC-12 as the refrigerant in mobile air conditioning, providing that further toxicity studies do not show negative results. Other possible problems are oil compatibility and time for implementation.

CFC-22 may be used as a mobile air conditioning refrigerant. However, a 60 percent higher operating pressure would require significant redesign and retooling of the currently used air conditioning systems. A major problem is the difficulty in containing CFC-2. With present materials, permeation is about five times greater than CFC-12. Without substantial reduction of permeation, refrigerant losses would require annual recharging for every vehicle, and excessive CFC-22 emissions would reduce some of the progress made toward reducing stratospheric ozone depleting emissions.

CFC-114 (currently produced in small quantities) also may be used as a substitute mobile air

conditioning refrigerant. Permeation would be reduced for this low pressure system. However, CFC-114 still has a significant ozone depletion factor. Compared to current CFC-12 systems, emissions of ozone depleting substances would be reduced by 60 percent after implementation of CFC-114. However, complete redesign and retooling must be made for this low pressure refrigerant. Alternatively, low vapor pressure hydrocarbons with zero ozone depletion factor could be used in this system, if the problem of flammability of hydrocarbons were resolved.

* * *

Home Appliances

CFC-502 may be a good candidate for substitution of CFC-12 in home appliances. It has been used satisfactorily in both low and medium temperature retail food store refrigeration systems. However, redesign for higher pressures, including a compressor much smaller than food store applications, would be necessary. CFC-22 also has been used satisfactorily in medium temperature retail food store applications.

The CFC-22/CFC-142b mixture may be a very good candidate for substitution of CFC-12 in refrigerator/freezers. The addition of CFC-142b lowers the operating pressure required for pure CFC-22 and increases oil solubility in the refrigerant.

FC-134a also may be a good candidate for substitution of CFC-12 if it becomes commercially available. Also, development work must overcome the problem with electrodeposition of copper. FC-134a causes electrodeposition of copper and copper salts from the motor windings on the internal surfaces of the expansion capillary and on the bearings of the motor and compressor.

* * *

Thus, there are more potential candidates for refrigerants for home appliances than for mobile air conditioning. However, additional development work specific to this application is necessary to insure that any given substitute will indeed be acceptable.

Flexible Foam Blowing Agents

From a technical and safety standpoint, CFC-123 appears to be a good substitute CFC blowing agent for flexible polyurethane foams. The major impediment to

its implementation is its cost and availability. These factors are not yet well-defined. Economic evaluations are hindered until a practical commercial process for CFC-123 is developed.

CFC-133a has less potential then CFC-123 as a flexible foam blowing agent, due to its recognized toxicity and uncertainty regarding compatibility with differing feed formulations.

In comparison with CFC-123, there is much greater uncertainty associated with CFC-141b application as a substitute blowing agent. Questions regarding inplant safety hazards and solvent affinity toward the foam product cannot be adequately resolved with presently available information.

Rigid Polyurethane Foam Blowing Agents

An attractive alternative CFC to CFC-11 as a rigid urethane blowing agent may be CFC-123. The processing and product characteristics of this alternative closely resemble those of CFC-11, yet the estimated ozone depletion factor of CFC-123 is 91 percent lower than that of CFC-11. The main trade-off with using CFC-123 is production of foams which have a lower insulating efficiency. The other alternatives, CFC-141b and CFC-133a, may not be suitable blowing agents because of their toxicity and their strong solvent action. An additional drawback to CFC-133a are its low boiling point which could compromise foam quality.

* * *

Solvent Applications

Both CFC-123 and CFC-132b appear to be very good substitutes in several applications for CFC-113 to reduce stratospheric ozone depletion. However, it is not certain that they would be acceptable in all or most applications. Since the ozone depletion potentials are only one third less than methyl chloroform and the projected costs are relatively high, both CFC-123 and CFC-132b currently appear to be high-cost substitutes for reducing stratospheric chlorine from methyl chloroform emissions.

As to costs of the potential substitutes, the draft report states:

The inexpensive source of chlorocarbons and hydrogen fluoride allows the very inexpensive manufacture of current commercial CFCs via the Swarts reactions. Common CFCs are priced in the range of $1.50 to $2.00 per kilogram. It would be very

difficult to produce the newer CFCs with a specific structure at competitive prices. Bulk prices for newer CFC when fully commercialized are expected to be in the range of $2.55 to $10.20 per kilogram, although CFC-124 may be as high as $15.00 per kilogram (see Section 8). (Underlining supplied)

The draft report and the U.S. protocol do not appear to address another concern about how the user industry and the small business service industry, and the small business service industry, particularly in case of home and commercial refrigeration/air conditioners and motor vehicle air conditioners, will be able to continue to service those systems over their lifetime, once reductions begin. Those vehicles and units were built and installed with CFCs now being considered for global reduction. Some require recharging, although the draft report says that is "very infrequent" for home appliances which, may or may not include home central air conditioners which often do require recharging. It is not clear that the substitutes would be compatible or suitable for existing installed systems, particularly mobile systems. Many such systems have long lifetimes.

6. (a) Please explain to what extent you disagree or agree with the above comments about the availability of substitutes. What analysis was made by the U.S. of the availability of substitutes and their costs within the timeframes and percentages contemplated in the November 25 draft? Do the proposed reductions suggested in the draft consider the availability of present CFCs for existing units?

(b) Is there any reason to believe that producers in other countries with existing patents will develop substitutes sooner than U.S. firms? I note that the draft report states that the "patents are based upon laboratory scale results, and do not imply that each process could be commercialized on a large scale." In the case of CFCs-123, 124, 132b, 133a, 134a and 141b, the draft report states that "development work at DuPont has been stopped." My understanding is that DuPont is not the only U.S. firm trying to develop substitutes. What is the status of this effort by any firm? To what extent do these substitutes present possible problems for the user industries, such as safety and fuel economy problems, for the motor vehicle industry? Are those problems being examined by the applicable agencies?

(c) I note that a Wall Street Journal article of December 2, 1986 states that "U.S. chemical producers clearly aren't rushing to develop substitutes" and DuPont is not planning "heavy spending" on CFC 134a "until regulatory action or consumer demand justify it." The World Resources Institute states that without a "stiff tax, chemical companies may be unwilling to

invest" in substitutes. I presume this would be a U.S. tax only. How will the U.S. draft protocol encourage on a global basis acceptable and reasonable substitutes for the user industries? Do you agree that a tax is needed?

(d) World Resources urges "short-term reductions of one third "to promote substitutes and a total phase out in "perhaps a decade." The Natural Resource Defense Counsel seeks 30% reduction by the end of 1988, 85% by 1992, and a phaseout in ten years. The draft EPA report does not appear to support such short timeframes. It states:

> In the absence of future regulations, the newer CFCs do not appear cost effective compared to current CFCs. Up to five years of additional development work may still be required, depending on remaining process problems. Thus, it is anticipated that commercialization of new CFC chemicals would require about four to 10 years, depending on the status of current process development work, the remaining process problems, and the strength of the driving forces to proceed.

Lead time and technology problems, if any, including safety, for the user industries to adopt to such substitutes is not discussed in the U.S. Views.

What are your views on the time required to develop suitable substitutes and for the user industries to be able to adopt them (a) after a protocol is developed and (b) after the protocol is effective? What is the justification for a "technology-forcing approach" in this case and what is the implication of that approach for the user industries? What is the likelihood that a protocol will reflect the recommendations of the World Resource Institute or the NRDC?

(e) To what extent is recycling and the use of closed systems, especially in the case of solvents, expected to result in considerable reductions? To what extent are these used by the CFC 113 users in this country?

(f) During discussions of the draft protocol with observers present, Mr. Benedick explained that the draft protocol provides for adjustments in the stringency, timing, and scope of the control measures if the substitutes are not developed and/or the users cannot accommodate to the substitutes within the time set in the protocol. However, our staff pointed out that the draft (Article IV: 3) allows such adjustments only in "light of scientific review." Mr. Benedick agreed that the draft needed revision to reflect his

statements. Please make that revision.

7. The December 2 Wall Street Journal article states that an "estimated 70% of the world's CFC use occurs outside the U.S." and greater demand is "projected in future years" by developing nations. The article states that "EPA is also under a court-ordered May deadline to decide on added CFC regulations." Please provide a copy of that order. What is the status of that decision effort in light of the on-going United Nations negotiations and the above estimates? How will CFC regulations in the U.S. significantly impact the global picture of emissions? What will be the impact on U.s. industries competing with other nations with no corresponding regulations? Would the regulations, if any, be issued under section 157 of the Clean Air Act? What substances will be considered for regulation?

8. Please describe the Soviet and Nordic proposals and explain any concerns about them. What is being done to encourage more nations to participate in the next negotiations? Please describe your efforts to further examine the trade issues concerning CFCs. What are those issues?

9. I am in receipt of a November 26, 1986 release by the Department of Energy (DOE) of a December seminar to describe DOE's "state-of-the-art reports on carbon dioxide research and the greenhouse effect." Senator Chafee, in recent Senate hearings, said ozone "depletion and the greenhouse effect can no longer be treated solely as important scientific questions." The World Resource Institute is also concerned about the greenhouse problem. What is the science today regarding the greenhouse effect and what is the status of the research? What is the relationship of this to the ozone issue? What is being done about this problem in the U.S. and worldwide? If the problem relates to the burning of fossil fuels in the U.S. and elsewhere, what are the alternatives since halting such burning by our factories, homes, and utilities does not appear likely?

I am also providing a copy of this letter to the World Resources Institute, the NRDC, and the Alliance. I welcome their comments on the matters discussed herein. In the case of the Alliance, I urge that the Alliance provide copies thereof to its members and encourage all the members, but particularly the users of CFCs, to submit comments on these matters directly to the Committee within the next 60 days with specific attention to the quality, trade, energy, technological, competitive, safety, economic, and other problems users may identify with the development of substitutes and the lead times required for users and the need for incentives of any kind to stimulate the development of substitutes and/or recycling or other measures to prevent or greatly reduce emissions.

SCIENTIFIC ADVICE REGARDING COMPOUNDS TO BE INCLUDED IN THE PROTOCOL

I. Definitions

Suggest that compounds be listed by individual chemical formula rather than generic labels in order to avoid any ambiguity in scope of chemicals to be included in the protocol.

For example, there would then be no confusion as to whether CF2BrCl (i.e., Halon 1211) is a fully halogenated chlorofluorocarbon.

II. Criteria for consideration of priority order of compounds that have the potential of destroying stratospheric ozone

1. Rate of release of the compound into the atmosphere.
2. Fraction of the compound released at ground level that reaches the stratosphere.
3. Efficiency of the compound to destroy ozone once in the stratosphere.

III. Preliminary Conclusions

Based on our knowledge of the three factors above, the compounds that deserve consideration for inclusion in the protocol are in the following approximate order of importance:

First priority:

CFC13 (11), CF2C12 (12), and C2F3C13 (113)

reason: • high emission rates

• high fraction reaching the stratosphere

• high efficiency to destroy ozone

Second priority:

CF3Br (1301) and CF2C1Br (1211)

reason: • low current emission rates but with potential for rapid growth

• high fraction reaching the stratosphere (unity or close to unity)

• very high efficiency to destroy ozone (bromine is about a factor of ten more efficient than chlorine per atom)

Third priority:

CF2C1H (22) and CH3CC13 (methyl chloroform)

reason: • even with significant emission rates, only a small fraction (1/5 - 1/20) of the ground-level release reaches the stratosphere (removal in the troposphere due to the hydrogen content of the compound)

• moderately high efficiency to destroy ozone once in the stratosphere

The details are given in Tables I and II

TABLES

TABLE I. SIMPLE APPROXIMATE CALCULATION OF IMPACT OF COMPOUNDS ON OZONE USING THREE CRITERIA OUTLINED

CATEGORIES	COMPOUND	EMISSIONS+	FRACTION REACHING STRATOSPHERE	EFFICIENCY # ATOMS	EFFICIENCY E	TOTAL
I	CFC13 (11)	300	1	3	1	900
	CF2C12 (12)	400	1	2	1	800
	C2F3C12 (113)	150	1	3	1	450
II	CF3Br (1301)	1-10*	1	1	10	10-100
	CF2ClBr (1211)	1-10*	~0.5	1	10	5-50
III	CF2ClH (22)	50-200**	0.2	1	1	10-40
	CH3CC13	500	0.1	3	1	150

+ millions of kilograms - annual global production

* estimated range of current production

TABLE II. ESTIMATES OF ATMOSPHERIC LIFETIMES (YEARS)

I.	CFC13 (11)	75
	CF2C12 (12)	110
	C2F3C13 (113)	90
II.	CF3Br (1301)	110
	CF2ClBr (1211)	25
III.	CF2ClH (22)	20
	CH3CC13	6

Additional comments:

(a) Any source of chlorine or bromine to the stratosphere is thought to eventually lead to some ozone depletion.

