

## **Universal Social Accounting Matrices (SAMs):**

**Analysis of Global Social Support for  
Human Development**

Barry B. Hughes and Anwar Hossain  
University of Denver  
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### Table of Contents

1.	Introduction: Analysis Purposes .....	1
2.	General Characteristics of the Approach .....	4
2.1	The IFs Modeling Platform.....	4
2.2	The Philosophy and Methodological Approach of IFs .....	7
2.3	The Structural Foundation of Social Accounting Matrices .....	10
2.3	The Presentation to Follow .....	12
3.	An Overview of the Universal SAM .....	13
3.3	Flows in the SAM .....	13
3.2	Stocks in the SAM .....	15
3.3	Integration Within International Futures .....	16
4.	Details of Development and Structure .....	18
4.1	IFs Pre-Processor: The SAM and More .....	18
4.2	Initializations of Flows in the SAM.....	20
4.2.1	Intersectoral Flows and Value Added.....	20
4.2.2	Other Sector-Specific Flows .....	22
4.2.3	Government-Specific Domestic Flows .....	23
4.2.4	Household and Firm Flows and Reconciliations, Recalculations.....	28
4.2.5	International Financial Institution (IFI) Flows .....	32
4.2.6	Other International Agent-Specific Flows .....	33
4.3	Initialization of Stocks .....	33
4.4	SAM Computation in Subsequent Years .....	36
4.4.1	Domestic Dynamics Around the SAM .....	37
4.4.2	International Dynamics Around the SAM .....	46
4.5	Concluding Comments: SAM and the Broader Model.....	50
5.	Analysis.....	52
5.1	Pensions and the Aging in Chapter 2 of the Great Demographic Transition....	52
5.1.1	The Demographic Context of the Aging/Pension Issue.....	54
5.1.2	Insights from Social Accounting .....	59
5.2	A Global Social Safety Net in Chapter 2 of the Great Economic Transition ...	65
5.2.1	The Context of the Social Protection/Safety Net Issue.....	66
5.2.2	Insights from Social Accounting .....	69
6.	Scenarios .....	73
7.	Next Steps .....	75
	Bibliography .....	77

## **Abstract**

This paper describes work underway in creating and using an integrated model for the analysis of long-term, global social support for human development. The paper describes a specific effort within the larger project, namely the creation and use of universal social accounting matrices (SAMs).

Protection and enhancement of the human condition is perhaps the ultimate goal of all socio-political activity. The level of human development may therefore be the ultimate measure of success or failure of such activity. The definition and measurement of human development is not without controversy. The United Nations Development Program's Human Development Index combines life expectancy, income, and educational level. The Millennium Development Goals focus particular attention on income and educational levels in recognition that increased life expectancy will normally follow from achievements in those domains.

Social efforts to enhance human development engender still more controversy than measurement does. Dimensions of disagreement include the appropriate targets of the social efforts and the character of activities that provide the greatest leverage. Sometimes the focus is on the poorest of the poor, and at other times on all humans. At times the emphasis is on providing basic social safety nets and at other times the provision of human capabilities for self help.

Regardless of the approach to human development, analysis clearly requires attention to multiple human systems, including demographics, markets for goods and services, and patterns of financial flows across countries and categories of actors within them. It requires more as well, including attention to health and educational systems, and to the character and capacity of governance systems.

This paper explains how the use of social accounting matrices, as part of a broader representation of human systems, can contribute to the analysis of social efforts to enhance human development. The paper is primarily a documentation of the current state of developing a system of universal social accounting matrices within an integrated global model named International Futures (IFs). In addition to the SAM systems, IFs contains: a cohort-component representation of demographic systems; a multi-sector, general equilibrium-seeking representation of economies; a module of formal education at primary, secondary, and tertiary levels; and other subsystems. The IFs system also facilitates the development and comparison of multiple scenarios for underlying variables and subsystems as disparate as the rate of change in systemic multifactor productivity, the evolution of the HIV/AIDS epidemic, and the attention that societies give to different levels of education.

Specific issues around human development that such a modelling system can help investigate range widely. They include, for instance, both the effort to create basic social safety nets or social protection systems throughout the developing world and the unfolding pension crises of many developed countries. Although that paper illustrates such analysis, extended treatment will follow in other documents.

## 1. Introduction: Analysis Purposes

The broad purpose of the International Futures (IFs) modelling system is to serve as a thinking tool for the analysis of long-term country-specific, regional, and global futures across multiple, interacting issue areas. With respect to social development and performance, such futures can range from state failure, at one extreme, through rapid social development with stability and democratization, at the other extreme.<sup>1</sup> With respect to human development, such futures can range from rapidly advancing human capabilities in even the poorest countries to collapse of the human condition in even the richest.

Two examples of change in the human condition can illustrate more concretely the range of possible futures. The first focuses on the poorest of the poor and the second on the continued well-being of those who have reached a much higher level of human development.

The Millennium Summit's Development Goals (declared in September, 2000) are only a recent set within a long series of efforts to state objectives for addressing poverty in LDCs. The summit's summary statement is, nonetheless, very important and focuses our attention sharply on human development: "We will spare no effort to free our fellow men, women, and children from the abject and dehumanizing conditions of extreme poverty to which more than a billion of them are currently subjected." The Millennium Development Goals (MDG) that have grown out of this declaration all have clearly measurable and specific targets.

