ISSUES IN MODELING THE GLOBAL DIMENSIONS OF DEMOGRAPHIC CHANGE

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ABSTRACT

Over coming decades demographic shifts will have a profound effect on the world economy -- both directly on the countries undergoing demographic change, as well as indirectly through changes in global trade and capital markets. Yet the tools needed to better understand the general equilibrium consequences of significant demographic change are still not adequately developed. Without these tools, there is likely to be a policy vacuum. As a first step in developing a better framework for dealing with global demographic change, this paper surveys the areas in which we need to improve existing global analytical frameworks to deal with the range of important policy issues that will emerge as a part of the demographic shifts. The paper attempts to summarize what is now known, identifies areas where important unresolved debates still exist, and explores theoretical and empirical issues on which more research needs to be undertaken.

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1. Introduction and Overview of the Project

This paper focuses on underlying forces in the world economy that will become increasingly apparent over the next two decades and that will have important consequences for national economies. The most important trends are demographic, in particular the progressive aging of populations and the pronounced rise of elderly retired persons relative to individuals working in the labor force.

Population aging will occur at differing paces and with differing degrees of intensity in the industrialized countries of the world. Significant aging is already under way in some economies, for example Italy, Japan, and Germany. Major demographic changes in the United States and Canada begin in the second decade of the 21st century. With a still longer lag, the demographic trends will be manifest in developing economies as well.

The changes in the demographic structure of populations will have major economic and political consequences. One focus within individual countries has already been the resulting pressures on government budgets. In addition to the fiscal issues, the levels of saving and investment and the overall saving-investment balance will change significantly in many regions of the world economy. These changes will likely be associated with large changes in cross-border flows of financial funds and goods. Whatever the proximate impetus for the changes, large adjustments in exchange rates and balance-of-payments positions will likely be required. The resulting international tensions will add greatly to the complications faced by national governments as they try to cope with the pressures on their domestic fiscal budgets and appropriately revise their economic policies.

The Brookings Institution has established a new project, The Global Dimensions of

Demographic Change, to catalyze research on these important issues.[1] This paper is the first

product of the project. The goal of the paper is to take stock of what the economics profession

knows about modeling the macroeconomic consequences of population aging. We focus

particular attention on the likely consequences for changes in saving-investment-current-account

balances and in asset prices -- for individual nations, and for the world economy as a whole.

Subsequent research sponsored by the project will refine the theoretical and modeling

capabilities required to understand the many complex interdependencies. This research will be

evaluated in workshops. Later papers will then build on this research and the associated

workshop discussions to develop policy recommendations, indicating how national governments

can best cope with the consequences of demographic changes. The project will conclude with a

final conference, followed by subsequent publications summarizing the project's research and

policy recommendations.

The project was initiated with three inventory-taking workshops. The first, attended

primarily by researchers resident in North America, was held at the Brookings Institution in

Washington, DC on July 15, 1998. The second, primarily for European researchers, was held at

the OECD in Paris on July 27, 1998. The Tokyo workshop, primarily for Japanese and other

Asian researchers, was held at the Mita campus of Keio University on July 31, 1998.

This paper draws on the authors' background reading and on contributions made by

participants in the July 1998 workshops. In effect, we try to provide a concise inventory of what

economists think they do and do not know about this subject area. Drawing on the discussions at

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[1] The temporary working title for the project prior to the July 1998 workshops was "Demographic Turbulence and Global Stability."

the initial workshops, we also summarize points for which consensus does and does not exist and indicate priority directions for further research.

The objectives of this project, with its emphasis on the cross-border consequences of demographic change, cannot be achieved without use of one or another multi-country, general-equilibrium macroeconomic model. Existing multi-country macro models are inadequate to the task in several ways. Yet without such models, there is no way to analyze the many interdependencies involved. Here, as in many other situations requiring analysis, the familiar cliche applies: you can't beat something with nothing. Explicit multi-country, general-equilibrium macro models, despite their warts and weaknesses, will be unambiguously preferable to alternatives for conjecturing about the complex behavior of economies that rely on partial-equilibrium or implicit, unsystematic methods.

The most notable inadequacy in existing multi-country macroeconomic models is their failure explicitly to incorporate the effects of demographic changes. As preconditions for achieving the major objectives of the project, therefore, researchers working with the multi-country models must improve their equation specifications in at least three respects. An improved analysis is required of the effects of demographic changes on:

> (1) consumption (including possibly patterns of consumption across different goods and services), saving, and wealth accumulation, with appropriate allowance for the openness of national economies;

> (2) the production/supply sides of national economies, again with appropriate allowance for openness; and

> (3) expenditures, transfers, and revenues in government budgets.

The next section of this paper identifies the existing literature on the economics of

demographic change. We then discuss key issues for how to improve existing multi-country

models, focussing on the impacts on consumption, saving and wealth accumulation (section 3), on

the supply side impacts (section 4), on fiscal implications (section 5), and on developing countries

(section 6). A conclusion and some thoughts on where we go from here are presented in section

7. Appendix A identifies the range of existing multi-country models for readers who may not be

familiar with these models as referred to in the body of the paper.

2. Existing Literature on Demographic Change

A substantial and growing literature has been calling attention to population aging and

other demographic changes associated with it. Because the basic trends have been widely

discussed, our summary here only identifies the trends and directs the reader to sources where

detailed analyses may be found.

The percentage of the population aged 65 years or older in the mature industrial

economies has been rising slowly but steadily for more than a century. Declining birth rates and

increases in life expectancy due to advances in medical and health care have been the two main

forces underlying this trend. In the first two and a half decades after World War II, however, the

long-term downward trend in birth rates was dramatically though only temporarily interrupted.

The resulting baby boom caused a bulge in youth dependency ratios (the ratio of children to

working-age adults) and then subsequently a spurt in labor force growth. Meanwhile, advances in

medical technology and increases in life expectancy continued at a rapid rate. Fertility rates fell

back to lower levels.

As demographers look ahead and make projections, they are in broad consensus that

fertility rates in industrial countries will remain relatively low in the first half of the twenty-first century and that population growth rates are likely to continue to decline, and eventually even turn negative for a while. By the year 2050, populations in countries such as Italy, Germany, and Japan could be substantially smaller than in 1990. Concurrently, the numbers of individuals in the age group 15-64 years are projected to begin to decline. In some projections, the absolute size of this working-age group could be declining in all the main industrial countries except the United States.

These changes in population growth would greatly alter the age composition of populations. The percentage of children would decline sharply while the proportion of the population 65 years and older would rise rapidly in all countries, especially after the first decade of the next century when the baby-boom generations reach retirement age. Elderly dependency ratios, defined as the number of persons aged 65 years and older relative to persons aged 16-64 years, could reach unprecedented levels in most countries as the first half of the 21st century progresses.

As a representative example of the projections of elderly dependency ratios, Table 1 below is a reproduction of a summary table from the April 1998 report prepared by a working group of the Group of Ten (1998). These figures were derived from the "medium-variant" projections contained in the 1996 edition of UN World Population Prospects.