(b) If the release of compounds such as CFC13 or CF2C12 do cause ozone to be depleted significantly, then the full recovery of the atmospheric system after complete termination of emissions will take many decades or centuries due to the long atmospheric lifetimes of these compounds. However, in contrast, once releases of CH3CC13 or CF2ClH are terminated, the recovery is much quicker (e.g., decades) due to the shorter atmospheric lifetimes.

(c) CC14 was not explicitly considered since our understanding of the emission rates is inadequate -- most is not released to the atmosphere but rather is used to produce F11 and F12.

United States Senate
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
WASHINGTON, DC 20510-6175

February 20, 1987

Mr. A. Alan Hill
Chairman
Executive Office of the President
Council on Environmental Quality
722 Jackson Place, N.W.
Washington, DC 20006

Dear Mr. Hill:

By this letter we request the submission of information, not later than March 6, 1987, regarding your agency's activities in addressing the environmental problems of the greenhouse effect, global climate change, and stratospheric ozone depletion.

The Senate Environment and Public Works Committee has held a number of hearings on the greenhouse effect, global climate change, and stratospheric ozone depletion. Testimony given at these hearings has shown that we are already committed to an unprecedented increase in surface temperature over the next few decades, with possible effects including a rise in global sea level, changes in ocean circulation, and changes in precipitation patterns.

We are deeply concerned by the prospect of such major and unparalleled changes in the composition of the atmosphere, and the implications for global climatic and environmental change. We are requesting information regarding your agency's efforts in these areas to assist us in understanding the existing and anticipated programs already addressing these issues. Specifically we would appreciate your responses to the attached questions.

We have forwarded a copy of this letter to the Chairman of the Appropriations Committee, and have requested that he incorporate these questions and your responses in the record of the budget hearings for FY88.

We look forward to receiving your response no later than March 6, 1987. If you have questions, please feel free to call Kate Kimball, Ron Cooper, Steve Shimberg, or Curtis Moore. They may be reached through the Committee on Environment and Public Works at 224-6176.

Thank you for your support in working with us on these important environmental issues.

Sincerely,

Robert T. Stafford

Quentin N. Burdick

John H. Chafee

George J. Mitchell

Dave Durenberger

Max Baucus

1. Please describe each of your program(s) which directly or indirectly involve or support work on (a) the greenhouse effect, (b) climate change, and (c) stratospheric ozone depletion, including:
   (a) basic research efforts
   (b) effects on human health, biota, etc.
   (c) studies of policy options for avoiding, minimizing, or coping with predicted changes, including use of alternative fuels and substitute chemicals and conservation.
   (d) international programs

2. Please indicate your current agency priorities and where, among these priorities, the problems of the greenhouse effect, global climate change, and stratospheric ozone depletion appear.

3. Does your agency have a major thrust or focus with respect to greenhouse, climate change, and stratospheric ozone issues? What are the priorities <u>within</u> your greenhouse, climate change, and stratospheric ozone programs? Are these multi-year efforts? When do you anticipate completing each of these projects?

4. The scientific evidence demonstrates that we are already committed to a $2^{o}C$ increase in global average temperature, and that the effects of global warming may be manifested as early as the next several decades. How have these findings been factored into your planning? How does the magnitude and timing of these changes affect your projects?

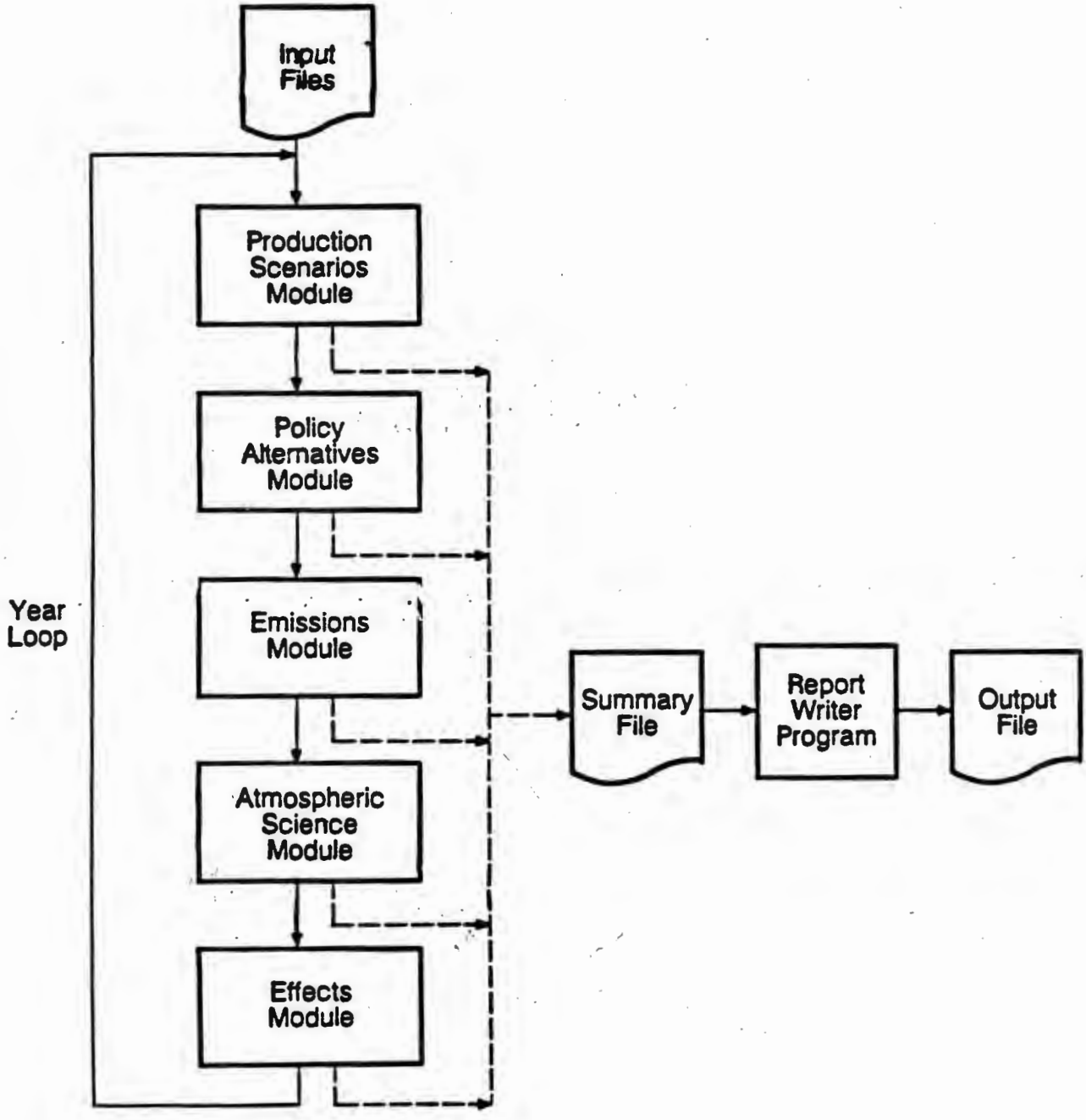
5. Please provide a detailed accounting on the following, including a breakdown by specific offices/laboratories and projects for each fiscal year.
   (A) For the greenhouse effect
      (1) Expenditures in FY86.
      (2) Appropriations and expected expenditures in FY87.
      (3) Budget request in FY88.
   (B) For climate change
      (1) Expenditures in FY86.
      (2) Appropriations and expected expenditures in FY87.
      (3) Budget request in FY88.
   (C) For stratospheric ozone depletion
      (1) Expenditures in FY86.
      (2) Appropriations and expected expenditures in FY87.
      (3) Budget request in FY88.

6. Please describe how your agency's efforts are coordinated with those of other federal agencies and the scientific community.

7. What do you see as the five highest priority research needs in the area of greenhouse effect, global climate change, and stratospheric ozone depletion?