Although very large numbers of intergovernmental and nongovernmental organizations have been involved and continue to be active in achieving summit goals such as eradicating extreme poverty, the World Bank has taken an important role through its research and field programs, such as those aimed at implementing "poverty reduction strategies" and creating "social protection" (World Bank 2000; Holzmann and Jørgensen 2000). One of the desired elements of social protection has long been the creation of social safety nets, focusing sometimes on assuring basic levels of income for all and

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<sup>1</sup> The developments to International Futures that have made possible the model development and analysis described here have been funded in substantial part by the TERRA project of the European Commission and by the Strategic Assessments Group of the U.S. Central Intelligence Agency. In addition, the European Union Center at the University of Michigan has provided support for enhancing the user interface and ease of use of the IFs system. None of these institutions bears any responsibility for the analysis presented here, but their support has been greatly appreciated. Most recently, the RAND Frederick S. Pardee Center for Longer Range Global Policy and the Future Human Condition has begun to motivate and sponsor this work. Thanks also to the National Science Foundation, the Cleveland Foundation, the Exxon Education Foundation, the Kettering Family Foundation, the Pacific Cultural Foundation, the United States Institute of Peace, and General Motors for funding that contributed to earlier generations. Also of great importance, IFs owes much to the large number of students, instructors, and analysts who have used the system over many years and provided much appreciated advice for enhancement (some are identified in the Help system). The project also owes great appreciation to Anwar Hossain, Mohammad Irfan, and José Solórzano for data, modeling, and programming support of the most recent model generation, and to earlier student assistants (again see the Help system).

sometimes on specific targets such as food for children, relief for the unemployed, or adequate pensions for the retired.

In addition to the proactive impetus for attention to social safety nets and human development that has long come from the United Nations, the World Bank and many other actors, there is also an increasing impetus for attention that has come from the critics of globalization. Those critics, including respected scholars such as Rodrik (1997) and Stiglitz (2002), have pointed with increasing urgency to the potential that globalization processes can undercut efforts to enhance social safety nets and, in some cases, lead to weakening of those systems already in place. Even the greatest supports of globalization processes, including the International Monetary Fund and *The Economist*, have increasingly recognized the threats to human support systems and the need for protection of them.<sup>2</sup>

Perhaps the key difference between traditional emphases on safety nets and emerging approaches to social risk management is the recognition that temporary, palliative assistance to those in greatest need (safety nets alone) is best addressed as part of the larger problem of meeting needs in the context of broader economic and social development (not least of which is the creation of strong educational systems). The central issue of interest to us here therefore tends to be the creation of what might be called a “sustainable safety net,” namely the generation/provision of basic levels of income and social support in a growing economy and a developing socio-political system.

More economically-developed countries have their own issues around human development. One such issue is the re-organization of educational systems in the face of the emergent global knowledge-based economy. Another, however, is the funding of pension plans in the face of rapidly aging populations, an issue that threatens current social safety nets and human condition. For instance, the Center for Strategic and International Studies (CSIS) has issued a series of reports. England (2001) authored *The Fiscal Challenge of an Aging Industrial World* and followed (2002) with *Global Aging and Financial Markets: Hard Landings Ahead?* CSIS also sponsored a report by Hewitt (2002) called *Meeting the Challenge of Global Aging: A Report to World Leaders from the CSIS Commission on Global Aging*. Ryutaro Hashimoto, Walter Mondale, and Karl Otto Pöhl chaired that 85-member commission.

Many others have weighed in concerning the growing challenge of pension funding. The World Bank (1994) provided an early and still seminal analysis. See Orszag and Stiglitz (1999) for an updated and extended analysis. The OECD has weighed in with studies such as its *Ageing in OECD Countries: A Critical Policy Challenge* (1996) The Population Reference Bureau published an issue of its Reports on America called

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<sup>2</sup> The December 16, 2002, issue of the IMF Survey (see [www.imf.org/imfsurvey](http://www.imf.org/imfsurvey)) reported on a conference on social safety needs sponsored by the International Labor Organization, the Carnegie Endowment for International Peace, and the Brookings Institution. *The Economist* devoted a special section in its issue of May 3, 2003, to “A Cruel Sea of Capital.”

*Government Spending in an Older America* (Lee and Haaga 2002). The Council of Ministers of the European Union met in Barcelona in early 2002 and the issue was high on its agenda.

Two issues tend to dominate the discussion of possible pension crises: the immediate fiscal problems for states that have pay-as-you-go pension plans and aging populations; and the larger macro-economic implications of changing ratios between employed workers and the larger population.

This working paper will return illustratively to these issues in the final chapter. Its primary purpose, however, is to document a methodology that will help address a great many issues around social support for human development. Specifically, the methodology is a universal, or at least global representation of social accounting matrices within the International Futures modelling system.

## 2. General Characteristics of the Approach

Analysis of long-term social change, including addressing of problems such as those identified in Chapter 1, requires tools that have empirical foundation, analytic strength and very considerable breadth. Much can be learned from simple extrapolative techniques (often used in looking at pension issues) or from relatively narrowly-focused models (much development study benefits from them). Particularly as the geographic scope and the temporal range of interest expand, however, the potential contribution of larger scale, integrated and dynamic models becomes greater. This chapter provides a brief introduction to the International Futures (IFs) modelling system and then turns to the development of Social Accounting Matrices (SAMs) within it.

### 2.1 The IFs Modeling Platform

International Futures (IFs) has been evolving for more than 20 years in support of investigation into global demographic, economic, social, and environmental transitions. Integrated modelling offers a number of advantages that supplement individual issue analyses:

1. The ability to compare the impact that alternative policy levers produce relative to a range of goals within a consistent framework. No modelling system will ever provide a comprehensive representation of all complex underlying systems, but over time such a system can evolve so as to capture what analysts identify as the dominant relationships<sup>3</sup> and the dominant dynamics within them.
2. The potential to explore secondary and tertiary impacts of policy interventions or of attaining policy targets. For instance, we know that rebound effects are persistent in many systems that have a general equilibrating character; without the representation of such equilibration, such rebound effects are difficult, if not impossible, to analyze.
3. The option of exploring interaction effects among the policy interventions themselves. Ideally we want to consider interventions individually, in order to isolate the leverage they provide us, but also to investigate them in combinations that might, on one hand, represent politically feasible policy packages or, on the other hand, maximize our ability to reach goals.