Table 1: Elderly Dependency Ratios

	1990	2010	2030	2050	1990	2010	2030	2050
	Population aged 65 and older divided by population aged 15-64				Population aged 65 and older divided by population aged 25-64			
G-10 countries								
United States	18.9	19.2	33.0	35.2	24.1	24.3	41.6	44.2
Japan	17.2	32.3	44.0	56.5	22.0	38.3	53.0	70.1
Germany	21.7	27.7	40.4	51.5	27.1	33.3	47.6	62.1
France	21.3	25.6	40.1	46.8	27.6	31.5	49.0	58.3
Italy	21.0	30.4	47.9	68.8	27.4	35.7	55.8	82.8
United Kingdom	24.1	25.0	36.5	39.3	30.9	31.0	45.0	49.3
Canada	16.5	20.4	38.3	42.3	21.0	25.2	47.2	52.9
Belgium	22.6	25.1	40.2	43.5	28.4	30.5	49.2	54.5
Netherlands	18.6	22.4	41.9	46.1	24.1	27.2	50.3	57.3
Sweden	27.7	27.9	37.9	39.4	35.2	35.0	46.9	49.3
Switzerland	20.9	24.6	44.4	49.7	26.2	29.9	53.4	61.5
Selected non-G-10 countries								
Argentina	14.8	15.8	19.9	28.5	20.2	21.3	25.6	36.1
Brazil	7.1	9.3	18.2	28.9	10.5	12.4	23.2	36.5
Chile	9.6	13.0	22.8	28.6	13.6	17.4	29.1	36.1
China	8.4	10.7	21.5	31.0	12.4	13.8	26.5	38.4
India	7.3	8.7	14.1	23.2	10.8	12.2	18.0	29.0
Indonesia	6.4	8.6	14.2	24.6	9.8	11.6	17.9	31.0
OECD	17.1	21.7	32.3	42.1	22.8	26.9	39.6	52.4
G10	19.8	24.4	37.8	42.6	25.3	30.0	46.5	53.1

Source: Group of Ten (1998) Table 1.1 page 7.

Between 1990 and 2050 elderly dependency ratios are projected to more than double in OECD countries. In countries such as Japan and Italy, the ratios rise to much higher levels even during the 1990-2010 period. By the middle of the 21st century, the ratios are projected to rise to high levels even in many non-industrial countries.

Demographic projections are of course uncertain, and significant differences of view exist about the details of the trends just identified. As an illustration, see the discussion for the United States by Lee and Tuljapurkar (1994). Lee (1994) is an example of a discussion of some of the issues in formal demography.

Demographic trends will probably be the primary determinants of the future growth of labor supply. But the effective supply of labor also depends on the evolution of behavioral determinants. Most industrial countries have experienced two important behavioral trends. Labor force participation rates for male workers, especially in the last years of normal working life, have been declining. And labor force participation rates for female workers have been secularly rising. The first of these behavioral trends exacerbates the adverse effects of population aging on the effective labor force. The second has worked in an offsetting direction.

As population aging and labor-force behavioral trends increase the number of consumers relative to producers in national economies, the growth of living standards in the 21st century will have to decline unless slower labor-force growth can somehow be counteracted by faster increases in capital accumulation or by more rapid growth in technical progress and hence total factor productivity.

In addition to the obviously important effects on growth in output and living standards, population aging is certain to put intense pressures on both the expenditure and revenue sides of government budgets. As the numbers of eligible retirees increase sharply, expenditures for retirement pensions and government-financed health-care benefits will rise rapidly relative to the size of national economies. At the same time, revenues will grow less rapidly because the number of people working and paying taxes will grow more slowly, or even decline. Absent changes in governments' policies, mismatches between government revenues and government spending will get larger and larger, with increasingly serious consequences for budget deficits and government debt stocks.

Several recent official reports provide broad overviews of population aging and the likely

consequences within national economies. See in particular two surveys prepared by the Organisation for Economic Cooperation and Development -- OECD (1996, 1998) -- and the April 1998 report of a working party of the Deputies of the Group of Ten (1998). These documents are a good starting point for readers not already familiar with the major trends and issues.

The numerous comparative studies appearing in the 1990s include a series of three volumes on aging issues edited by David Wise (1992, 1994, 1998); the World Bank (1994) volume on *Averting the Old Age Crisis*; Richard Disney (1996); a volume edited by Eugene Steuerle and Masahiro Kawai (1996); a study by Axel Borsch-Supan (1996) of the effects on saving, investment and growth; an IMF Occasional Paper by Sheetal Chand and Albert Jaeger (1997); a collection of studies edited by Barry Bosworth and Gary Burtless (1998); and the survey by Richard Kohl and Paul O'Brien (1998) that focuses on pensions and savings. Peter Peterson (1994, 1999a, 1999b) has called attention to the problems in a series of publications aimed at a general, non-technical audience.

Studies concentrating on the United States include, among others, Aaron and Bosworth (1996), Council of Economic Advisers (1997), and Hurd and Yashiro (1997). For studies on European economies, see for example Bovenberg and van der Linden (1997), Davis (1997), and Borsch-Supan and Schnabel (1998). Examples for Japan include Takayama (1992), Ando (1996), Hurd and Yashiro (1997), and Yashiro and Oshio (1997). Bloom-Williamson (1997), Higgins-Williamson (1997), Heller (1997), and Heller-Symansky (1997) discuss Asia more broadly.

The analysis of demographics and growth has of course a long tradition. The many studies that could be cited prior to the 1990s include Coale-Hoover (1958); Kuznets (1967); Fukao (1985); Heller-Hemming-Kohnert (1986); Mason (1987, 1988); Aaron-Bosworth-Burtless

(1989); Cutler-Poterba-Sheiner-Summers (1990); Auerbach-Kotlikoff-Hagemann-Nicoletti

(1989); Hagemann-Nicoletti (1989); Bos-Weizsacker (1989); Heller (1990); and Hurd (1990).

The functional areas of economics in which demographic factors are likely to be important

include the consumption and saving decisions of households, the changing consumption bundles

of households, labor supply decisions, the nature of the infrastructure required by growth in

developed and in emerging economies, and the size and composition of government budgets. The

remainder of this paper is organized along these functional lines.

3. Demographic Influences on Consumption, Saving, and Wealth Accumulation

During the July 1998 workshop discussions for this project, a large part of the dialogue

was devoted to analytical methods for studying the consequences of demographic changes for

consumption, saving, and wealth accumulation. Given the wide variety of analytical views held in

the profession, this area is one of a few central topics on which substantial further research is

warranted. (This conclusion is widely shared among workshop participants, though there is a

marked diversity of views on which particular projects in this area deserve highest priority.)

At a very general level, since the work of Modigliani-Brumberg (1954, 1979) and

Friedman (1957), economists have accepted in broad terms the idea that many households will

wish to smooth their consumption across time. The degree of this intertemporal smoothing and

the main factors driving it, however, continue to be much in dispute. One set of issues concerns

the manner in and degree to which households or individuals voluntarily want to act as

intertemporal smoothers. A second set pertains to whether constraints external to the household

inhibit or prevent agents from acting as intertemporal smoothers. In an analytical model, the

average degree of smoothing taking place in the model economy also depends sensitively on how the model builder chooses to treat households' expectations, particularly about future developments in labor income and wealth.

Explicit life-cycle approaches hypothesize that consumers save little in their early years, save most in their middle-to-late working years, and then spend down their wealth accumulation after retirement. Some researchers interpret the empirical evidence as broadly supporting the life-cycle view, including the hypothesis that consumers are patient enough to begin saving for their retirement early in their working lifetimes. Examples of researchers sympathetic to the life-cycle view include Attanasio-Browning (1995) and Meredith (1995). Other researchers, however, read the empirical evidence as providing only weak support for the life-cycle view of saving and instead supporting the hypothesis that consumers save and accumulate wealth primarily to insulate consumption against uncertainty about fluctuations in income. In this latter view, the saving-for-retirement motive is much less important than the precautionary saving-for-uncertainty motive. (Precautionary saving for uncertainty leads to the accumulation of "buffer-stock" assets.) Examples of researchers emphasizing the importance of precautionary saving and doubting the empirical importance of the life-cycle theory include Deaton (1991, 1992), Carroll-Summers (1991), Carroll (1992, 1997), and Carroll-Samwick (1997). The papers in the international-comparison volume edited by Poterba (1994) tend to have a similar emphasis.