EXHIBIT A-1

Flow of Analysis Program



BRIEFING FOR OMB

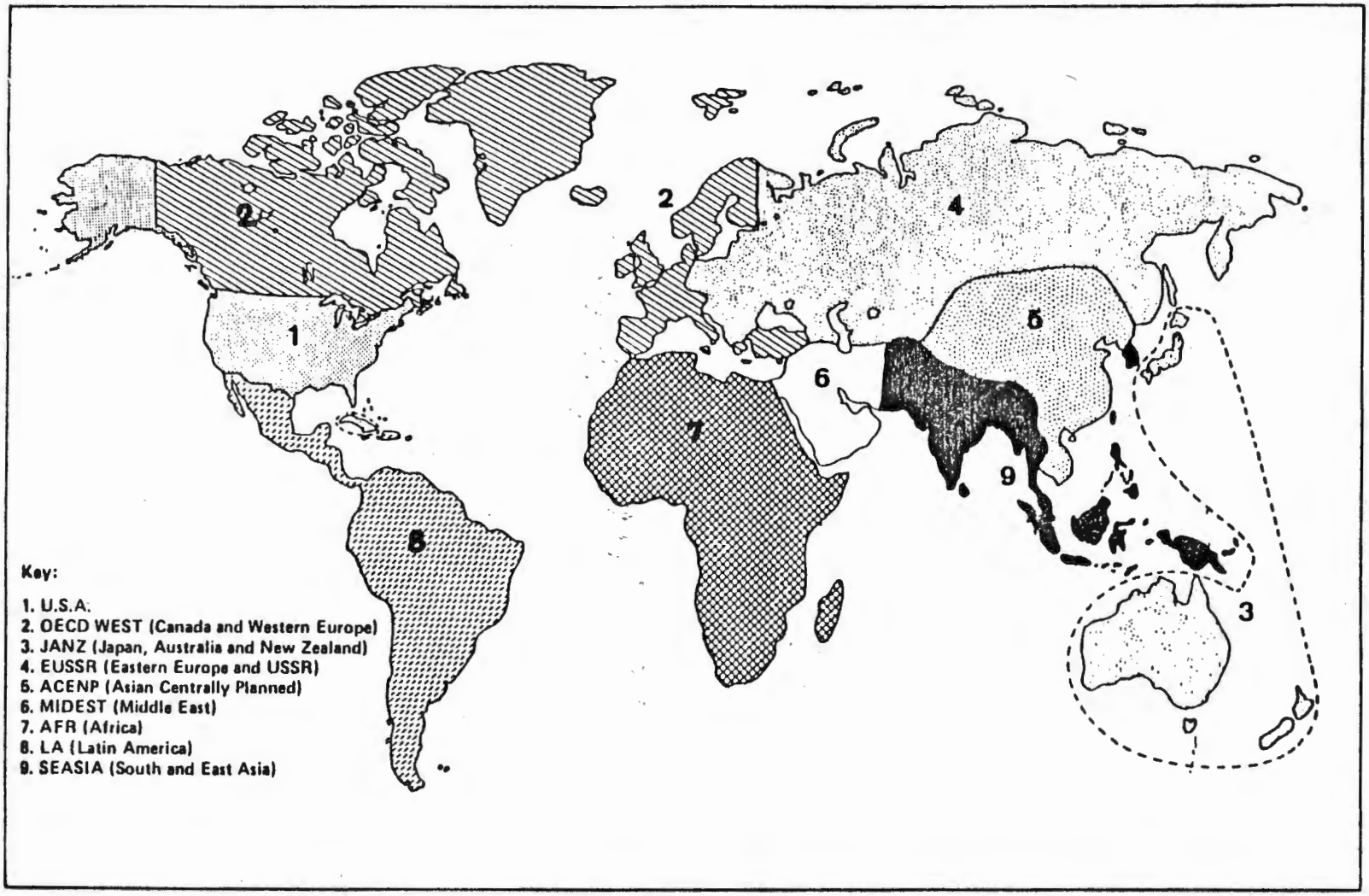
ASSESSMENT OF THE RISKS OF STRATOSPHERIC OZONE MODIFICATION: MODELLING ISSUES

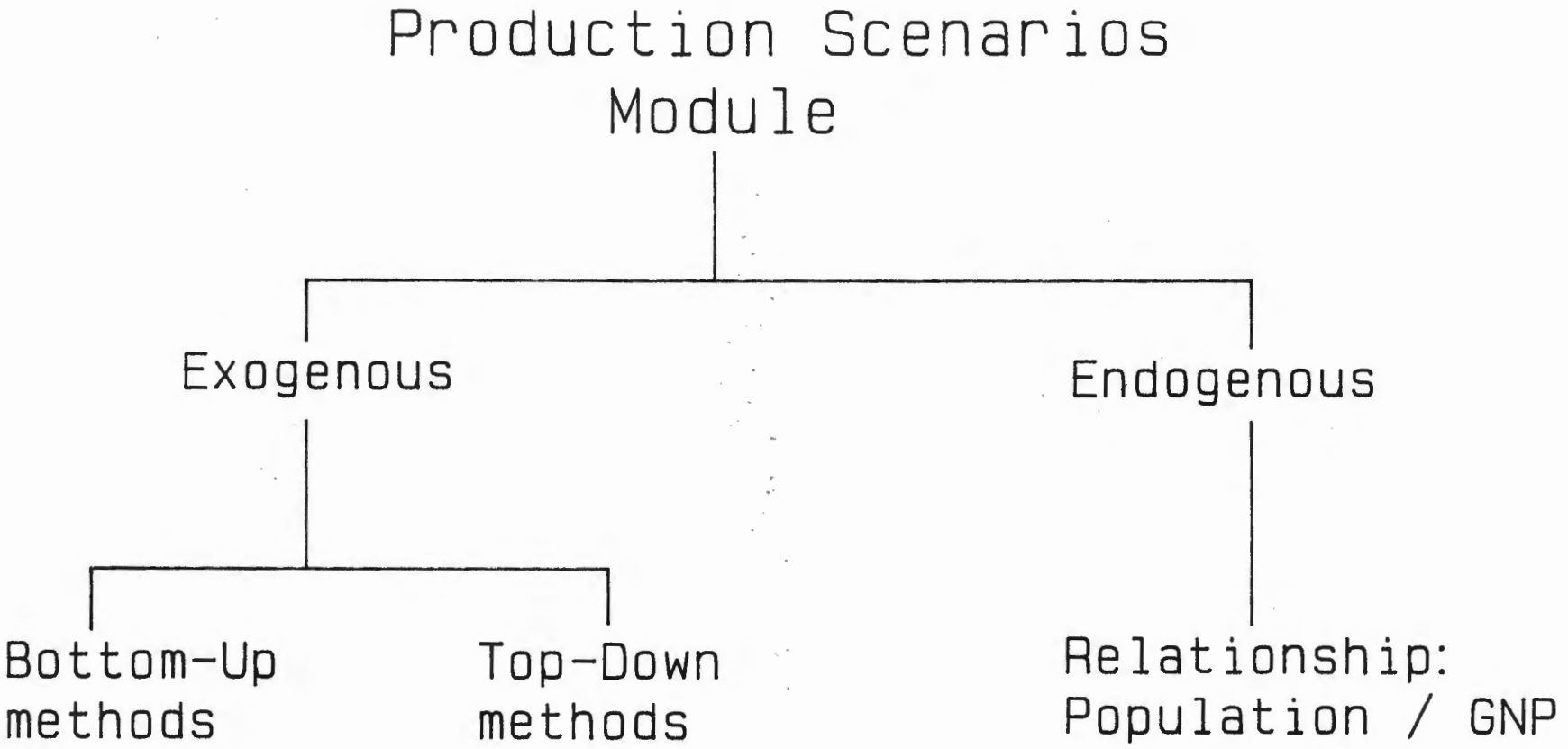
PREPARED BY

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR AND RADIATION

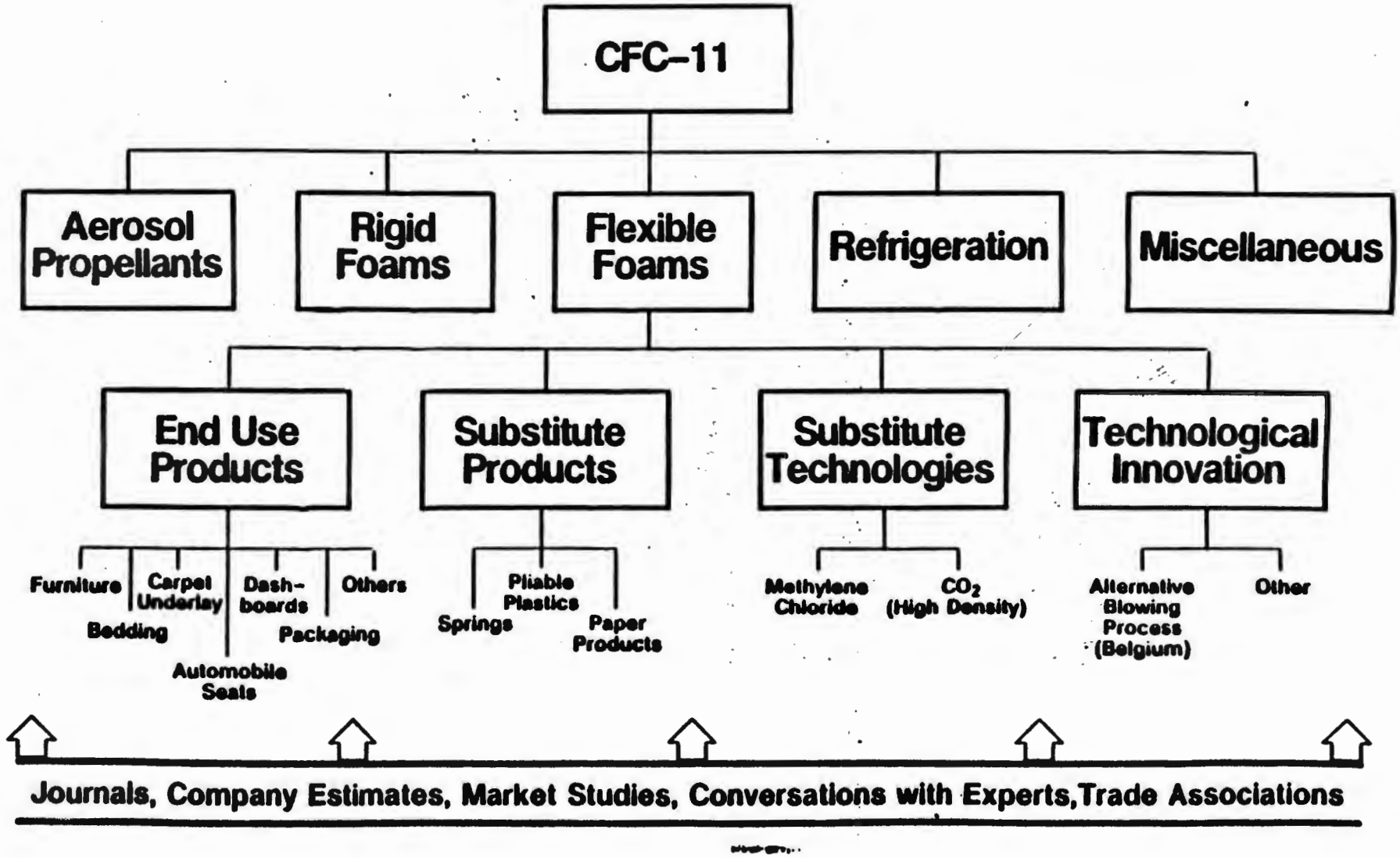
APRIL 6, 1987

GEOPOLITICAL REGIONS




Production Scenarios Module
Exogenous
Endogenous
Bottom-Up methods
Top-Down methods
Relationship: Population / GNP

BOTTOM UP APPROACH

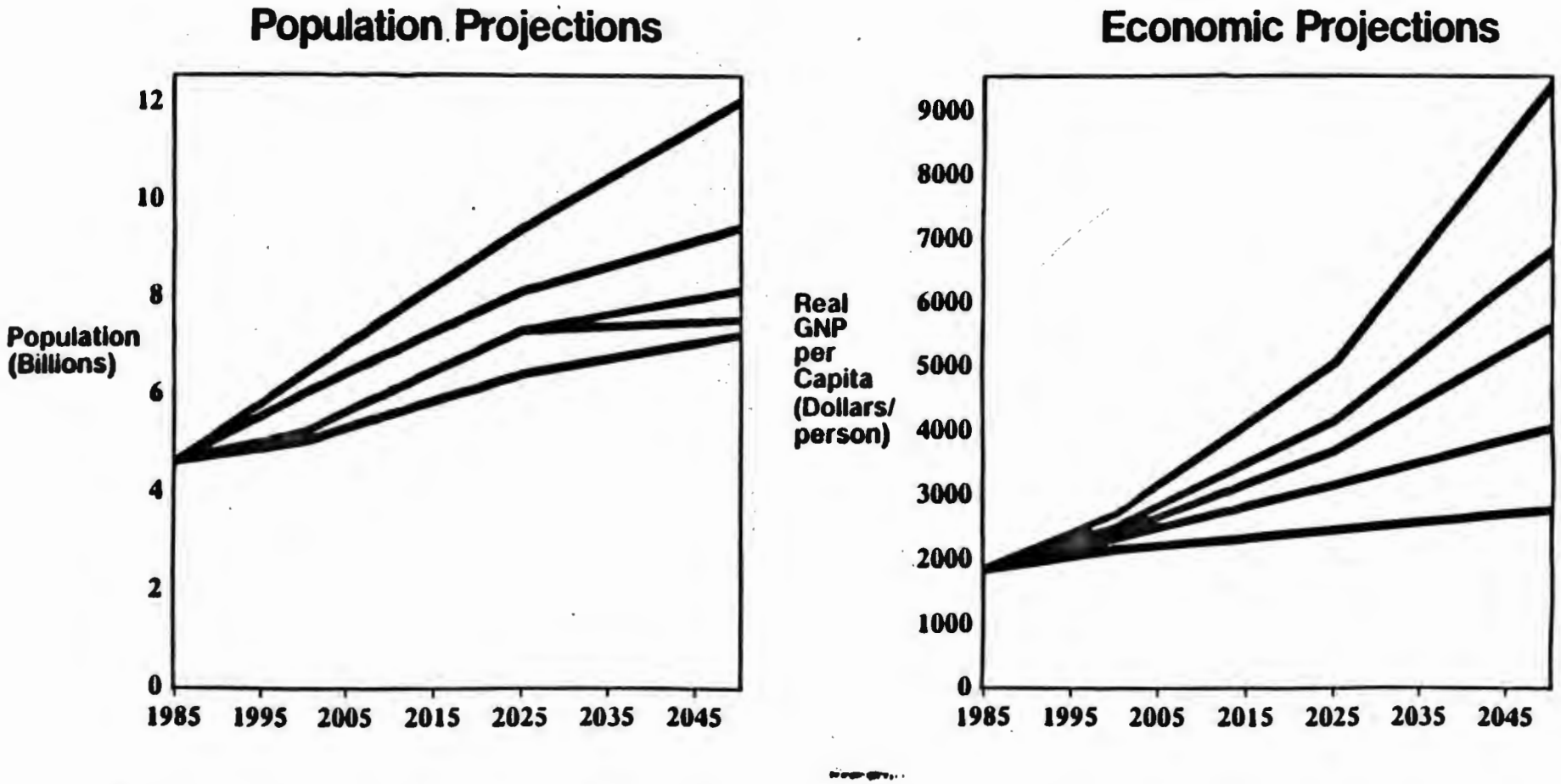


Source: "Overview Paper for Topic #2: Projections of Future Demand," UNEP Workshop, May 1986