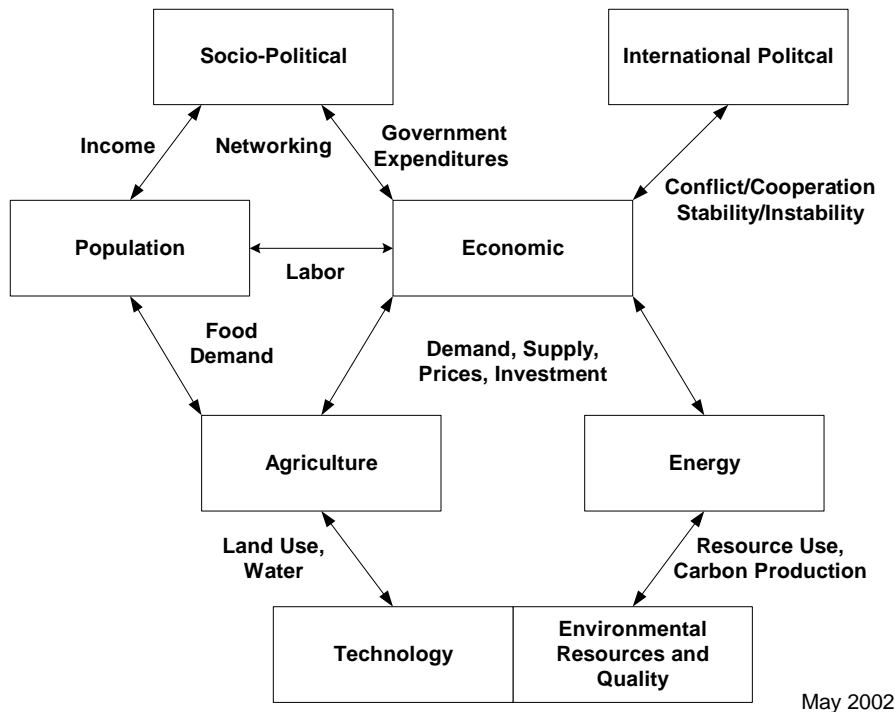
Full documentation of the International Futures (IFs) modelling system, albeit somewhat behind recent model developments, exists in the on-line help system of the system itself. The system is now in its fourth generation. For introduction to the character and use of the third generation see Hughes (1999). Here we provide only very basic summary information on the structure of the system, before turning to the primary purpose of this paper, namely the new SAM structures and the analysis that can be based on them.

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<sup>3</sup> Within the TERRA project Mihajlo Mesarovic has placed particular stress on the necessity of making dominant relations clear within integrated modeling structures.

International Futures is a global modelling system. The extensive data base underlying it includes data for 164 countries over as much of the period since 1960 as possible. The modelling system has a “pre-processor” that cleans and reconciles data from a variety of sources and across a variety of units, then aggregates it into initial conditions and parameters for whatever geographic representation of the world the user desires. The model itself is a recursive system that can run without intervention from its initial year (currently 2000); the model interface facilitates interventions flexibly, however, across time, issue, and geography.

Figure 2.1 shows the major conceptual blocks of the International Futures system. The elements of the technology block are, in fact, scattered throughout the model.



**Figure 2.1 An Overview of International Futures (IFs) for TERRA**

The population module:

- represents 22 age-sex cohorts to age 100+
- calculates change in cohort-specific fertility and mortality rates in response to income, income distribution, and analysis multipliers
- computes average life expectancy at birth, literacy rate, and overall measures of human development (HDI) and physical quality of life
- represents migration and HIV/AIDS
- includes a newly developing submodel of formal education across primary, secondary, and tertiary levels

The economic module:



- represents the economy in six sectors: agriculture, materials, energy, industry, services, and ICT (other sectors could be configured, using raw data from the GTAP project)
- computes and uses input-output matrices that change dynamically with development level
- is a general equilibrium-seeking model that does not assume exact equilibrium will exist in any given year; rather it uses inventories as buffer stocks and to provide price signals so that the model chases equilibrium over time
- contains a Cobb-Douglas production function that (following insights of Solow and Romer) endogenously represents contributions to growth in multifactor productivity from R&D, education, worker health, economic policies (“freedom”), and energy prices (the “quality” of capital)
- uses a Linear Expenditure System to represent changing consumption patterns
- utilizes a "pooled" rather than the bilateral trade approach for international trade
- has been imbedded in a social accounting matrix (SAM) envelope that ties economic production and consumption to intra-actor financial flows

#### The agricultural module:

- represents production, consumption and trade of crops and meat; it also carries ocean fish catch and aquaculture in less detail
- maintains land use in crop, grazing, forest, urban, and "other" categories
- represents demand for food, for livestock feed, and for industrial use of agricultural products
- is a partial equilibrium model in which food stocks buffer imbalances between production and consumption and determine price changes
- overrides the agricultural sector in the economic module unless the user chooses otherwise

#### The energy module:

- portrays production of six energy types: oil, gas, coal, nuclear, hydroelectric, and other renewable
- represents consumption and trade of energy in the aggregate
- represents known reserves and ultimate resources of the fossil fuels
- portrays changing capital costs of each energy type with technological change as well as with draw-downs of resources
- is a partial equilibrium model in which energy stocks buffer imbalances between production and consumption and determine price changes
- overrides the energy sector in the economic module unless the user chooses otherwise

#### The socio-political sub-module:

- represents fiscal policy through taxing and spending decisions
- shows six categories of government spending: military, health, education, R&D, foreign aid, and a residual category
- represents changes in social conditions of individuals (like fertility rates or literacy levels), attitudes of individuals (such as the level of

- materialism/postmaterialism of a society from the World Value Survey), and the social organization of people (such as the status of women)
- represents the evolution of democracy
  - represents the prospects for state instability or failure

The international political sub-module:

- traces changes in power balances across states and regions
- allows exploration of changes in the level of interstate threat
- represents possible action-reaction processes and arms races with associated potential for conflict among countries

The environmental module:

- allows tracking of remaining resources of fossil fuels, of the area of forested land, of water usage, and of atmospheric carbon dioxide emissions
- provides a display interface for the user that builds upon the Advanced Sustainability Analysis system of the Finland Futures Research Centre (FFRC), Kaivo-oja, Luukhanen, and Malaska (2002)..