Several participants in the July workshops emphasized the point that the life-cycle hypothesis, as studied in the context of microeconomic panel data, appears unable to account for the most prominent observed changes in several countries' saving behavior. For example, the life-cycle hypothesis does not do a good job of explaining the pronounced decline in the saving ratio

in the United States in the last several decades. Nor can it explain the pronounced increases in

saving ratios in several Asian countries (such as China, Indonesia, South Korea, Singapore, and

Thailand). For these cases, one observes large time-series changes in the aggregate saving ratio --

in effect, a pronounced time trend. But the demographic changes in these countries do not seem

to help in accounting for the time trends. Most of the households in the U.S. economy seem to

have cut their saving at the same time, and most of the households in the relevant Asian

economies seem to have increased their saving at the same time. Yet the microeconomic analyses

of saving behavior are not throwing up a consensus explanation for these time trends. In

particular, the demographic components of the simpler versions of the life-cycle hypothesis are

certainly not providing the explanation.[2]

One of the complicating factors leading to differences in view about the empirical validity

of the life-cycle hypothesis concerns the availability and treatment of data about government

pension (social security) programs. In pay-as-you-go pension programs, a major intergenerational

issue is salient. It is younger and middle-aged workers that currently pay the tax revenue into the

government programs, whereas it is the elderly that currently receive the benefit payments.

Moreover, the operation and fiscal balance of the pension programs is importantly influenced by

regulations and provisions determining eligibility. For example, provisions setting the age for

early retirement eligibility have a big effect on the actual age at which workers retire, which in

turn have major effects on the pressures on government budgets (Gruber-Wise, 1998).[3]

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[2] On the relevance of life-cycle models, see also Bosworth-Burtless-Sabelhaus (1991),
Hubbard-Skinner-Zeldes (1994), Deaton-Paxson (1997), and Lusardi (1998).

[3] Here is another example: if the provisions in the government pension program specify a
fixed age for retirement, increases in life expectancy may then increase the incentives of a worker

Unfortunately, the available microeconomic survey data typically do not collect information on payments received by households from pension systems. This omission is a major problem for studies of the age profile of saving behavior. It could be -- as argued, for example, by Meredith (1995) -- that these data omissions partially explain why the life-cycle hypothesis appears not to perform well in many microeconomic studies of saving behavior.

A further difference of view in the saving-consumption literature concerns agents that in practice may not be able to borrow and lend freely as the simplified intertemporal smoothing models presume they can. The theoretical treatment and empirical importance of such liquidity-constrained households is controversial. A number of papers provide evidence suggesting that the behavior of a sizable minority of households cannot be adequately described by intertemporal smoothing. But there is also recognition that it may not be possible to separate the features of behavior that lead to differing degrees of willingness to smooth intertemporally (e.g., the precautionary saving motive) versus the effects of external impediments such as borrowing constraints that prevent some households from intertemporal smoothing. Recent references on liquidity-constrained consumption behavior include Zeldes (1989), Deaton (1991), Attanasio-Browning (1995), and Berloffa (1997).

The treatment of bequests is also controversial in the specification of consumption-saving and wealth accumulation. Issues at stake include the relative importance of voluntary or strategic versus involuntary, accidental bequests. References on the role of bequests in saving include Davies (1981), Menchik-David (1983), Abel (1985), Bernheim-Schleifer-Summers (1985),

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to save through channels outside the pension system.

Bernheim (1991), Borsch-Supan and Stahl (1991), Altonji-Hayashi-Kotlikoff (1992), Wilhelm (1996), and Laitner-Juster (1996). In his overview in the Clarendon Lectures, Deaton (1992, p. 217) remarks that "it now seems that bequest motives are a good deal more important than we used to think."

The treatment of agents' expectations is still another area where analytical views are heterogeneous. Few if any analysts now prefer to use backward-looking, adaptive expectations in their research. The use of forward-looking, model-consistent expectations has become common. Yet the extreme assumptions of rational, model-consistent expectations may in some ways be almost as unsatisfactory as the opposite extreme of adaptive, backward-looking expectations. Reliable empirical evidence about the pervasiveness of forward-looking behavior by individuals, households, and firms is sketchy, and behavior no doubt varies significantly across different types of agents. Although forward-looking behavior of some sort is widespread, it is still an open question what proportion of consumers behave as if their decisions in practice are based on model-consistent expectations.

Consumption and wealth accumulation are central to both microeconomics and macroeconomics. Yet the unresolved issues seem remarkably salient -- even before one gets to the complications introduced by open national economies. Some degree of consensus may exist among researchers that the simplest versions of permanent-income or life-cycle models are not sufficient by themselves as adequate descriptions of saving and consumption behavior. For example, Deaton (1992, p. 217) summarizes that "the accumulating microeconomic evidence casts increasing doubt on the life-cycle hypothesis, or at least on the insights that come from the 'stripped-down' version, that saving is largely hump-saving for retirement, that consumption is

based on lifetime resources, that aggregate wealth is accountable for by life-cycle saving, and that saving responds positively to productivity and population growth." He interprets the evidence as primarily against the low-frequency intertemporal smoothing of consumption, and perceives expected future income, especially distant future income, as having "limited relevance."[4]

For more recent surveys of the consumption-saving-wealth-accumulation literature, see Muellbauer-Lattimore (1995), Browning-Lusardi (1996), Deaton-Paxson (1997), and Attanasio (1998). Muellbauer-Lattimore (1995) discuss differences between "Euler-equation approaches" versus "solved out consumption functions," arguing that the former have been overemphasized relative to the latter in recent years.

It seems natural to suppose that large changes in the demographic structure of populations will have significant effects on consumption and saving. The effects should be larger, the more pervasive are life-cycle elements in the behavior determining saving. A household manifesting the traditional life-cycle behavior will have a "hump-shaped" lifetime profile for its saving rate: low saving in its early years (when, for example, children are very young), high saving in middle age in anticipation of retirement, and then low or even negative saving after retirement. Population aging due to the retirement of the baby-boom workers and lower fertility should thus, other things equal, lead to a decline in the private saving rate.[5] Developing countries that experience sharp

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[4] Indeed, Deaton suggests that a preferable taxonomy of intertemporal choice models would lump together the (formal) permanent-income and (conventional) life-cycle models and differentiate those models sharply from approaches incorporating liquidity constraints and/or precautionary saving.

[5] The effects on the private saving rate of increasing life expectancy could work in the opposite direction, leading households to save *more* during their working years to be able to sustain their consumption over a longer retirement period. (For this effect to be important, of course, the life-cycle motive has to be an important determinant of saving behavior.)

declines in infant mortality, rising fertility, and hence a surge in the population of dependent

children should likewise experience higher consumption and lower saving. A nation experiencing

unusually rapid growth in the labor force as baby-boom children move into the years of working

age should exhibit, other things equal, a higher private saving rate.