TOP DOWN PROJECTION METHOD

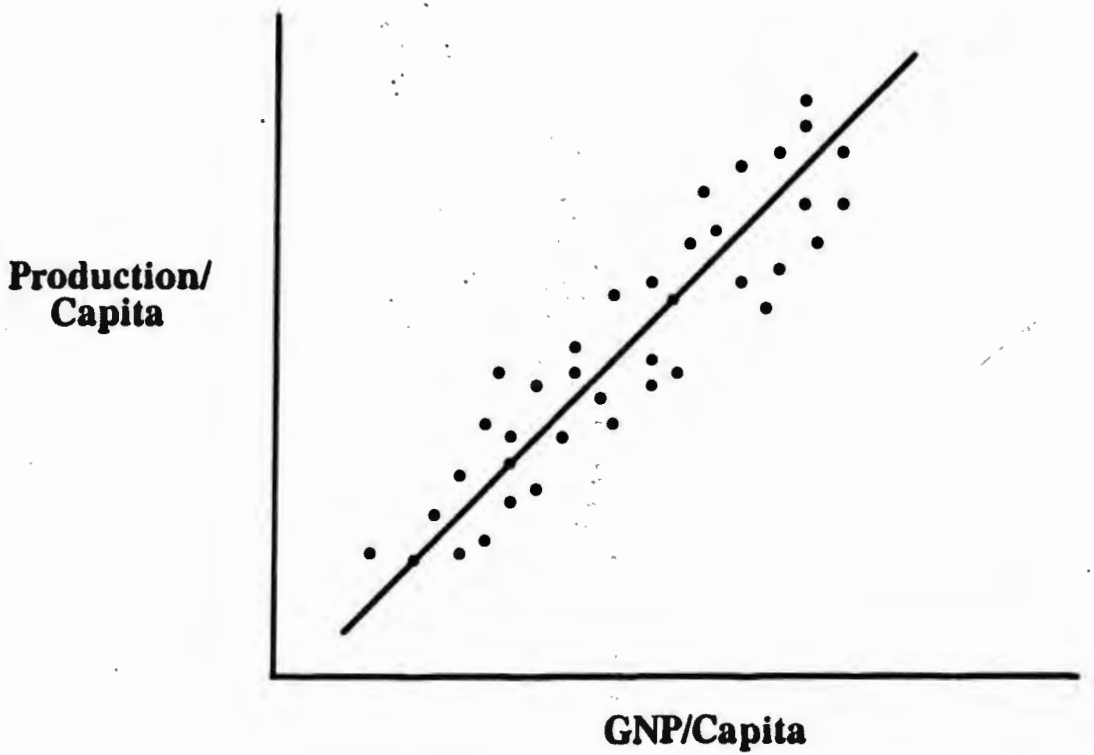
- Aggregate statistical relationship
  - Explains variance in historical data
  - Reflects historical innovation/displacement
- Future demand
  - Projections of aggregate values (e.g., GNP, population)
  - Adjustments for technological change
- Limitations
  - Reliance on aggregate values
  - Representativeness of historical data
  - Adjustments rely on judgments

APPLY RELATIONSHIPS TO RANGES OF POPULATION AND ECONOMIC PROJECTIONS



Source: "Overview Paper for Topic #2: Projections of Future Demand," UNEP Workshop, May 1986

Method: OECD



• = Historical Data: 1958–1983

— = Fitted Relationship : Use/Capita = A + B x GNP/Capita

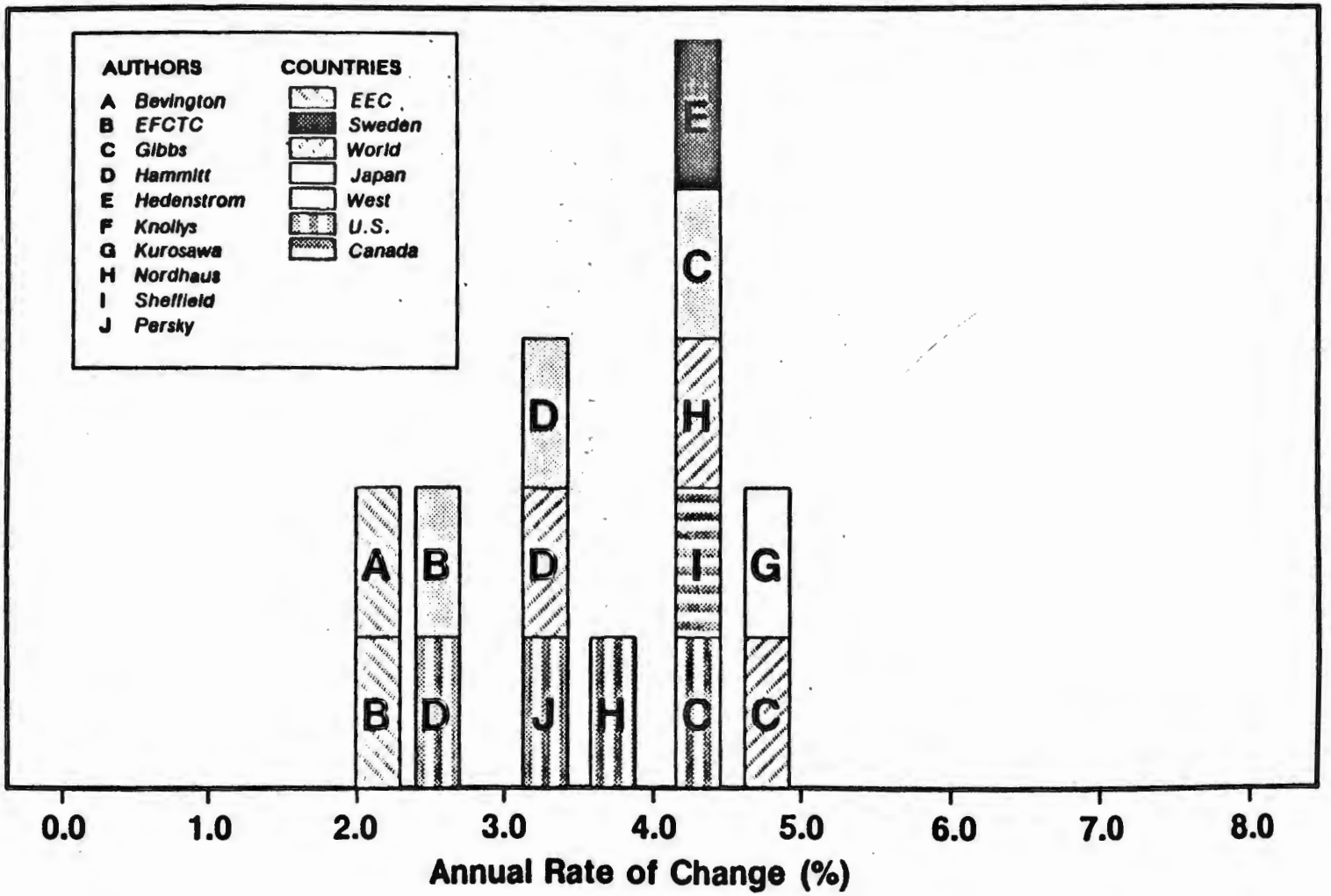
HISTORICAL DATA REFLECT TECHNOLOGICAL CHANGE

- **Rates of new product introduction**
- **Rates of product displacement**
- **Changes in the intensity of use of CFCs in products**

i.e. started to use CFC 12 > efficiently in refrigerators

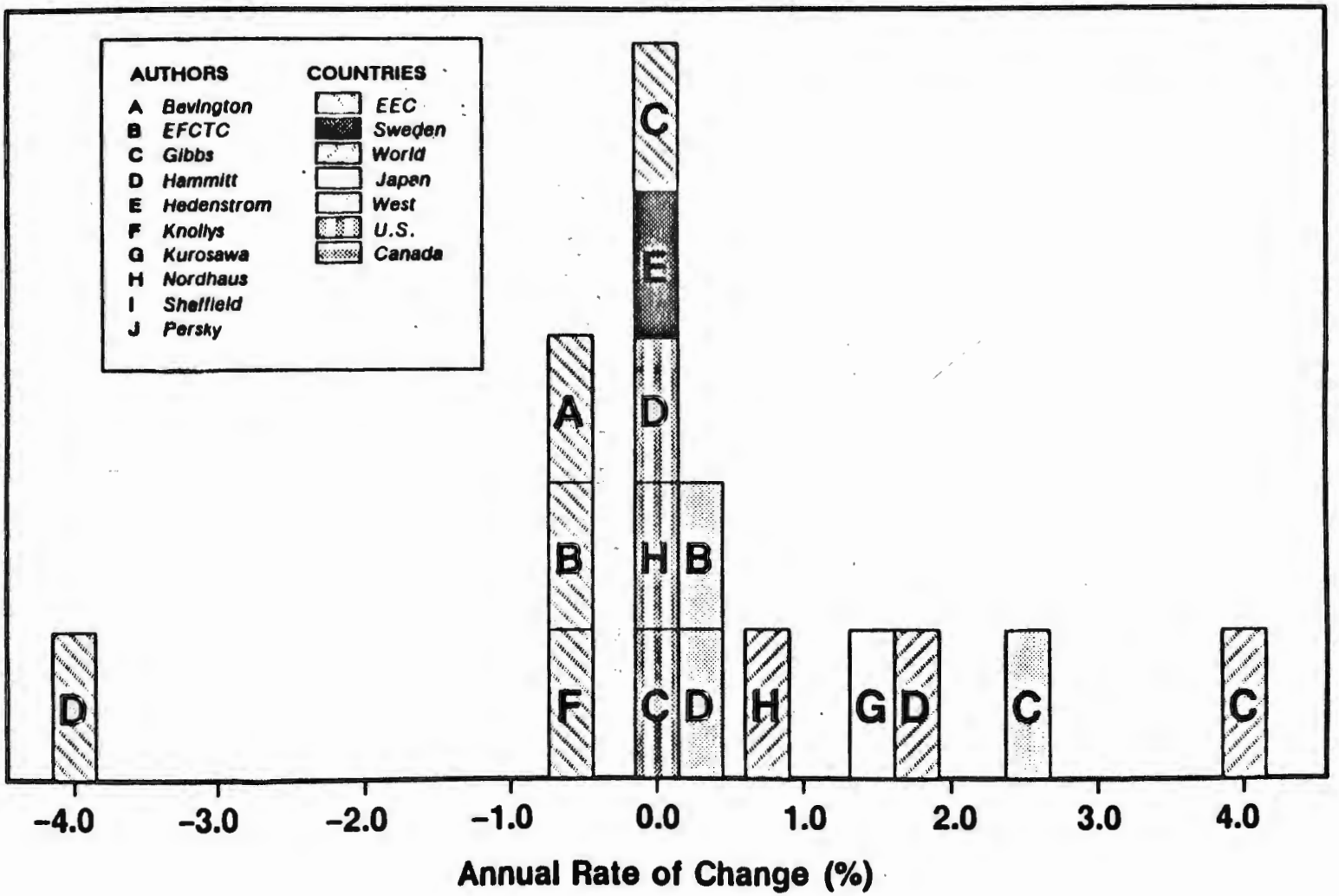
SHORT TERM

Nonaerosol Projections: CFC–11 and CFC–12 (1985–2000)



SHORT TERM

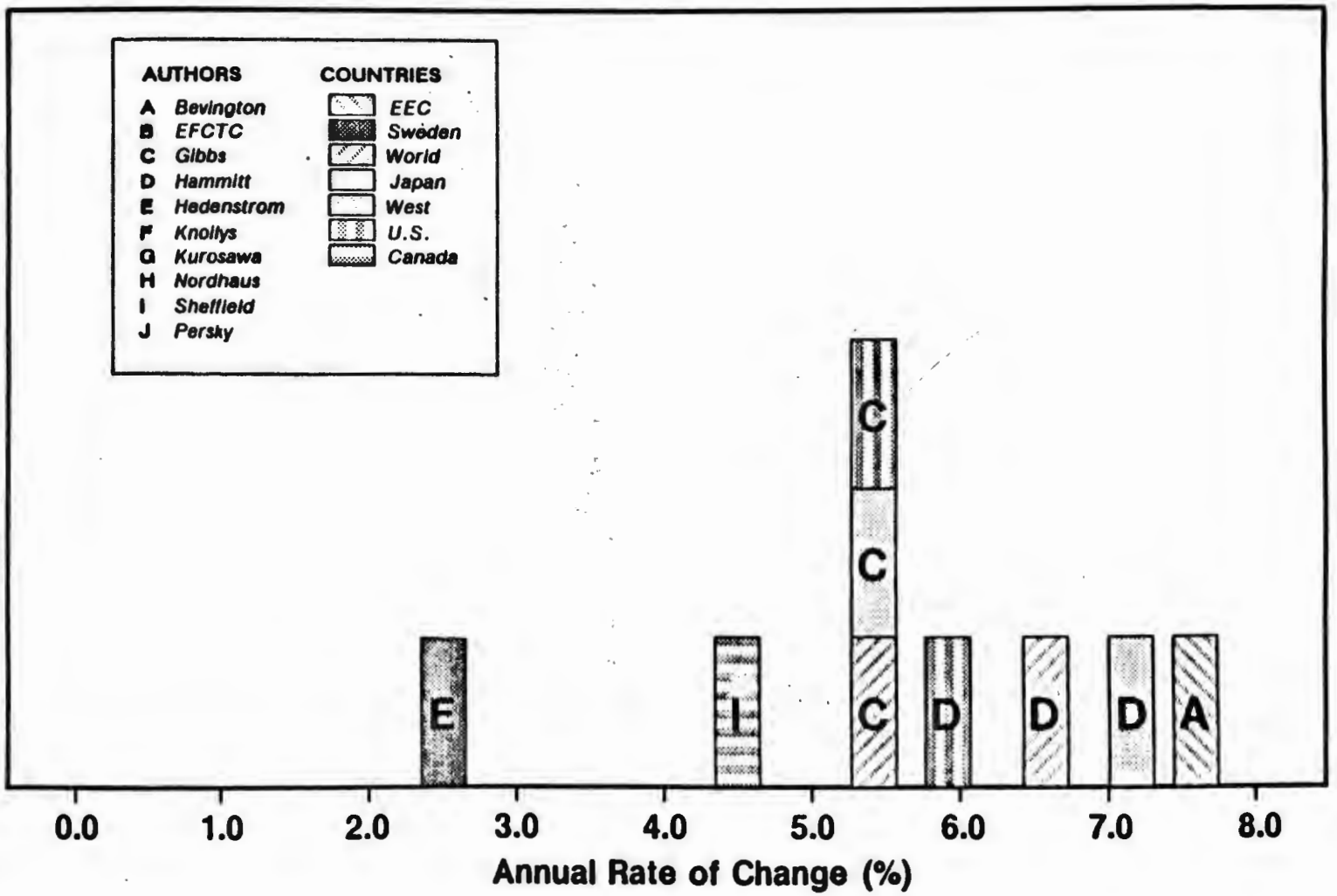
Aerosol Projections: CFC–11 and CFC–12 (1985–2000)



production of 113 is the same as 11 now in U.S. but not in world.