The implicit technology module:

- is distributed throughout the overall model
- allows changes in assumptions about rates of technological advance in agriculture, energy, and the broader economy
- explicitly represents the extent of electronic networking of individuals in societies
- is tied to the governmental spending model with respect to R&D spending

## **2.2 The Philosophy and Methodological Approach of IFs**

The submodules of IFs are not simply collections of equations. Instead, there are strong structural foundations for those equations. IFs draws upon techniques found in both econometric and systems dynamics traditions, but also reaches beyond those, especially in its structural representations. The emergent methodological approach of IFs can be called “Structure-Based and Agent-Class Driven Modeling.” That modelling approach has five key elements methodologically: organizing structures, stocks, flows, key aggregate relationships, and key agent-class behavior relationships.

Table 1 provides more detail, focusing on three sub-systems within IFs. The structural representations of those sub-systems are cohort-component systems for population, markets for production, exchange, and consumption of goods and services, and social accounting matrices (SAMs) for financial flows. In general, the structural foundations for all modules draw upon a varying combination of accounting system and equilibrating system elements for the structures. For example, the cohort-component structure is primarily an accounting system; markets and SAMs combine accounting systems with equilibrating ones.

It will be useful to elaborate somewhat on the approach to demographic modelling and to use that elaboration as a basis for turning to social accounting matrices. Demographers have widely accepted the representation of demographic systems and the development of demographic models with cohort-component structures. Those structures have a standard form, normally representing 5-year cohorts of population differentiated by sex in three basic ways: by numbers in the age-sex cohorts, by fertility rates in them, and by mortality rates in them. In fact, the United Nations, the U.S. Census Bureau, and the International Institute for Applied Systems Analysis (IIASA), perhaps the three pre-eminent demographic forecasting institutions, all use cohort-component modeling (O'Neill and Balk 2001).

System/Subsystem	Demographic	Goods and Services	Financial
Organizing Structure	Cohort-Component	Market (GEM)	Market plus Socio-Political Transfers (SAM)
Stocks	Population by Age-Sex	Capital, Labor, Accumulated Technology	Government, Firm, Household Assets/Debts
Flows	Births, Deaths, Migration	Production, Consumption, Trade, Investment	Savings, FDI, Foreign Aid, IFI Credits/Grants, Government Transfers (pensions and other social expenditures)
Key Aggregate Relationships (Illustrative, not Comprehensive)	Life Expectancy (including HIV/AIDS) With Exogenous Technological Assumptions	Production Function with Endogenous Technological Change	Exchange Rate Movements With Net Asset/Current Account Levels
Key Agent-Class Behavior Relationships (Illustrative, not Comprehensive)	Household Fertility and Migration	Households and Work/Leisure, Consumption, and Female Participation Patterns; Firms and Investment; Government and Direct Expenditures	Household Savings/Consumption; Firm Investment/Profit Returns and FDI Decisions; Government Revenue, Expenditure/Transfer Payments; IFI Credits and Grants

**Table 1. Structure and Agent-Class Modeling of Demographics, Markets, and Financial Systems.**

The second and third elements in Structure-Based, Agent-Class Driven modelling are stocks and flows, which may remind many readers of systems dynamics. In demographic systems, the stocks are numbers of people in age- and sex-specific cohorts, while the flows are births, deaths, and migration. Systems dynamics would deal with the key relationships as auxiliaries, but econometrics would recognize them as equations that

require empirical estimation. Table 1 divides them into two categories: Key Aggregate Relationships (potentially represented multiple agents) and Key Agent-Class Behavioral Relationships. Life expectancy or mortality is a key aggregate relationship, clearly a function of income, perhaps education, and certainly of technological change. In contrast, fertility can be described as an agent-class behavioural relationship. In the case of fertility, there is one primary agent-class, namely households, whose behavior, as a function again of income, education, and technology, will change over time. Key Aggregate Relationships are often actually Agent-Class behaviors that have not yet been decomposed enough to represent in terms of specific agent classes. For instance, life expectancy is clearly a function of government and firm spending on R&D as well as household life-style choices; it could eventually be decomposed to the agent-class level.

It is important to say more about the emphasis placed on agent-class representations. First, they are important because they begin to represent elements amenable to human decision-making/choice. Ideally we would want all key relationships decomposed to that level, but doing so is a gradual process. Second, they truly are agent-class representations, to be differentiated from the micro agents of agent-based modeling. Although micro-agent modeling is laudable in more narrowly-focused models, global systems and structures are far too numerous and well-developed for such efforts to succeed across the breadth of concerns in world models, at least given contemporary modeling capabilities. Instead we focus on primary agent classes, especially households, firms, and governments, taking structures as given, albeit malleable, rather than emergent.<sup>4</sup>

In terms of the comments above, the cohort-component structure is a deep theoretically-based kernel of the demographic model, one which would seldom be altered in an open environment. In contrast, both key aggregate and agent-driven relationships should ideally be completely accessible to users for their replacement with theoretically and empirically stronger versions.