Most aggregative macroeconomic models have failed to allow for such changes in the

demographic structure of the population. The seminal contributions to growth theory in the

1950s and 1960s abstracted from such demographic factors. In effect, those models contained no

children and no elderly, with the result that a faster (steady-state) rate of growth of population

caused the saving rate unambiguously to rise in response to higher requirements for investment

and a higher capital stock. Tobin (1967) developed a simulation model differentiating workers

from retirees (but still without children). Tobin's model also predicted that faster population

growth would raise the private saving rate, because the faster growth caused the population

distribution to become younger (more working, saving households relative to retirees who were

older and dissaving).[6]

Even as theoretical growth models matured, most empirical macro models still abstracted

from shifts in the demographic composition of the population. This omission persisted despite the

major emphasis in consumption theory of life-cycle considerations in the microeconomic behavior

of households.

A strand in the literature on development economics was sensitive to these issues; see, for

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[6] Cross-country empirical studies found a positive relationship between faster growth and higher saving; see for example Modigliani (1970). Subsequent empirical work with microeconomic data questions whether the correlation observed in the cross-country comparisons can be correctly attributed to life-cycle saving behavior; see for example Paxson (1996) and Deaton-Paxson (1997).

example, Coale-Hoover (1958), Mason (1987, 1988), and Taylor-Williamson (1994). The

builders of empirical macroeconomic models, however, did not try to incorporate this work. To

be sure, the development-economics literature for the most part did not directly address the

details of how to adapt the consumption-wealth specifications in general-equilibrium macro

models. The development-economics literature on population dynamics and saving is reviewed in

recent papers by Higgins-Williamson (1997) and Bloom-Williamson (1997). Deaton-Paxson

(1997, 1998, 1998) and Paxson (1996) are recent studies.

When specifying the consumption-saving-wealth relationships in macroeconomic models,

issues of aggregation are very important. In particular, the aggregation issues are central for

getting an adequate macro specification of the demographic influences. Macro models built up

from a micro theory positing a single representative agent are not easily adapted so as to

incorporate demographic changes. By definition, changes in the demographic composition of the

population require analysis to acknowledge the heterogeneity of agents -- at the very least

heterogeneity in age.[7]

The spirit of overlapping-generations (OLG) models is to grapple directly with one or

more dimensions of heterogeneity across agents. Proponents of the OLG modeling tradition tend

to believe that macro-model specifications without allowance for heterogenous agents are bound

to be inadequate -- see, for example, Kydland-Petersen (1997). Illustrations of OLG models

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[7] In the microeconomic empirical research on consumption, some conclusions have been found to be sensitive to whether the consuming agents are defined as "households" or as "individuals." For discussion, see Deaton-Paxson (1998, 1998), who use data for Taiwan and construct life-cycle saving profiles defined for cohorts of individuals rather than cohorts of households; their analysis shows stronger demographic effects on age profiles of saving for the individual than the household definition of cohorts.

which directly tackle the issue of different age cohorts and their saving decisions include

Auerbach-Kotlikoff (1987), Rios-Rull (1994, 1996), Fougère-Mérette (1997, 1998), Storesletten

(1995, 1997), and Brooks (1998).

For adequate macroeconomic analysis of the effects of demographic changes on

consumption and wealth accumulation, is it essential to use explicit multi-cohort OLG models?

Alternatively, for many analytical purposes, could it be sufficient to adopt one or another

empirical "shortcut" to modify existing macro models (those that have a more conventional life-

cycle, permanent-income specification and that currently either ignore demographic composition

effects or else treat them in an aggregative, representative-agent approach)?

Any researcher wanting to work in this area must take a stand on these questions, one way

or the other. Prior to the July 1998 workshops, we conjectured that a majority of researchers

might come down on one side rather than the other of this fence. In fact, however, nothing like a

consensus emerged from the workshop discussions. Thus from the perspective of the profession

as a whole, both approaches will continue to be followed and further refined.

The tradeoff facing researchers at the moment is between using analytical "shortcuts" to

get demographic effects into the consumption-saving specifications in macroeconomic models

versus the approach of some form of overlapping-generations (OLG) model that explicitly keeps

track of different cohorts, their saving decisions, and their wealth stocks. An explicit multi-cohort

approach, at least seen from some perspectives, appears more rigorous theoretically. But such an

approach may also be more difficult and demanding, and will probably take much longer to

advance to the stage where the models can deliver interesting empirical conclusions. The

requirements of a multi-cohort specification are of course especially demanding in a model with

numerous separate national economies and national currencies. Another possible disadvantage of

the multi-cohort specification is that it might, if calibrated to partial-equilibrium relationships

derived from micro-level evidence, deliver misleading inferences about aggregative

macroeconomic relationships.[8] As of the time this paper is written, the economics profession has

no sound basis for judging whether an explicit, multi-cohort approach will over the longer run

provide the most reliable empirical conclusions and projections about macroeconomic behavior.

What we have here labeled "empirical shortcuts" in the consumption specifications of

macro models exist in a variety of forms. Masson-Tryon (1990) followed one such route in their

first effort to adapt the IMF Staff's MULTIMOD to study the consequences of population aging;

see also Masson (1992) and Masson/Bayoumi/Samiei (1995). Meredith (1995) followed a similar

approach in studying demographic changes and saving in Japan.

These approaches have in common the specification of a negative macroeconomic link

between dependency ratios and saving rates. This relationship has been justified in part on the

basis of regression analysis with macroeconomic data. Numerous macroeconomic studies have

reported such a finding. Thus, at least at first blush, the age profile of savings appears more

consonant with the life-cycle hypothesis at the macro than at the micro level.

Table 2 replicates a survey of estimates from previous studies prepared by Guy Meredith

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[8] As emphasized to us by Hamid Faruqee in a comment made after the July workshops, it
is both the virtue and the vice of a micro-level specification for individual agents that variables
such as goods prices and interest rates are taken as exogenously given. But goods prices and
interest rates self-evidently cannot be modeled as exogenous at an aggregative, economy-wide
level. It is thus unclear whether a disaggregated OLG model, based on partial-equilibrium
relationships estimated from micro-level data, will yield correct inferences and predictions for
general-equilibrium, macroeconomic behavior (in the sense of being able to replicate the moments
of actual macroeconomic data).

(1995, Table 4-1).[9] It is relatively easy with macroeconomic data, as the table shows, to run

regressions using an aggregate saving rate as the dependent variable that yield significant

coefficients on the youth dependency ratio and the elderly dependency ratio. Some of the

estimated coefficients in these studies are implausibly high, suggesting for example that a 1

percentage point increase in the elderly dependency ratio could lead to a decline in the saving ratio

of as much as 1 percentage point or more. But even the macroeconomic studies estimating much

smaller coefficients, for example as small as -0.15 to -0.30, imply very substantial effects on

saving from changes in the demographic composition of the population.

As emphasized in the workshops, macroeconomic estimates such as those in Table 2 are

contentious, at least to some degree. Skeptics assert that when one adjusts such macroeconomic

regressions properly for country intercepts and other econometric problems, one finds that the

demographic effects again tend to be rather small, if not to go away altogether. The adjusted

effects also seem to be quite heterogeneous across countries. As stressed above, moreover, there

is substantial dissonance between these macroeconomic estimates and the microeconomic

evidence based on household survey data.

A different short-cut approach to incorporating the effects of demographic changes in the

equations of macroeconomic models is described in Fair-Dominguez (1991). Fair and Robin

Brooks are currently working on further extensions of this research, including applications of it to

the equations in the Fair multi-country model.