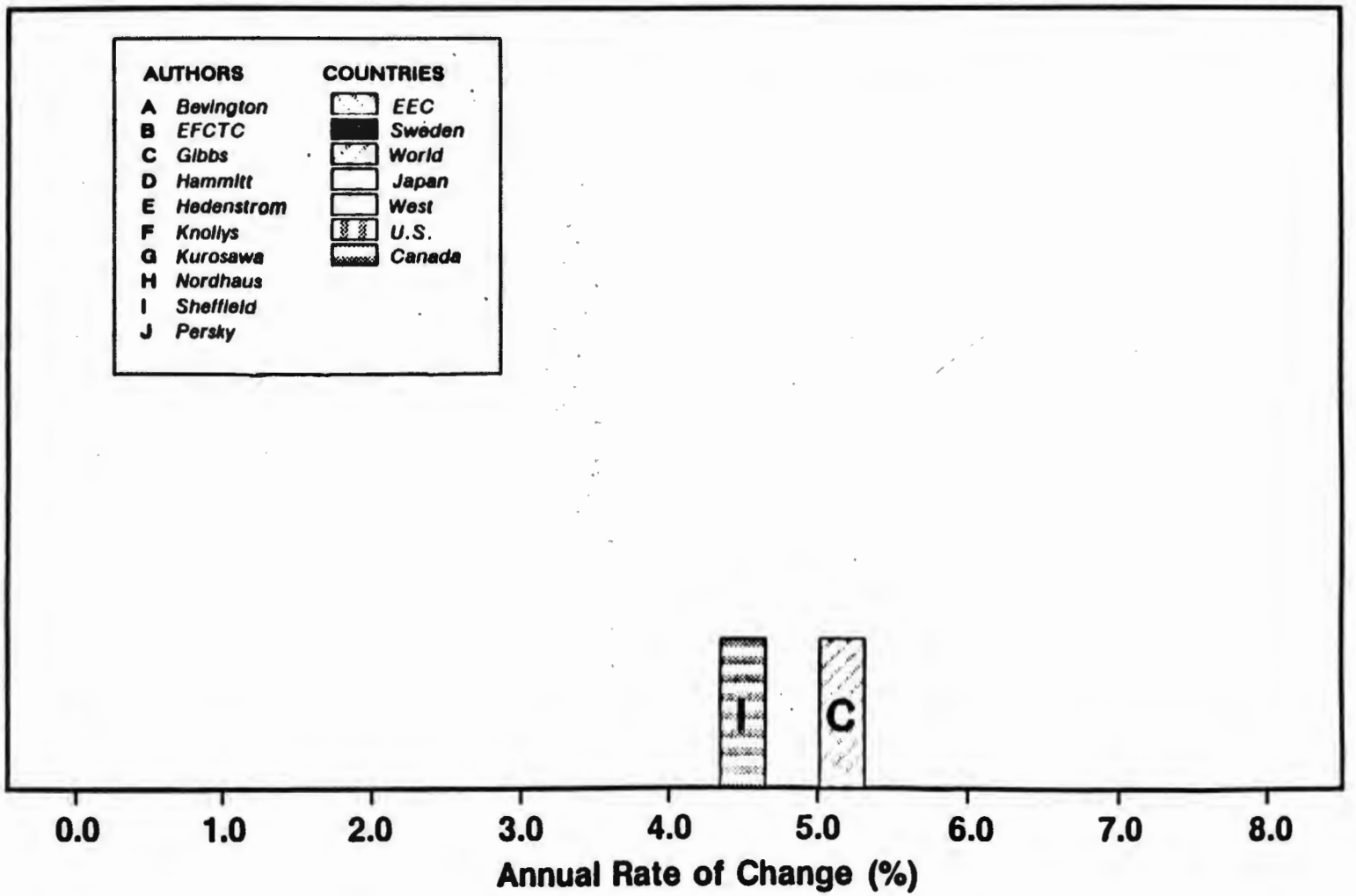
SHORT TERM

Nonaerosol Projections: CFC–113 (1985–2000)

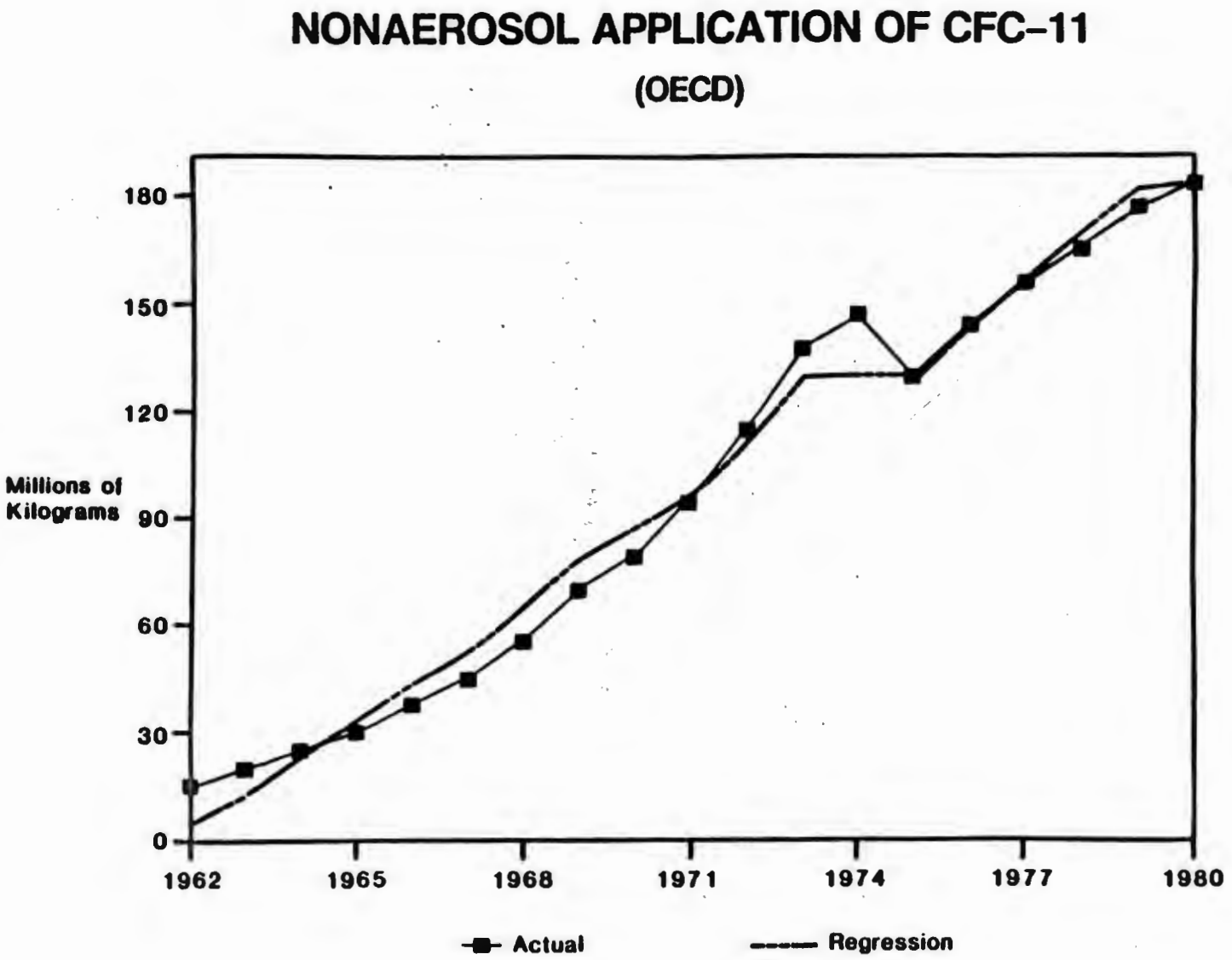


SHORT TERM

Nonaerosol Projections: CFC–22
(1985–2000)