The second systemic and structural element in Table 1 is that of markets in goods and services. Again there are obvious stock and flow components of markets that are desirable and infrequently changed in model representation. Perhaps the most important key aggregate relationship is the production function. Although the firm is an implicit agent-class in that function, the relationships of production even to capital and labor inputs, much less to the variety of technological and social and human capital elements that enter a specification of endogenous productivity change (Solow 1957; Romer 1994), involve multiple agent-classes. In the representation of the market now in IFs there are also many key agent-class relationships as suggested by Table 1.

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<sup>4</sup> Debates around the relationships of structures and agents pervade all social sciences. In general, the literatures conclude that the two are mutually formative. Although there will normally be more dynamism in agent-class behaviour than in structures, it is important to recognize that structures also change.

### 2.3 The Structural Foundation of Social Accounting Matrices

The third systemic and structural element in Table 1 is financial flows, including those related to the market (like foreign direct investment), but extending also to those that have a socio-political basis (like government to household transfers). Once again, an increasingly widely-accepted approach to structural representation is the Social Accounting Matrix (SAM).

A SAM integrates a multi-sector input-output representation of an economy with the broader system of national accounts, also critically representing flows of funds among societal agents/institutions and the balance of payments with the outside world. Richard Stone is the acknowledged father of social accounting matrices, which emerged from his participation in setting up the first systems of national accounts or SNA (see Pesaran and Harcourt 1999 on Stone's work and Stone 1986). Many others have pushed the concepts and use of SAMs forward, including Pyatt (Pyatt and Round 1985) and Thorbecke (2001). So, too, have many who have extended the use of SAMs into new frontiers. One such frontier is the additional representation of environmental inputs and outputs and the creation of what are coming to be known as social and environmental accounting matrices or SEAMs (see Pan 2000). Another very productive extension is into the connection between SAMs and technological systems of a society (see Khan 1998; Duchin 1999).<sup>5</sup> It is fitting that the 1993 revision of the System of National Accounts by the United Nations has begun explicitly to move the SNA into the world of SAMs.

Once again, the structural system portrayed by SAMs is well represented by stocks, flows, and key relationships.<sup>6</sup> Although the traditional SAM matrix itself is a flow matrix, IFs has introduced a parallel stock matrix that captures the accumulation of assets and liabilities across various agent-classes. The dynamic elements that determine the flows within the SAM involve key relationships, such as that which constrains government spending or forces increased revenue raising when government indebtedness rises. Many of these, as indicated in Table 1 represent agent-class behavior.

In essence, this structural representation is an extension of the traditional general equilibrium formulations that surround SAMs. Again, Stone was a pioneer, leading the Cambridge Growth Project with Alan Brown. That project placed SAMs into a broader modeling framework so that the effects of changes in assumptions and coefficients could be analyzed, the predecessor to the development and use of computable general equilibrium (CGE) models by the World Bank and others. Some of the Stone work continues still with the evolution of the Cambridge Growth Model of the British economy

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<sup>5</sup> Faye Duchin, who worked with Wassily Leontief on the UN World Model in the 1970s, has been an active proponent of SAM-based analysis. She was instrumental as an early reviewer in the TERRA project in the decision to develop a SAM structure within IFs.

<sup>6</sup> Pentti Malaska of the Finland Futures Research Centre (FFRC) and the TERRA project has elaborated a perspective on modeling and documentation of models that involves synchronic and diachronic elements. His perspective has helped inform the discussion here.

(Barker and Peterson, 1987). Kehoe (1996) reviews the emergence of applied general equilibrium (GE) models and their transformation from tools used to solve for equilibrium under changing assumptions at a single point in time to tools used for more dynamic analysis of societies.

The approach described here is both within these developing traditions and an extension of them on five fronts. The first extension is in universality of the SAM representation. As noted, most SAMs are for a single country or a small number of countries or regions within them (see Bussolo, Chemingui, and O'Connor 2002 for a multi-regional Indian SAM within a CGE). The project here has created a procedure for constructing relatively highly aggregated SAMs from available data for 164 different countries, relying upon estimated relationships to fill sometimes extensive holes in the available data. Each SAM has an identical structure and they can therefore be easily compared or even aggregated (for regions of the world).

The second extension is the connecting of the universal set of SAMs through representation of the global financial system. Most SAMs treat the rest of the world as a residual category, unconnected to anything else. Because IFs contains SAMs for all countries, it is important that the rest-of-the-world categories are mutually consistent. Thus exports and imports, foreign direct investment inflows and outflows, government borrowing and lending, and many other inter-country flows must be balanced and consistent.

The third extension is a representation of stocks as well as flows. Both domestically and internationally, many flows are related to stocks. For instance, foreign direct investment inflows augment or reduce stocks of existing investment. Representing these stocks is very important from the point of view of understanding long-term dynamics of the system because those stocks, like stocks of government debt, portfolio investment, IMF credits, World Bank loans, reserve holdings, and domestic capital stock invested in various sectors, generate flows that affect the future. Specifically, the stocks of assets and liabilities will help drive the behaviour of agent classes in shaping the flow matrix

The fourth extension is temporal and builds on the third. The SAM structure described here has been embedded within a long-term global model. The economic module of IFs has many of the characteristics of a typical CGE, but the representation of stocks and related agent-class driven behaviour in a consciously long-term structure introduces a quite different approach to dynamics. Instead of elasticities or multipliers on various terms in the SAM, IFs seeks to build agent-class behaviour that often is algorithmic rather than automatic. Thus the World Bank as an actor or agent could base decisions about lending on a wide range of factors including subscriptions by donor states to the Bank, development level of recipients, governance capacity of recipients, existing outstanding loans, debt-to-export ratios, etc. Much of this kind of representation is in very basic form at this level of development, but the foundation is in place.