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[9] Meredith circulated this update of his table, which adds several papers not included in
Meredith (1995), at the July 1998 workshops. A similar update table is given in the OECD study
by Turner and others (1998, Table 2, p. 46). In their update table, the OECD staff contrast the
macroeconomic studies with the microeconomic evidence, the latter tending to find near-zero or
very low effects on the saving rate from changes in dependency ratios.

Table 2
Summary of Previous Studies' Estimates of Demographic Effects on Saving Rates

Study	Data Source	Effect on Saving Rate of a 1 Percentage Point Rise in Demographic Ratio	
		Youth Dependency Ratio	Elderly Dependency Ratio
Aggregate cross-section studies:			
Modigliani (1970)	....	-0.20 (3.7)	-0.88 (3.1)
Modigliani and Sterling (1983)	....	-0.13 (1.4)	-0.51 (4.3)
Feldstein (1980)	....	-0.77 (3.9)	-1.21 (2.7)
Horioka (1986)	21 OECD countries 1976-82 average	-0.92 (4.2)	-1.61 (4.0)
Graham (1987)	24 OECD countries, 1975 or 1970-80 average	-0.87 (2.9)	0.12 (0.3)
Koskela and Viren (1989)	23 countries, 1979-83 average	-0.73 (1.7)	-0.76 (0.8)
Horioka (1991)	14 OECD countries, 1980-88 average	-0.44 (1.7)	-1.09 (2.4)
OECD (1990)	14 OECD countries, 1980-88 average	....	-0.93 (2.4)
Time series studies:			
Shibuya (1987)	1966-83 (Japan)	....	-0.34 (3.8)
Horioka (1991)	1956-87 (Japan)	-0.30 (5.1)	-1.13 (3.7)
Masson and Tryon (1990)	1969-87 (pooled) G7 plus small industrial countries	-1.10	
Weil (1994)	1960-85 (pooled)	-0.3	-0.5
Masson-Bayoumi-Samiei (1995)	1972-93 (pooled) 21 industrial countries	-0.15 to -0.30	
Meredith (1995)	simulation model	-0.30	

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Source: see Meredith (1995). Figures in parentheses are estimated t-statistics. The youth dependency ratio here is defined as the ratio of the population aged 0-19 to population aged 20-64. The elderly dependency ratio is defined as the ratio of the population over 64 to population aged 20-64 (except in the OECD (1990) study where it is the ratio of population over 64 to total population). See Meredith's original table for additional footnote information.

An important recent short-cut attempt has been undertaken by the staff in the Economics Department at the OECD with a new "Minilink" model; see Turner and others (1998). Bryant has also been experimenting along analogous lines at Brookings, using a two-region abridgement of the IMF Staff's MULTIMOD (Bryant and Zhang, 1996a, 1996b, 1999). The OECD staff and Bryant have both been adapting a substantially modified consumption-saving-wealth specification embodied in a recent revision of MULTIMOD. For that revision, see Laxton and others (1998) and Faruqee and others (1997). Faruqee and Laxton are currently doing research that will result in a further refinement of this specification.

Another aspect of consumption which may be important for understanding the impacts of demographic shifts is changes in the composition of consumption bundles over an individual's lifetime. In a single good world, it is not possible to capture the impact that changes in preferences may have on the relative prices of alternative goods and services. For example, in an aging society it is likely that the demand for health services will rise, which will cause shifts in the relative prices of these services and a change in the allocation of resources to satisfy shifting demands. Conventional single-good macroeconometric models will not be able to capture this type of compositional effect. Multi-sectoral multi-country models, such as the G-Cubed model of McKibbin and Wilcoxen (1995), can do so.

4. Demographic Influences on Production and the Supply Side

Although the omission of demographic influences on consumption and wealth accumulation in multi-country macroeconomic models is probably the most serious shortcoming of those models for studying the consequences of population aging, omissions on the supply side

of the models may also be serious. The more aggregative the models' supply side, the more problematic may be these omissions.

Demographic effects on the modeling of labor supply may be the least worrisome of supply-side problems. A rudimentary treatment of labor supply is often included in most general-equilibrium macro models. Labor or effective labor is typically modeled as an endogenous input into the production function. In some macro models, moreover, the supply of labor is dependent not only on growth in the total population but also on the age-structure and dependency-structure of the population, and on the participation rates of working-age individuals. (These labor-supply variables, however, are typically modeled just as exogenous.) The IMF's MULTIMOD (Laxton and others, 1998, for the most recent version) and the OECD's new Minilink (Turner and others, 1998) are examples of multi-country models incorporating these features.

In some other macro models, however, no distinction is made even between the labor force and the total population. Such models fail altogether in allowing changes in demographic structure to influence output supply. For illustrations, see for example the G-Cubed and MSG2 models (McKibbin and Wilcoxen, 1995; McKibbin, 1992), the Bank of Canada's Canadian Policy Analysis Model -- CPAM (Black and Rose, 1997) -- and the Reserve Bank of New Zealand's FPS model (Black, Cassino, and others, 1997).

If an empirical multi-country model is to be used to study the international consequences of population aging, the model should presumably include, at the very least, variations in the effective supply of labor due to changes in the age and dependency structure of the population.

The omission of demographic influences on investment in physical capital is another serious matter. Most aggregative macro models have no explicit demographic variables in their

investment equations. If the models were to embody significant disaggregation across types of goods, and hence were to include several different capital stocks for producing the different products, the varying effects of demographic influences on the demands for the products and the types of capital used in producing them might be captured indirectly through relative-price movements (e.g., as in the G-Cubed model of McKibbin and Wilcoxen). In aggregative macro models specifying explicitly only one composite good and one composite type of capital, on the other hand, such relative-price effects are absent by construction. For such models, perhaps it may be necessary either to disaggregate the number of goods being produced or, as a short cut, to include explicit demographic variables in the equations for investment.

Fair-Dominguez (1991) do propose such empirical adjustments, and these adjustments appear in the current version of the Fair model for the United States.[10] Fair and Robin Brooks are currently engaged in research to incorporate such adjustments in the equations of the Fair multi-country model. Bloom-Williamson (1997) and Higgins-Williamson (1997) argue that such supply-side effects can be important.

The missing or inadequate treatment of infrastructure capital and government investment is a related problem. Very few aggregative macro models address this issue. On a priori grounds, one might expect demographic-compositional effects on investment and capital accumulation to be significant for some forms of government infrastructure investment; examples might include schools for children, or medical-care facilities for the elderly. Again, this issue probably matters the most in models which have only a single composite type of capital stock (rather than a variety

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[10] The current version of the model, with explanations of the specifications, can be viewed on Fair's web site (the URL is http://fairmodel.econ.yale.edu).).

of different types of capital). The MSG2 model has a separate government capital stock in the production function (see McKibbin and Bagnoli (1993)). So far, however, most macro models have not yet attempted this refinement.

Even more difficult issues arise in connection with macro models' treatments of technical progress. Almost all the larger empirical models still specify the rate of increase in technical progress as exogenous. A burgeoning theoretical literature has considered alternative ways to treat technical progress as endogenous. For an overview and references to the literature, see for example Macklem (1992), Helliwell (1995), and the textbook of Barro and Sala-I-Martin (1995).

In several recent papers, Fougère-Mérette (1997, 1998) construct a smaller empirical model focusing on demographic change which does incorporate a form of endogenous technical progress. It seems likely that the next decade will witness more intensive attempts to model technical change endogenously. At the current time, however, no consensus yet exists among theorists or empirical modelers about what changes along these lines, if any, should be incorporated in workhorse macroeconomic models.