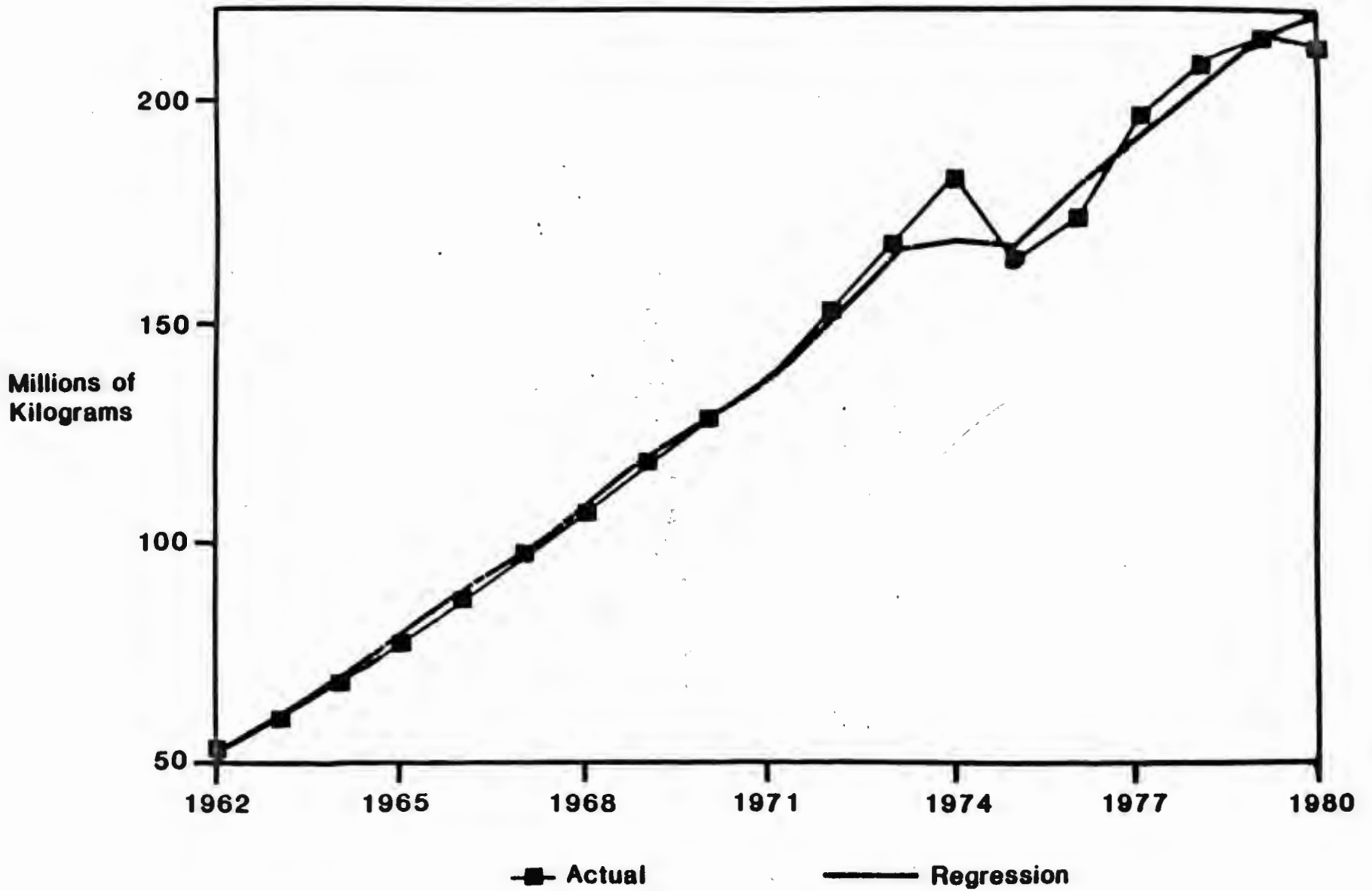


HISTORICAL DATA ARE WELL REPLICATED



NONAEROSOL APPLICATION OF CFC-12

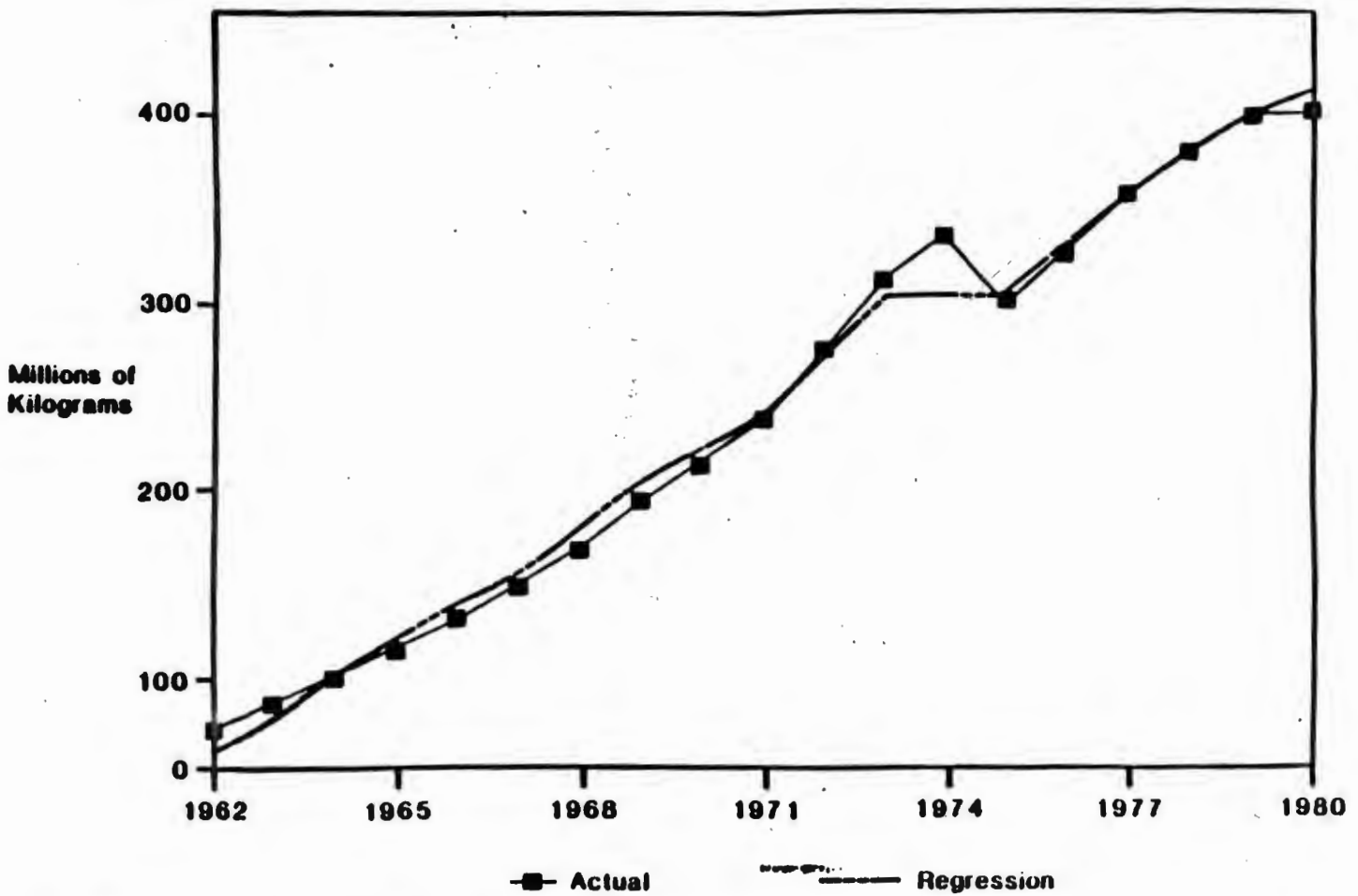
(OECD)



DEVELOP HISTORICAL RELATIONSHIPS

NONAEROSOL APPLICATION OF CFC-11 AND CFC-12

(OECD)



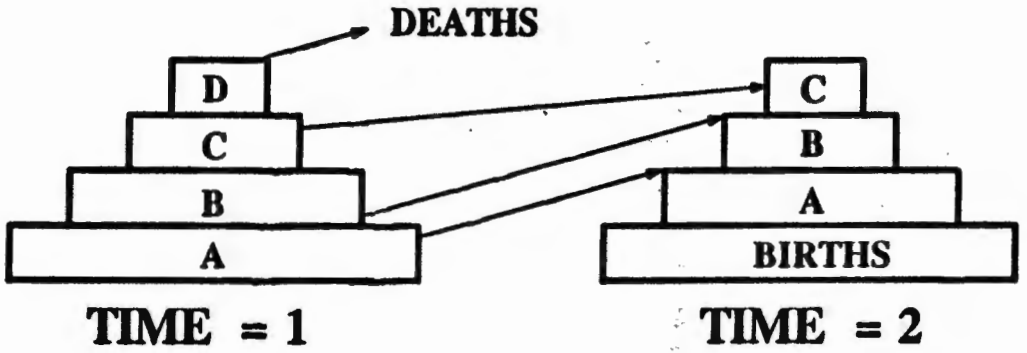
Source: "Overview Paper for Topic #2: Projections of Future Demand," UNEP Workshop, May 1986

POPULATION: DETERMINANTS

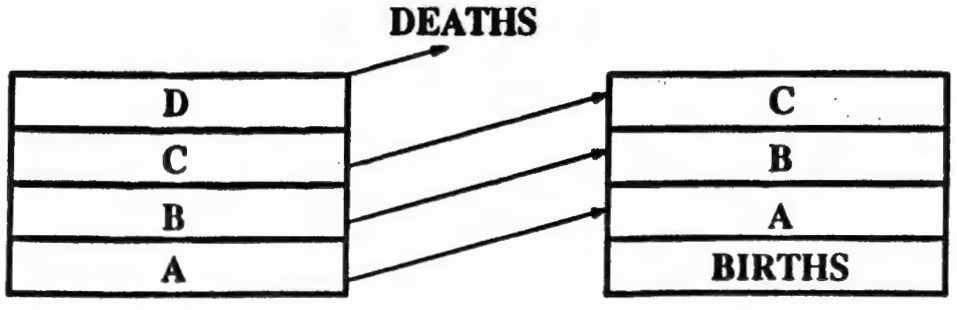
- **Fertility**
- **Mortality**
- **Migration**

Reaching Zero Population Growth

1. Births = Replacement Rate: Approximately 2.1 – 2.2
2. Births = Deaths



Population Grows:
BIRTHS > DEATHS



Population Stable:
BIRTHS = DEATHS

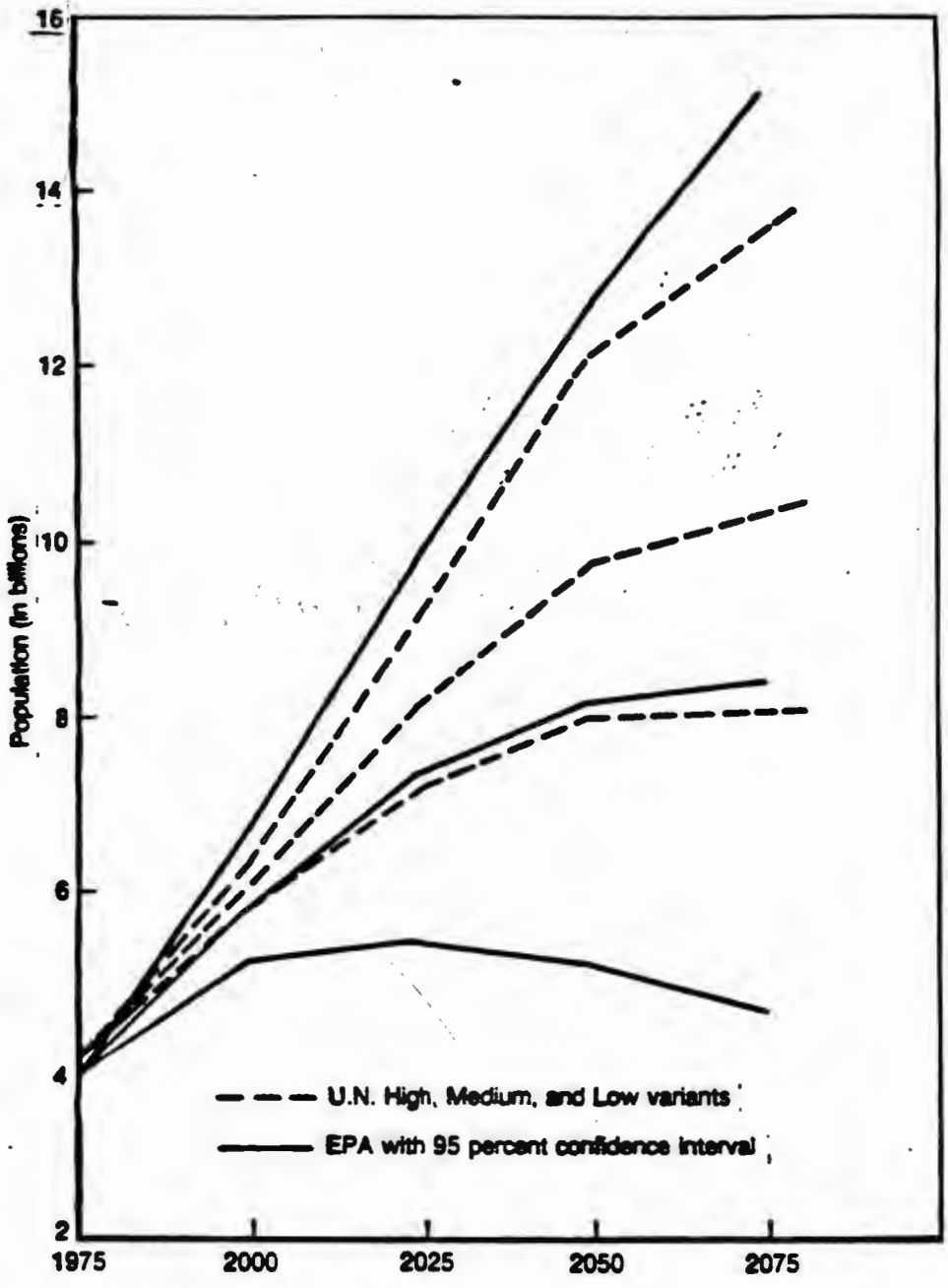


Fig. B.1—Projected world population with confidence interval

Table B.2

ALTERNATIVE POPULATION GROWTH RATES

(percent per year)

Study	Region	1950	1975	2000	2025	2050	2075
EPA	World		1.9	1.6	0.9	0.4	0.1
	OECD		1.2	0.7	0.4	0.1	0.1
	East Bloc		1.2	0.7	0.4	0.1	0.1
	Developing		2.1	1.9	1.0	0.5	0.1
U.N. (1985, 1981)							2080
Medium variant	World			1.6	1.2	0.7	0.2
	OECD			0.5	0.3	-0.1	0.0
	East Bloc			0.8	0.5	0.0	0.1
	Developing			2.0	1.3	0.9	0.3
Low variant	World			1.5	0.8	0.4	0.0
	OECD			0.4	-0.0	-0.2	-0.1
	East Bloc			0.7	0.4	-0.1	0.0
	Developing			1.8	1.0	0.5	0.1
High variant	World			1.8	1.5	1.1	0.4
	OECD			0.7	0.5	0.1	0.1
	East Bloc			0.9	0.8	0.0	0.1
	Developing			2.1	1.7	1.3	0.5
			1980				
World Bank (1984)	World			1.6	1.2	0.7	0.2
	OECD			0.5	0.2	0.0	0.0
	East Bloc			0.6	0.4	0.2	0.1
	Developing			2.0	1.4	0.8	0.2
			1985	2020			
Population Reference Bureau (1985)	World			1.6	1.2		
	OECD			0.4	0.1		
	East Bloc			0.7	0.6		
	Developing			1.9	1.4		
				2030			
IIASA (1981)	World			1.7	0.9		
	OECD			0.8	0.4		
	East Bloc			1.3	0.7		
	Developing			2.4	1.1		
				2020			
World Energy Conference (1977)	World	1.5		1.8			
	OECD	1.0		0.7			
	C.P.(a)	1.2		1.1			
	Developing	2.0		2.4			
Kahn et al. (1976)(b)	World			2.0	1.4	0.9	
Rotty and Marland (1980)(b)	World			1.3			
OECD (1979)(b)	World			1.6			

a. Centrally planned nations, including East Bloc, Peoples' Republic of China, and other centrally planned Asian nations.
b. Reported in Clark (1982).