The fifth and final extension has already been discussed. In addition to the SAM, IFs also includes a number of other submodels relevant to the analysis of longer-term forecasts. For example as discussed above, efforts have been made to provide a dynamic

base for demographic and economic drivers of the IFs model such that forecasts can be made well into the 21<sup>st</sup> century. It is important to quickly emphasize that such forecasts are not predictions. Instead they are scenarios to be used for thinking about possible alternative longer-term futures.

### **2.3 The Presentation to Follow**

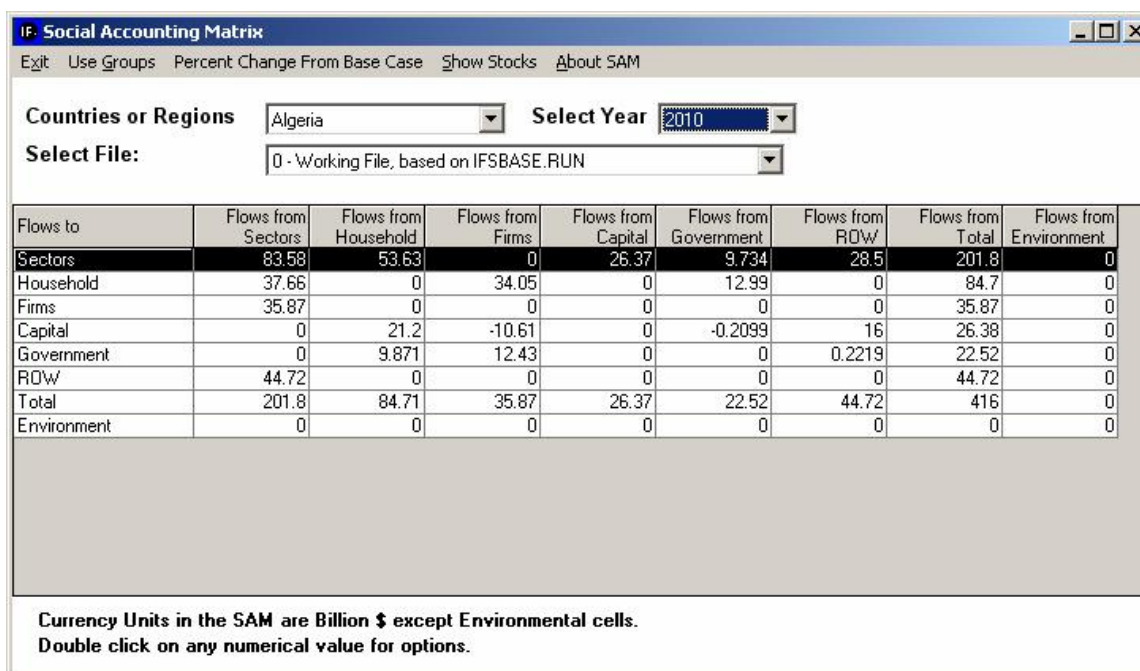
The next chapter of this report outlines in brief the basic elements of the SAM in this project and the way in which the SAM is integrated into the International Futures system, focusing on how it looks to the user of the system. Chapter 4 will then detail the construction and character of the system, beginning with the input-output matrices and continuing across social actors/institutions. Then Chapter 5 will turn to the actual use of the system for the study of long-term social support of human development.

### 3. An Overview of the Universal SAM

For details on the system, the eager reader can jump to the next chapter. This chapter gives a birds-eye view of the SAM structure within the IFs model, hopefully facilitating the more detailed look.

#### 3.3 Flows in the SAM

International Futures (IFs) has a menu-driven interface to facilitate investigation of the model's base case, creation of alternative scenarios, and exploration of an extensive data base via longitudinal and cross-sectional analysis. Figure 3.1 shows one of the specialized displays that the interface can generate from the base case or other scenario runs of the model, namely a basic social accounting matrix, this particular one being from the base case for Algeria in the year 2010. The matrix in that figure is in a standard, but rolled-up form, not showing any detail for individual economic sectors or household types. As the options on the screen may suggest, it is possible to move quite easily across years, to change the country or region selected, to aggregate the matrix for a grouping of countries (such as the European Union), or to compute the percentage change between the matrix for a new scenario and that of the base case.



**Figure 3.1. Rolled-Up Social Accounting Matrix (SAM) from IFs**

The convention for social accounting matrices is that each cell shows the flow from a column to a row. Thus we can see that governments provide households transfer payments of \$13 billion dollars while households provide government with \$9.9 in various forms of taxes or other payments.

It is also conventional to include in the upper left-hand cell some representation of economic sectors or commodities tied to basic input-output analysis, and then to augment



this with flows between those economic sectors and among several different categories of social agents or institutions. The most common of these agents or institutions is some representation of households, of firms/businesses, and of government. In addition we often see a representation of a capital account and of interactions with the rest of the world (ROW). In each case, the column and row totals should be the same for any category. The matrix above has added environmental rows and columns that will be developed over time as a SEAM is elaborated from the SAM, but those cells now contain only zeros. The values in those cells will, however, differ from other cells in that all other cells are monetary values and the environmental cells will represent physical units (such as thousand cubic meters of water input or tons of carbon output).

Clicking on any non-zero cell elicits a pop-up box (not shown above) with three options. The first is to obtain some information about the contexts of each cell, many of which have multiple underlying elements. The second is to expand the cell, if there are, in fact, multiple element rolled-up into the cell. For instance, clicking on the Sector by Sector column and selecting the expand option brings up the table in Figure 3.2. The IFs economic model in its current configuration (more on this in Chapter 4) represents 6 economic sectors, five fairly standard ones and a sixth (information/communications technology) that was created for analysis within the TERRA project sponsored by the European Commission. Again, we can see flows from any column sector to any row sector, such as \$3.3 billion from manufactures to energy.