Two final points of a general nature deserve mention in this section. The first of these was stressed by John Helliwell in the July workshops. Existing multi-country macroeconomic analysis has tended to fall into a pattern of assumptions about the mobility of factors of production that does not stand up well in comparison with real-life economic activity. The typical assumption about the mobility of labor across national borders, made for analytical convenience, is that no mobility at all is possible. The opposite extreme assumption, again for analytical convenience, is made for cross-border movements of financial capital: the typical modeling effort assumes that assets and liabilities denominated in home currency are perfect substitutes for assets and liabilities

denominated in foreign currency (infinite capital mobility). The mobility of consumer goods and capital goods across borders is usually assumed to be intermediate.

Migration of people across borders is in fact far from negligible. Given the differing demographic trends in industrial and developing countries, the pressures to permit greater amounts of migration will probably intensify. Although the assumption of infinite mobility of financial capital is analytically convenient, fairly compelling empirical evidence exists that calls this assumption into question. It is certainly not true (as much recent commentary about "globalization" fashionably but superficially asserts) that national financial markets are now so completely integrated that the world has, in effect, a single unified capital market. More generally, as Helliwell (1998) demonstrates in his new book, national borders matter greatly for all types of cross-border transactions. Analysts seeking to prepare careful analyses of macroeconomic interactions in the world economy, including the consequences of demographic change, need to reexamine the conventional assumptions made about the mobility of factors of production.

The other general point concerns the distinction between partial-equilibrium and general-equilibrium analyses. For empirical research on both the production-supply and the consumption-wealth aspects of national economies, many studies have used only a partial-equilibrium approach. Yet the researchers conducting those studies have often asserted fairly sweeping conclusions. In principle, as emphasized by McKibbin-Wilcoxen (1998), failure to study behavior in a general-equilibrium context could lead to misleading inferences. For example, McKibbin-Wilcoxen use several variants of a simplified general-equilibrium model that incorporates both a permanent-income, life-cycle-like approach to savings and a standard adjustment-cost approach to

investment. The well known and frequently asserted implications of those traditional savings and investment approaches, particularly those emphasized in most empirical tests, are fully valid only in partial equilibrium. In general equilibrium, the permanent-income, life-cycle hypothesis and the adjustment-cost hypothesis for investment are actually in direct conflict. Intertemporally smoothing consumers, confronted with fluctuations in their incomes, would like to vary saving so as to reduce fluctuations in their consumption. Hence saving should be fairly volatile, certainly more so than consumption. The adjustment-cost model of investment behavior, however, implies that firms want to avoid large fluctuations in investment, which raise adjustment costs. Other things equal, firms try to reduce the volatility of investment.

In a closed economy, both sets of agents cannot achieve their objectives simultaneously. If consumers successfully smooth fluctuations in their consumption, savings and therefore investment will fluctuate substantially, raising adjustment costs. But if firms successfully reduce adjustment costs, savings must fluctuate less and therefore consumption must fluctuate more than households would prefer. The general-equilibrium outcome tends to produce substantially more volatility in consumption than would be predicted from the partial-equilibrium models of intertemporally smoothing consumers (even without taking into account external constraints on households that inhibit them from freely borrowing in capital markets). Although issues of the saving-investment balance are resolved in a more complex manner in an open than in a closed economy, an analogous point will be relevant even for open economies: some critical aspects of macroeconomic behavior can only be addressed in models that attempt to capture general-equilibrium interdependencies.

Participants in the July workshops agreed that the production, supply-side issues identified

in this section are critically important for further research on the global dimensions of demographic change. Unfortunately, however, there was no consensus on which of the issues merits greatest attention over the shorter run.

5. Demographic Influences on Government Budgets

Substantial amounts of analysis have been carried out on the likely effects of population aging on government budgets, for most if not all of the OECD countries. Special emphasis has been placed on expenditures on government-sponsored pension or social security systems and on government financing of health-care delivery. Somewhat less attention has been given to the effects of demographic changes on prospects for different classes of non-pension-system government revenues

The numerous references that could be cited include the comparative analyses carried out at the OECD -- Leibfritz and others (1996); Roseveare, Leibfritz and others (1996) -- and the studies of the Congressional Budget Office (1998), Bosworth (1996), Davis (1997), the European Commission Directorate-General II (1996), Takayama (1996), Hurd-Yashiro (1997), Bosworth-Burtless (1998), and Bohn (1998). For a recent analysis of the main policy choices being debated for the U.S. social security system, see Aaron-Reischauer (1998). An example of current European discussions is a meeting on pension reforms in Europe scheduled for end-January 1999 of the European Roundtable of Industrialists, sponsored by the newly established Fondazione Rodolfo DeBenedetti in Milan.

At one level, issues about estimates of demographic influences on government budgets are less complex than the issues discussed earlier about the consumption-wealth and the production-

supply-side sectors. Even on these government expenditure and revenue effects, however, analysis can also become quite complicated. Substantial uncertainty exists about -- to take only three of the most important variables -- life expectancy, the endogeneity of retirement ages, and the endogeneity of medical-care costs. This uncertainty causes significant variation in projections of government revenues and government expenditures for social security and health care.

A majority of participants in the July workshops tended to regard uncertainty about how to model the demographic influences on government budgets as less troublesome, and less consequential for the profession's ability to make helpful policy recommendations, than the uncertainties about how best to model the macroeconomic effects of demographic change on consumption, saving, and wealth accumulation (section 3) and on production and the supply side (section 4).

6. Developing Countries and Demographic Change

Although analysts of demographic changes have focused primarily on trends in and consequences for the industrialized economies, there are also many important issues for the global economy having to do with developing economies. Developing nations themselves will be experiencing important demographic changes and the associated effects within their economies. The changes in the industrial economies, moreover, may have quite large impacts on the savings-investment-current account balances of developing countries.

Analysis of the macroeconomic consequences of demographic changes in the developing countries is at an earlier stage than the analysis for industrial countries. Significant recent discussion may be found in, for example, Heller-Symansky (1997), Williamson-Higgins (1997),

Bloom-Williamson (1997), and Deaton-Paxson (1997,1998).   The partial-equilibrium study of

MacKellar and Reisen (1998) focuses on diversification of pension-fund investments between the

industrial and developing nations.

Little systematic empirical research has been conducted on the general-equilibrium

macroeconomic impacts on developing economies of shocks originating in the industrialized

economies.   Existing papers include Masson-Helliwell (1993) and the contributions in the volume

edited by Vines and Currie (1995). Our paper in the Vines-Currie volume (Bryant-McKibbin,

1995) summarizes the inferences that can be drawn from existing multi-country models.

The awkward fact is that most multi-country macroeconomic models have paid little

attention to developing countries.   Some recent research has begun to try to rectify this omission,

but many difficult problems remain to be addressed.[11]   Little or no effort has so far been made to

incorporate demographic effects in the models' treatment of developing-country regions. The

OECD Minilink model – Turner and others (1998) – is an important recent exception, though its

treatment of developing economies aggregates them all into a single (assumed to be homogenous)

region.