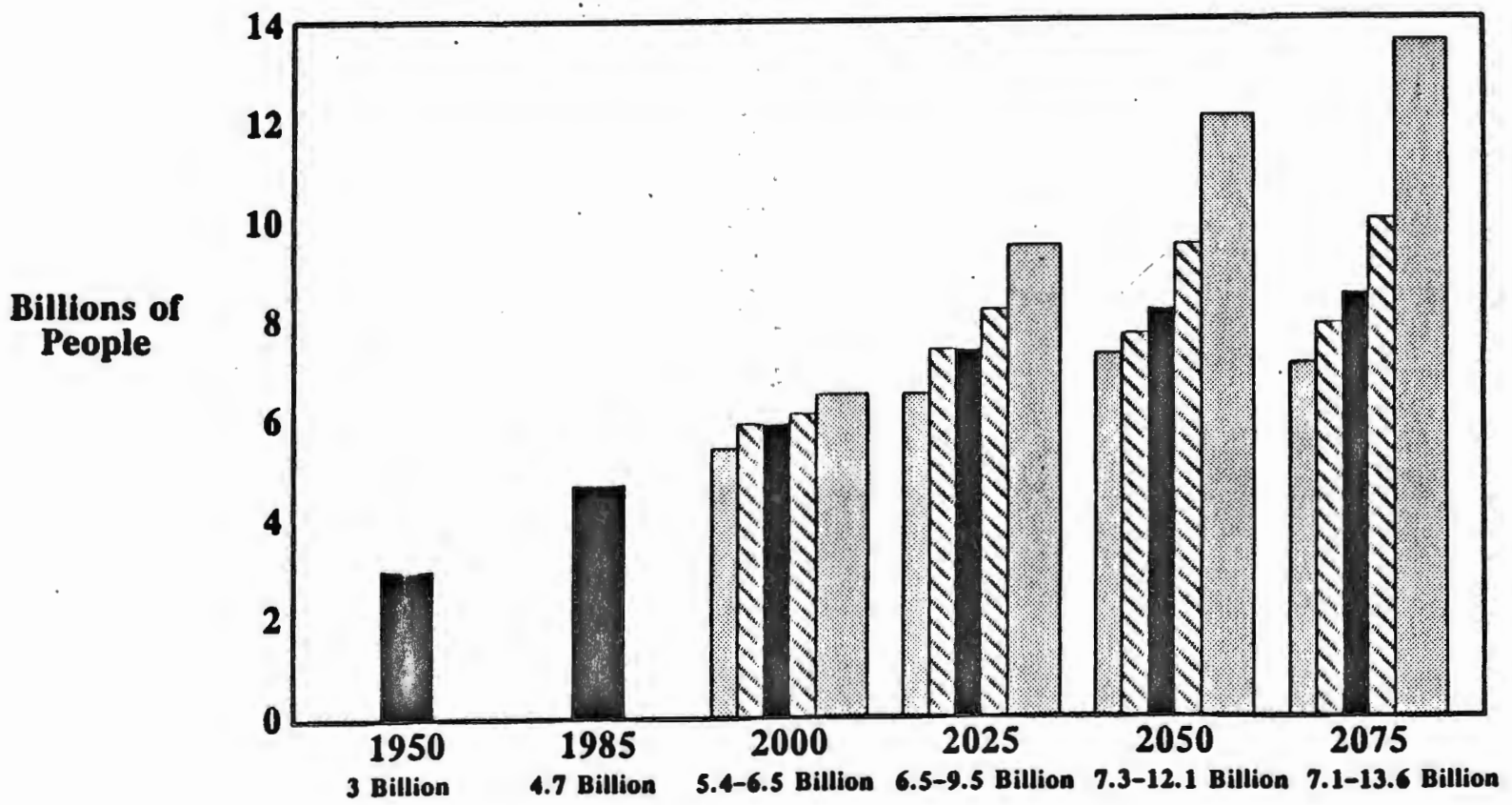
Table B.1

ALTERNATIVE POPULATION PROJECTIONS

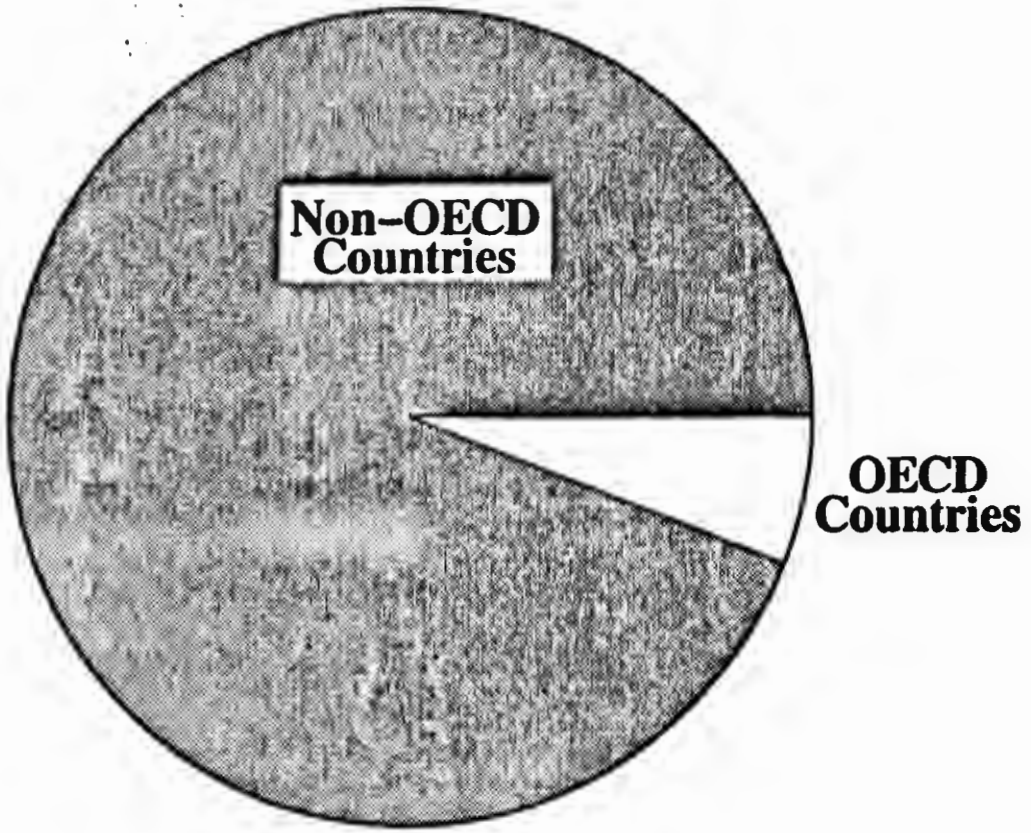
(Millions)

Study	Region	1975	1980	2000	2020	2025	2030	2050	2075	2080	2100
EPA	World	3976		5892		7364		8197	8446		
	OECD	747		884		974		1008	1023		
	Eastern Bloc	395		472		516		533	541		
	Developing	2834		4536		5874		6656	6882		
U.N. (1985,1981) Medium variant	World	4076		6127		8177		9775		10451	
	OECD	736		840		900		877		877	
	Eastern Bloc	359		436		498		503		512	
	Developing	2981		4851		6780		8395		9062	
Low variant	World	4076		5899		7278		8004		8099	
	OECD	736		812		808		773		758	
	Eastern Bloc	359		426		467		459		459	
	Developing	2981		4661		6003		6773		6881	
High variant	World	4076		6367		9185		12076		13767	
	OECD	736		869		995		1011		1034	
	Eastern Bloc	359		447		541		547		565	
	Developing	2981		5049		7649		10518		12168	
World Bank (1984)	World		4435	6145		8297		9778			10869
	OECD		760	832		883		879			885
	Eastern Bloc		378	430		475		500			522
	Developing		3297	4883		6939		8398			9462
Population Reference Bureau (1985)	World		7760	6135	7760						
	OECD		859	835	859						
	Eastern Bloc		491	436	491						
	Developing		6408	4864	6408						
IIASA (1981)	World			6080			7976				
	OECD			964			1082				
	Eastern Bloc			436			480				
	Developing			4680			6414				

Range of Population Projections



Most of the Population Increase is Expected in Non–OECD Countries



GNP PER CAPITA: DETERMINANTS

- **Productivity: Labor and Capital**
- **Natural Resources and Energy**
- **Government Policies**
- **Population**

Table B.4

ALTERNATE GROSS DOMESTIC PRODUCT PER CAPITA GROWTH RATES

(percent per annum)

Study	Region	1950	1975	2000	2025	2050	2075
EPA	World		1.6	1.7	1.7	1.6	
	OECD		2.2	1.9	1.7	1.7	
	East Block		1.7	1.6	1.5	1.5	
	Developing		2.7	2.4	2.1	1.5	
					2030		
IIASA (1981)	World		1.3-2.4	0.9-1.9			
	OECD		1.7-3.2	0.8-1.6			
	East Block		3.1-3.6	1.9-3.2			
	Developing		1.9-3.1	1.5-2.5			
					2020		
World Energy Conference (1977)	World	2.1	1.2 - 2.3				
	OECD	2.3	2.2 - 3.0				
	C.P.(a)	3.6	2.1 - 3.4				
	Developing	1.8	1.4 - 2.8				
					2030		2080
Lovins et al. (1981)	World		1.3	0.9		0.4	
	Developed(b)		2.0	1.2		0.0	
	Developing		1.9	1.5		0.1	
			1970				
Leontief et al. (1977)	Developed(b)		3.0-3.5				
	Developing		3.1-4.9				
Kahn et al. (1976)(c)	World		2.8	3.1		1.2	
Rotty and Marland (1980)(c)	World		1.5				
OECD (1979)(c)	World		1.9-3.4				

(a.) Includes Peoples' Republic of China and centrally planned Asia.
(b.) Corresponds to OECD plus East Block.
(c.) Reported in Clark (1982).

Table B.3

COMPARATIVE WORLD GROSS NATIONAL PRODUCT PER CAPITA

1975 = 1.00

Study			2000	2025	2050	2075
EPA			1.49	2.27	3.45	5.01
IIASA (1981)		low	1.38	2.21		
		high	1.81	2.90		
World Energy		low	1.35	1.82[a]		
Conference (1978)		high	1.77	3.12[a]		
Lovins et al. (1981)			1.38	1.73	1.96	2.16
Leontief et al. (1977)	low:	developed	2.09			
		developing	2.15			
	high:	developed	2.36			
		developing	3.31			
Kahn et. al. (1976)[b]			1.99	4.28	5.77	7.77
Rotty and Marland (1980)[b]			1.45	2.11		
OECD (1979)[b]		low	1.60			
		high	2.31			