	Agriculture	Energy	Materials	Manufactures	Services	ICTech
Agriculture	3.954	0.0044	0.017	1.302	1.141	0.0028
Energy	0.1891	4.961	0.3581	3.337	0.6477	0.0584
Materials	0.1267	2.25	3.168	4.686	0.61	0.0628
Manufactures	0.9449	7.236	0.8689	8.525	5.353	0.2634
Services	2.283	8.136	2.78	4.51	14.19	0.9094
ICTech	0.0342	0.0318	0.0754	0.0696	0.4243	0.0747

**Figure 3.2. Intersectoral Flow Elaboration.**

The second option provided when clicking on a cell is to see detail over time. Thus clicking on the firm column and government row (firm to government flows) and selecting that second option generates the table in Figure 3.3 (for whatever horizon the user has previously designated, potentially out to 2100). The three elaborated entries in Figure 3.3 are general taxes paid from firms to government, firm contributions to social security/pension schemes managed by the government, and indirect taxes.

	FIRMTAX[0]	FIRMGVSS[0]	INDIRECTTAX[0]
	Algeria	Algeria	Algeria
Year	Billion \$	Billion \$	Billion \$
2000	.609	.231	4.909
2001	.618	.234	4.982
2002	.711	.27	5.731
2003	.784	.297	6.315
2004	.911	.345	7.34
2005	1.021	.387	8.224
2006	1.088	.412	8.764
2007	1.182	.448	9.524
2008	1.23	.466	9.912
2009	1.266	.48	10.20
2010	1.317	.499	10.61
2011	1.308	.496	10.54
2012	1.395	.528	11.24
2013	1.416	.536	11.41
2014	1.47	.557	11.84
2015	1.581	.599	12.74
2016	1.603	.607	12.92
2017	1.716	.65	13.82
2018	1.823	.691	14.69
2019	1.849	.701	14.90
2020	1.946	.737	15.68
2021	2.014	.763	16.23
2022	2.081	.788	16.77
2023	2.136	.809	17.21
2024	2.205	.835	17.76
2025	2.279	.863	18.36

**Figure 3.3 Elaboration of Firm to Government Flows.**

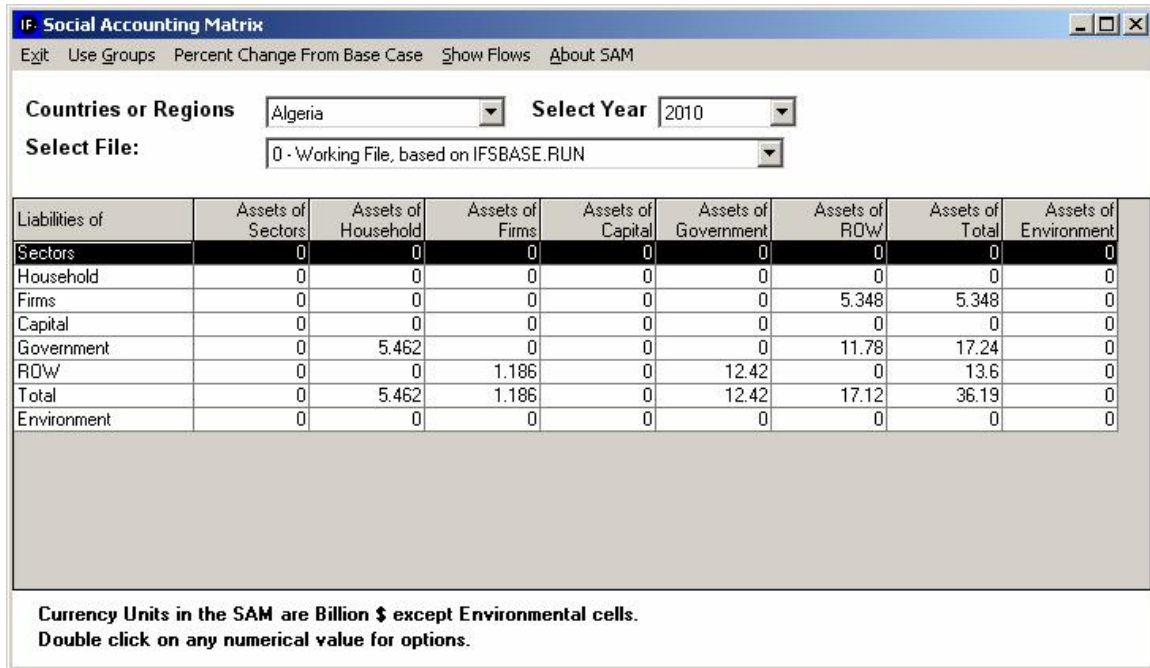
Algeria is one of the worst possible countries that could be selected for display of data from the modelling system, because so few data are available in the sources that IFs draws upon. Chapter 4 will discuss those data and the procedures used to generate base year (2000) and forecasted SAMs when data are scarce or poor.

### 3.2 Stocks in the SAM

As Chapter 2 discussed, many of the flows in the SAM augment or decrement underlying stocks. And many stocks, in turn, motivate agent-class behaviour that affects flows over time. Figure 3.4 shows the emerging stocks matrix that a model user can see by clicking on the Show Stocks toggle from the window shown in Figure 3.1. The options for

clicking to see explanations about cells, elaborations of them into underlying elements, and presentations of them over time are identical to the options for flows.

Chapter 4 will discuss the current state of construction of flow matrices, stock matrices, and the agent-class behavioural relationships. The traditional flow matrices are currently best developed.