Several participants at the project workshops pointed to this area as an urgent priority for

prospective research in this project. It was recognized that progress was bound to be slow. But

it was also emphasized that a satisfactory analysis of the global dimensions of demographic

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[11] The Asia-Pacific G-Cubed Model -- see McKibbin (1996) -- now incorporates 18
countries, 13 of which are developing economies. The IMF's MULTIMOD has always had a
rudimentary representation of a developing-nation bloc; recent work at the IMF for the 1998
World Economic Outlook experimented with constructing a bloc for emerging-market economies.
MULTIMOD may eventually incorporate more country detail – see Laxton and others (1998,
section 8).

change could not possibly be made without bringing in the general-equilibrium aspects of saving-investment interactions between industrial and developing economies.

The inadequacy of macroeconomic data for developing-country economies and regions has been a major deterrent to empirical analysis. In recent years, international databases assembled by international agencies and academics have improved this situation dramatically. The coverage of developing countries in computable general equilibrium models has improved as a result of the better data; see, for example, the GTAP model described in the volume edited by Hertel (1997). Progress is being made at the IMF in incorporating more developing countries or regions into the staff's multicountry model MULTIMOD.

7. Conclusions and Directions for Future Research

At each of the July 1998 workshops, the day concluded with a roundtable discussion about priorities for future research. We asked participating researchers to comment at two levels. First, we asked for views about the relative importance of the focus of this project -- the cross-border, international implications of demographic change -- among the entire range of topics that participants thought merited further research. Second, if participants thought that this general topic deserves high priority, they were also asked to express views about relative priorities within the project itself.

The workshops revealed a strong consensus that the topic of global dimensions of demographic change is a high-priority area for future research. It was widely agreed that the evidence on demographic effects is often conflicting (for example, the dissonance between microeconomic and macroeconomic studies), that there are significantly differing views on the

channels through which demographic effects manifest themselves, and that the cross-border and exchange-rate effects of demographic change could potentially be large. Thus the uncertainty on all these fronts about the macroeconomic consequences of demographic change are perceived as a major concern for policymakers.

To some extent, this general consensus was a foregone conclusion. We invited most of the world's leading researchers on the macroeconomic consequences of demographic change to attend the workshops. Well over half of the invitees were able to accept the invitation, and the great majority of the actual participants paid their own transportation and accommodation expenses to attend. Thus there was a strong element of self selection involved in the composition of the three groups. Virtually everyone was predisposed to believe that demographics are potentially important.

It was not a foregone conclusion, however, that participants would agree that the cross-border and global aspects of demographic change should receive high priority in future research. Quite the reverse. Since most research has focused only on the domestic aspects, inertia among researchers might have argued for merely continuing the dominance of domestic topics.

The general consensus at the workshops was broad -- shared by a large majority of participants. But it was not unanimous. A small minority felt that, though the problems were clearly of potential importance for policymakers, yet the analytical frameworks required for dealing with the cross-border aspects of demographic change were too little developed to support new research at this time, and probably could not be feasibly improved enough over the next few years to warrant a priority emphasis.

At the second level of discussion, choosing priorities within this topic area, no consensus

could be discerned. A wide dispersion of views was evident in each of the three workshops.

Each of the problem areas defined earlier in this paper is viewed by some researchers as a priority

for further work. But no single focus or set of topics, nor any particular methodological

approach, commands support from a clear majority.

The multiplicity of views about how best to study the cross-border dimensions of

demographic change precludes trying to obtain agreement among researchers in this project on

any dominant line of research. Given the numerous uncertainties afflicting the research,

moreover, a multi-pronged, let-many-flowers-bloom environment may in any event be the

preferred strategy for making significant forward progress.

Many researchers on demographic changes will almost certainly continue to de-emphasize

the international dimensions, not because they believe those dimensions to be unimportant, but

because they do not know how effectively to bring the international dimensions into their

research. Many of these researchers are under strong pressure to provide analysis and

recommendations on a purely domestic front -- for example, recommendations for the reform of

national social security systems. Still other researchers, while recognizing the importance of

general-equilibrium cross-border interactions among countries, feel it is impractical to try to use

any of the existing multi-country analytical frameworks, or to build new ones of their own.

Researchers who have not had contact with the multi-country models are understandably less

willing to believe that the multi-country frameworks can be useful.

Much of our focus in this paper has been on problem areas in the analytical modeling of

the consequences of demographic change. That emphasis reflects our own bias in favor of explicit

modeling. But we also believe that there is a valuable role in future research for comparative

cross-country analysis <u>not</u> based on explicit modeling. Many valuable insights can be gleaned

merely from systematic, thoughtful comparison of different countries' experiences, both as to key

features of macroeconomic behavior (e.g., saving and consumption, production and productivity)

and to the operation of institutions and programs (e.g., government pensions, delivery of health

care). Such comparative analyses will usually be unable to tackle the hardest, most understudied

issues of a general equilibrium nature. But we, and virtually all the workshop participants,

nonetheless regard this type of further research as important. As the cliché correctly states, one

must learn to walk before one can run.

Many comments were made at the workshops about the feasibility of explicit modeling of

the global dimensions of demographic change. Views on this subject ranged on a spectrum from

an extreme of pessimism to a position best characterized as cautious, guarded optimism. The

average degree of skepticism about the feasibility of improving the existing multi-country models

(to better incorporate demographic effects) was highest in the Tokyo workshop and least high in

the Washington workshop, with the Paris workshop somewhere in between. In the Tokyo

workshop, for example, perhaps a third of the participants said explicitly that the analytical

difficulties were too great to justify the expenditure of large amounts of resources on building new

multi-country models or trying to improve the existing models. The distribution of views on this

point was in part a function of the number of participants who had some familiarity with the

existing multi-country models. At the Washington workshop, a sizable minority of the

participants were already engaged in one or another sort of attempt to refine the existing models.

For the workshop participants who believe that the importance of the issues justifies

efforts to try to improve the existing multi-country macroeconomic models -- we count ourselves

as part of that group -- there is no illusion about the difficulties involved. In this paper we have summarized a range of areas where such improvements are required before it will be possible to prepare a fully coherent analysis of the effects of demographic change on the global economy. To reiterate, the areas of most importance include: the role of demographic influences on saving and consumption decisions at the aggregate level (as well as on the composition of consumption); the impact on economies of the changing composition of labor supply; impacts on requirements for investments in infrastructure (particularly in education and health care); and possibilities for the endogenous modeling of technical change.

In all these areas, a tradeoff exists between the amount of disaggregation required to capture compositional changes versus practical solutions for approximating these changes in aggregate macroeconomic relationships. This tradeoff is a perennial problem in any model building exercise. Decisions about the tradeoff become even more difficult in a multi-country modeling effort where disaggregation across national economies necessarily leads to a great increase in the complexity of the analytical framework.

If progress is to be made over the next several years in improving multi-country models, the advances will have to be achieved by individual modeling groups relying on their own comparative advantages and pursuing the particular issues that are most problematic for their own models. A collaborative, internationally coordinated effort to improve the models is not feasible, if only because resources to underpin such an effort are not available. Separate efforts, however, may well generate significant progress. The combination of each separate step forward can gradually increase the total stock of relevant analytical knowledge. No dominant model will emerge that handles all the demographic issues completely. But important lessons can be learned

incrementally. Incremental progress is especially likely if the various modeling groups maintain an active dialogue with each other, interacting to share information on the returns to different approaches. One of the main benefits of the three workshops held under the auspices of this project has been the sharing of information on alternative approaches.