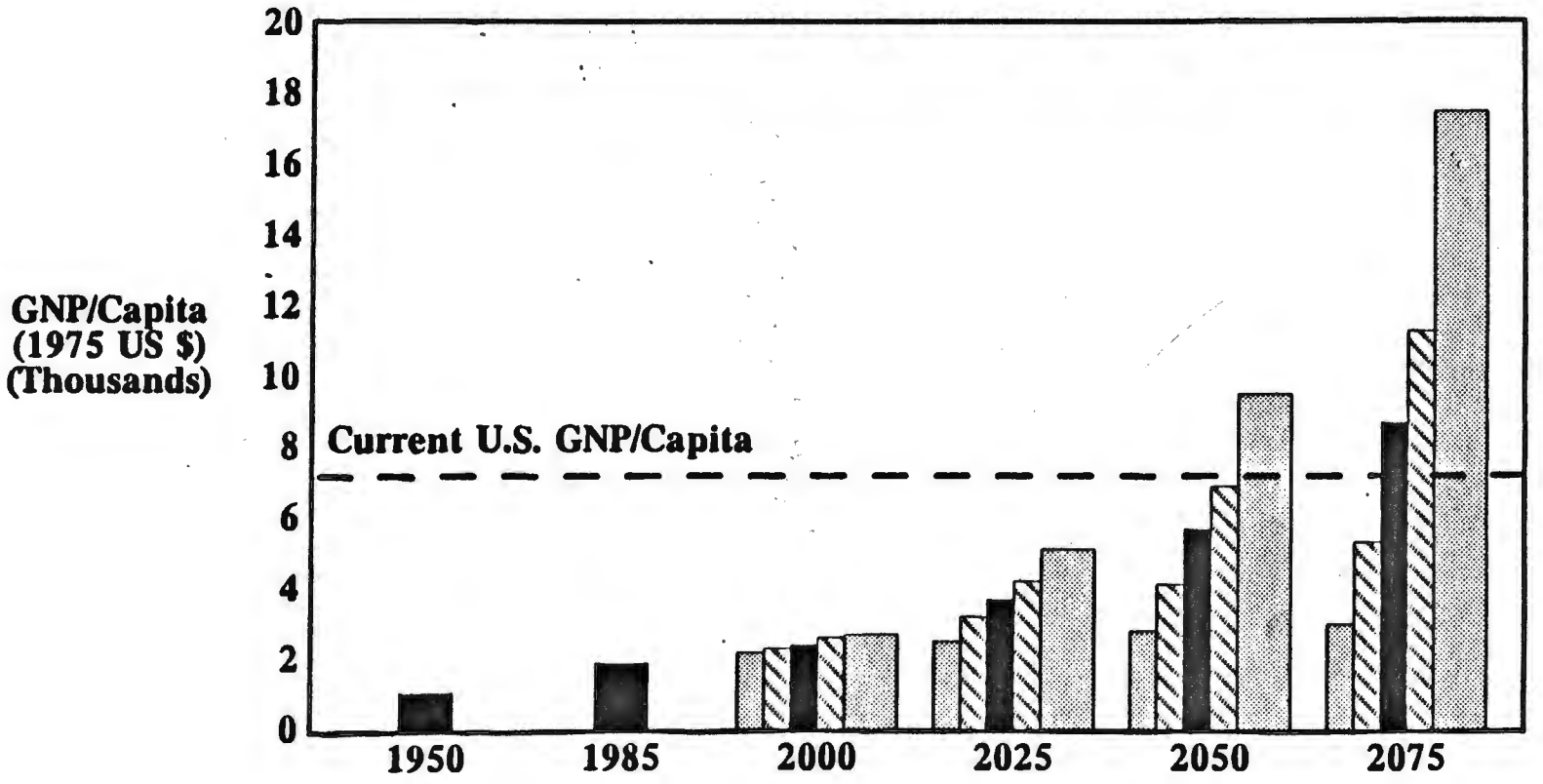
[a]Extrapolated from 2020 at projected 1975-2020 growth rate.

[b]Reported in Clark (1982)

The implied annual percentage growth rates, disaggregated by region where the sources allow, are reported in Table B.4. As are the population projections, the EPA projections are low to moderate compared to other reported projections of per capita GNP.

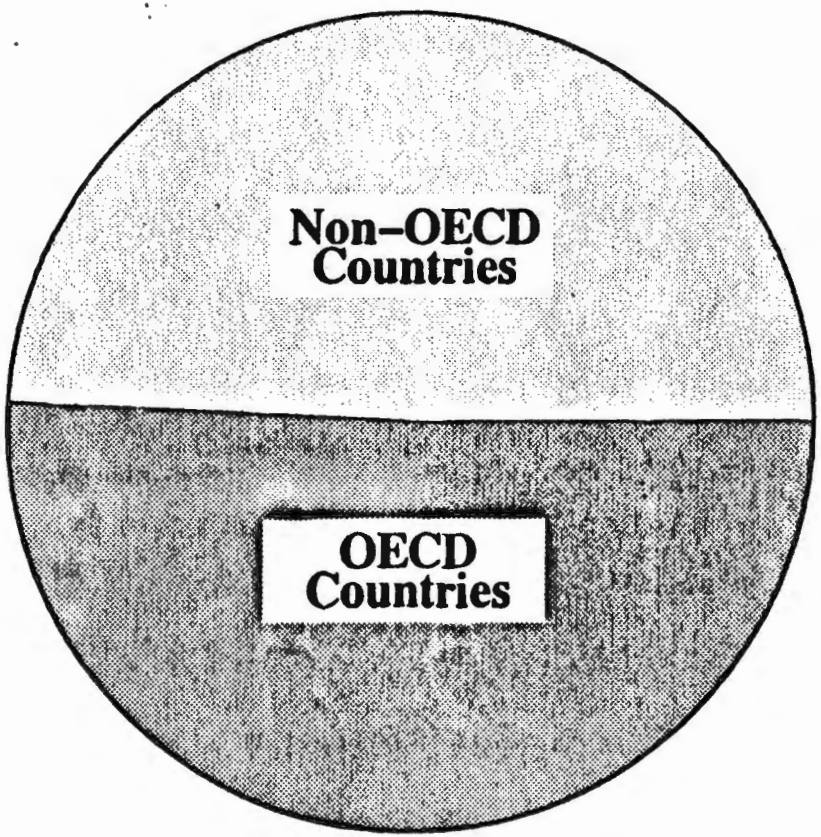
LDCs.

Range of GNP/Capita Projections

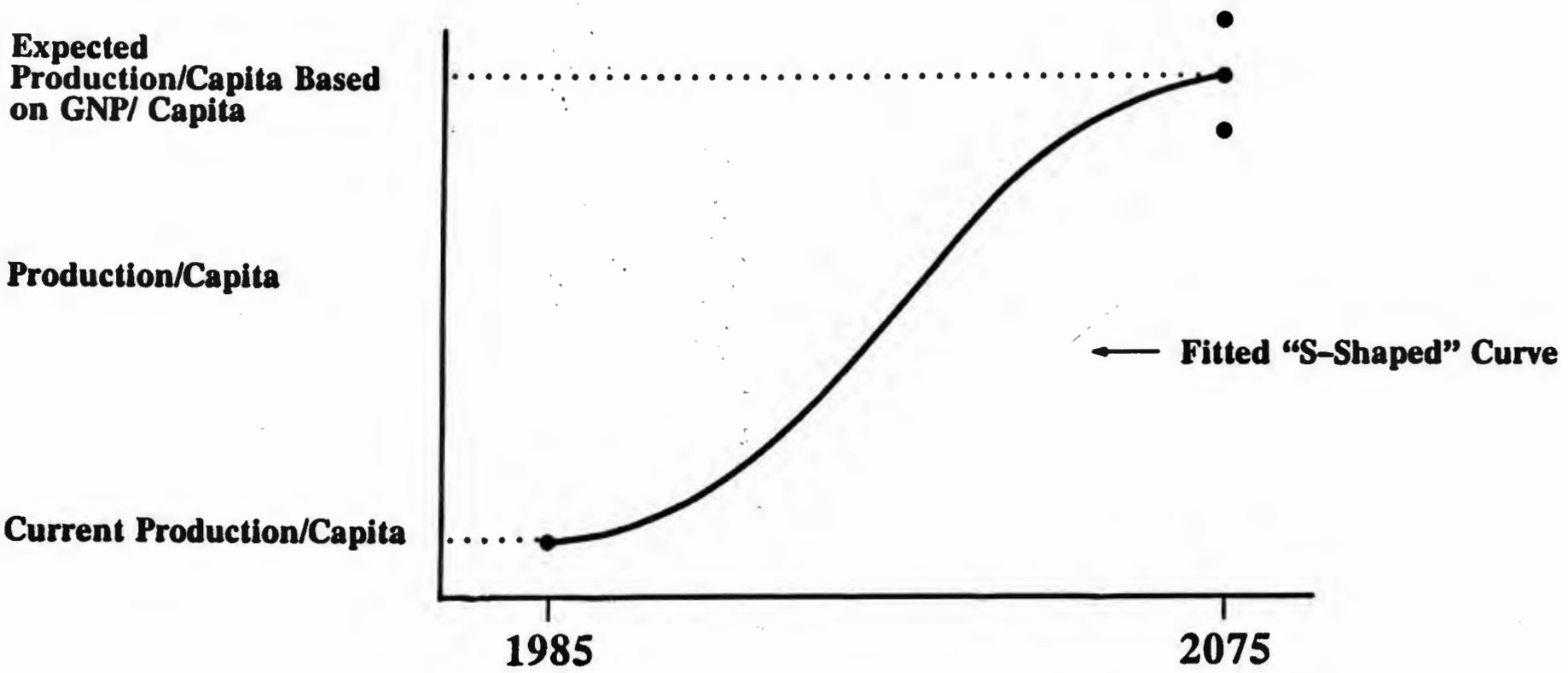


LDCs

Approximately One–Half of the Projected Economic Growth is Expected in the OECD Countries

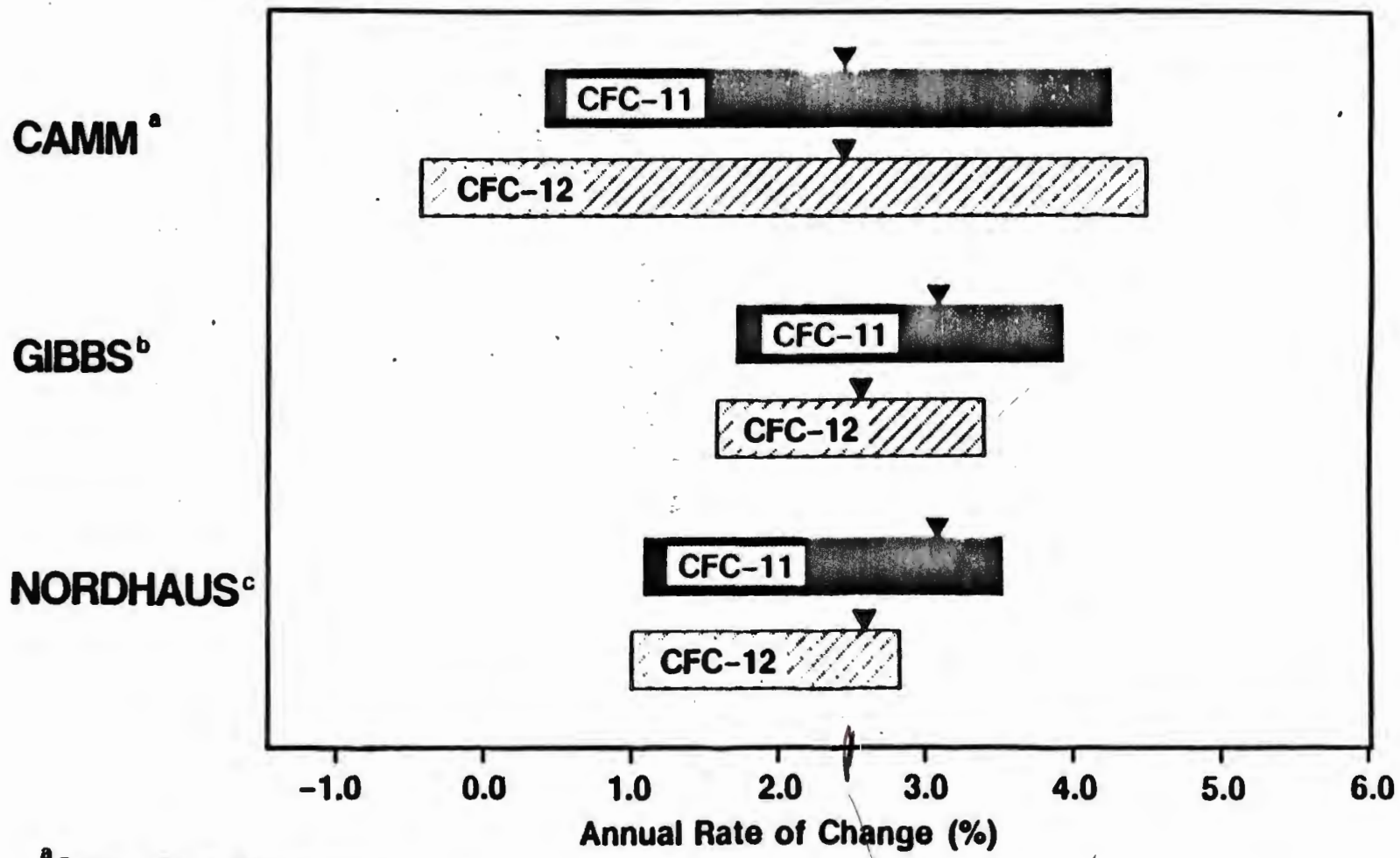


Method: Non-OECD Countries



LONG TERM PROJECTIONS

CFC–11 AND CFC–12 —World (2000–2050)



[a] Range = 5th to 95th percentile
[b] Probabilities not reported; range reflects five scenarios
[c] Range = 25th to 75th percentile; nonaerosol applicatory only

Source: "Overview Paper for Topic #2: Projections of Future Demand," UNEP Workshop, May 1986