As this paper emphasizes, the issues involved in demographic change are global as well as domestic. How economic policies are adapted in response to demographic changes will likely have very important consequences for the world economy in coming decades. As with other important research areas, a critical problem is how to generate enough investment in research and development now so that the appropriate analytical tools are available in the future before, rather than after, policies have to be formulated. In particular, to have research conclusions about the global dimensions of demographic change available when needed by policymakers, the research groups working with multi-country macroeconomic models must have sufficient resources to support their work.[12]

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[12] To judge from conversations held at the time of the July 1998 workshops, this provision of adequate resources is far from assured in the case of most modeling groups.

APPENDIX A:
<u>Existing Research Programs for Development of Multi-country and Open-Economy Macroeconomic Models</u>

In this appendix we briefly identify most of the research efforts that have produced empirical multi-country macro models. We also identify some of the empirical models representing the macro behavior of single national economies where the model builders have emphasized cross-border transactions and openness.

Institution-Sponsored Group Efforts Resulting in Larger Empirical Multi-country Models

The staff of the International Monetary Fund has since the late 1980s maintained a series of models known as MULTIMOD. Earlier references to the literature on MULTIMOD include Masson, Symansky, Haas, and Dooley (1988); Masson, Symansky, and Meredith (1990, 1991); and Meredith (1991). The most recent version, Multimod Mark III and its variants, is described in Laxton and others (1998).

Multi-country modeling work in the Economics and Statistics Department of the Organisation for Economic Cooperation and Development (OECD) goes back at least to the 1970s. For the earlier vintages, see for example Richardson (1988, 1993) and the references cited therein. The most recent work on the Minilink model, designed especially to deal with population aging issues, is summarized in Turner and others (1998).

The International Division staff of the Federal Reserve Board began work on a multi-country macroeconometric model in the 1970s. The original work is described in Stevens and others (1984) and subsequent changes in Edison and others (1987). The current version of the

multi-country model, now known as FRB/GLOBAL, is described in Levin, Rogers, and Tryon (1997, 1997). The International Division staff in the 1980s, in particular Joseph Gagnon, also built a smaller prototype multi-country model known as the MX3 model; for this work, see Gagnon (1991).

Multi-country modeling efforts at the European Commission in Brussels have recently focused on a model known as QUEST II; see, for example, Roeger (1997).

Researchers at the National Institute for Economic and Social Research (NIESR) and the London Business School in the United Kingdom during the 1980s and early 1990s developed several variants of a multi-country model known as GEM. The development of the model, known as NIGEM, has continued at the NIESR. A current manual for the NIGEM model is available as NIESR (1998); see Barrell-Sefton (1997) for standard simulations and model properties.   Other articles discussing properties of NIGEM include Barrell-Pain (1997) and Barrell-Pain-Sefton (1997).

For an overview of the efforts of an official Japanese multi-country modeling effort as of the mid-1980s, see Japanese Economic Planning Agency (1986).

The earliest efforts at multi-country macroeconomic modeling were organized under the auspices of Project LINK, led by among others Lawrence Klein. An overview of Project LINK's activities up through the late 1980s may be found in Hickman (1988). Earlier references include Ball (1973), Waelbroeck (1976), and de Grauwe and Peters (1983).

Empirical Multi-country Models Constructed by Individuals or Small Groups

Warwick McKibbin and Jeffrey Sachs (1991) built a global simulation model, known as MSG, during the second half of the 1980s. Variants of this model have subsequently been extended and refined by McKibbin and other co-authors; see, for example, McKibbin (1992) and McKibbin and Bok (1995).

Together with Peter Wilcoxen, McKibbin has also constructed a multi-sector multi-country model, known as G-CUBED. Its macroeconomic features are similar to those of MSG, but the model also has significant disaggregation of production into twelve sectors. For this research, see McKibbin-Wilcoxen (1995) and Bagnoli-McKibbin-Wilcoxen (1996) as well as McKibbin's web site (URL is http://www.msgpl.com.au).

John Taylor and various associates at Stanford University constructed a multi-country model in the 1980s, which has been maintained and used into the current decade. For an overview, see Taylor's book (1993). Recent references include Taylor (1993, 1995, 1998, 1998).

Ray Fair of Yale University likewise has built and maintained a multi-country model; the original work is described in Fair (1979, 1982). Information about both his multi-country model and his US model is available from Fair's web site (the URL is http://fairmodel.econ.yale.edu).

Another small-group multi-country modeling effort in the 1980s was sparked by Patrick Minford and colleagues at Liverpool in the United Kingdom; see Minford and others (1984, 1986).

In the last several years, Ralph Bryant at Brookings has been experimenting with a two-region (United States and "Rest of World") abridgement of the IMF Staff's MULTIMOD model.

This research, initially done with Long Zhang, has focused on the intertemporal and international aspects of fiscal policy -- Bryant and Zhang (1996a, 1996b, 1999). A fuller report on this research will appear in an as-yet uncompleted book (Bryant, 1999).

Model Comparison Publications

The Brookings Institution has sponsored several conferences or workshops to compare many of the preceding modeling efforts and to evaluate their strengths and weaknesses. This work is summarized in Bryant and others (1988, 1988, 1993). Mitchell and others (1998) summarizes a recent evaluation project conducted at the University of Warwick.

Empirical Single-Economy Models with Prominent Open-Economy Features

Most macroeconomic models constructed for individual national economies have at least a rudimentary treatment of the economy's imports and exports. We identify a few of the single-economy models here that are notable for a more careful, detailed treatment of the external sector.

The Bank of Canada has a long tradition of macroeconometric modeling, extending back to at least the 1970s. Research in the 1990s produced a new, innovative model, known as QPM (for Quarterly Projection Model), which exists in both steady-state and dynamic versions that are internally consistent. References include Bank of Canada Staff (1994), Black, Laxton, and others (1994), and Coletti, Hunt and others (1994). In the last several year, a streamlined version of the model has been constructed to facilitate stochastic simulations; known as CPAM (Canadian Policy Analysis Model), this model is described in Black and Rose (1997).

With assistance of some of the members of the Bank of Canada modeling team, the

Economics Department staff of the Reserve Bank of New Zealand has recently constructed a

similar model for the New Zealand economy. This effort, referred to as the FPS (Forecasting and

Policy System) model, is summarized in Black, Cassino and others (1997).

The Federal Reserve Board staff was a pioneer in efforts during the 1960s and 1970s to

build a macroeconometric model of the U.S. domestic economy. The 1980s version of the

"FRB/MPS" model is described in Brayton and Mauskopf (1985). The most recent version of

the domestic model, FRB/US, is described in Brayton and Tinsley (1996) and Brayton and others

(1997, 1997). The domestic and international sides of the Federal Reserve staff now routinely

collaborate to produce joint simulations with FRB/US and FRB/GLOBAL, iterating until the two

models produce internally consistent simulation paths.

For an illustration of a recent effort to model the U.K. economy with features emphasizing

the exchange rate, see the COMPACT model built by Simon Wren-Lewis (1997).

Smaller Models with Emphasis on Demographic Developments

We are still trying to collect information about additional modeling efforts that overlap

with the objectives of this project. For the time being, we identify here only two.

At the Department of Finance in Canada, Marcel Mérette and Maxime Fougère have

produced a series of papers based on a multi-country overlapping generations model. These

authors have also been collaborating with members of the OECD staff in Paris. This work is

described in Fougère-Mérette (1997, 1998). For related work at the OECD, see also Hviding-

Mérette (1998).

A modeling effort focused on the global diversification of investments in pension schemes

is being led by Landis MacKellar of IIASA in Austria and Helmut Reisen of the OECD

Development Centre. For an early report on this research, see MacKellar and Reisen (1998).

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