### 3.3 Integration Within International Futures

Before turning to a description of the procedures underlying generation of the SAMs, it is useful to re-iterate that the SAMs are fully tied to the broader dynamics of the demographic, economic, and other sub-models of the IFs system. Figure 3.4 (generated using the more general display capability of IFs) shows a forecast for five of the many variables that are calculated in a run of the model. Population and population between the ages of 15 and 65 (the primary working years) come, of course, from the cohort-component demographic model. GDP comes from the economic model, as integrated with the SAM. In fact, the calculation of GDP is as the sum of the value added in each economic sector. The \$73.53 billion value shown for 2010 therefore must be and is equal to the sum of the deliveries of the sectors to households and firms shown in Figure 3.1.

	POP[0]	POP15T065[0]	GDP[0]	MFPRATET[0]	HDI[0]
	Algeria	Algeria	Algeria	Algeria	Algeria
Year	Mil People	Mil People	Billion \$	Annl Rate	Index
2000	30.40	18.12	48.82	-.01	.697
2001	30.96	18.62	49.54	-.005	.696
2002	31.52	19.13	51.79	-.005	.699
2003	32.09	19.63	52.55	-.004	.698
2004	32.67	20.13	55.33	-.002	.702
2005	33.25	20.64	58.68	-.002	.707
2006	33.83	21.15	60.69	.001	.71
2007	34.41	21.67	64.11	-.001	.715
2008	35.00	22.20	67.13	.002	.72
2009	35.58	22.73	69.81	.003	.724
2010	36.15	23.27	73.53	.004	.73
2011	36.73	23.80	74.80	.006	.731
2012	37.30	24.33	79.37	.006	.737
2013	37.87	24.86	82.24	.01	.741
2014	38.43	25.39	85.00	.01	.745
2015	38.98	25.92	90.68	.011	.753
2016	39.53	26.34	92.91	.013	.756
2017	40.06	26.76	97.28	.011	.761
2018	40.60	27.17	102.9	.013	.768
2019	41.12	27.58	104.3	.015	.769
2020	41.63	27.97	106.3	.011	.77
2021	42.13	28.38	107.3	.012	.769
2022	42.63	28.78	107.9	.012	.767
2023	43.12	29.16	108.0	.011	.765
2024	43.60	29.54	108.9	.011	.764
2025	44.07	29.90	111.1	.013	.766

**Figure 3.4. Variables Forecast by the Larger IFs System.**

The value of GDP is not, however, determined by the SAM which is simply an accounting of the flows indicated. Instead, the model has a Cobb-Douglas style production function that determines value added in each economic sector. As indicated above, following the insight of Solow and heeding the advice of Romer, there is a relatively elaborate endogenization of multifactor productivity (MFP) in that model equation. The fourth column shows a calculation of the aggregate growth in MFP in the base case (with Algeria represented in the base case as moving from poor rates in recent years to rates more in line with its potential as a developing country; such rates could easily be changed for a different scenario).

Finally, the last column in Figure 3.5 shows a forecast for the United Nations Development Program’s Human Development Index (HDI), which aggregates three sub-indices representing life expectancy, GDP, and educational expenditures/attainment. The first two inputs clearly are derived from the demographic and economic submodels of IFs, respectively. The third comes from a separate educational submodel that is effectively linked to both demographic and economic representations.

## 4. Details of Development and Structure

This chapter will provide information on the generation of initial or base year SAMs, as well as information on dynamics that generate SAMs in forecasts. To make the presentation and reading somewhat easier, the basic conceptual division of the chapter, consistent with the Structure-Based, Agent-Class Driven Modeling methodology, is:

- initializations of elements in the SAMs
  - flows (further divided by agent-class)
  - stocks
- computations of SAM elements over time
  - key relationships (aggregate and agent-class based)
  - equilibrating dynamics

As an introduction to all of this discussion, a brief survey of the model's "pre-processor" is in order.

### 4.1 IFs Pre-Processor: The SAM and More

Preparing an initial data load for a model sometimes requires almost as much work as does creating and maintaining the dynamics of the model. Data inconsistency and data holes require attention; in a model like IFs with physical representations of partial equilibrium sectoral models (agriculture and energy) as well as a general equilibrium multi-sector model represented in value terms, there is also the need to reconcile the physical and value data.

Creation of a data pre-processor within IFs moved the project from manual handling of issues around data loads to automatic, algorithm-based processing. The pre-processor greatly facilitates both partial data updates as better data become available and rebasing of the entire model to a new initial year (such as the rebasing from 1995 to 2000). It works with an extensive raw data file for all areas of the model, using data gathered for 1960 through the most recent year available. This allows it to create an historic data load (based in 1960) for the purposes of historic validation analysis, as well as the load for forecasting.

It is not the purpose of this paper to fully document the pre-processor, but a summary description is important. In general, the pre-processing begins with demographics, and imposes total population data on the cohort-specific data by normalizing cohort numbers to the total. The pre-processor reads values for a wide range of population-related variables: total fertility rate, life expectancy, HIV infection rate, literacy rate, etc. IFs uses cross-sectionally estimated relationships to fill holes in such data (generally with separate functions for the 1960 and 2000 data loads). Most often, functions driven by GDP per capita at PPP have had the highest correlations with existing data; the best functions have often been logarithmic, because the most rapid structural change occurs at lower levels of GDP per capita (Chenery 1979). The philosophy in demographics and in

subsequent issue areas in the pre-processor is that values for all 164 countries in IFs will come from data when it is available, but will be estimated when it is not.

The pre-processor then proceeds to the agricultural and energy issue areas. In agriculture, the pre-processor reads data on production and trade. It aggregates production of various crops into a single crop production variable used by the model. It similarly aggregates meat and fish production for the model. It computes apparent consumption. It reads data on variables such as the use of water and on the use of grain for livestock feed. It uses estimated functions or algorithms to fill holes and to check consistency (for instance, checking grain use against livestock herd and grazing land data).

In energy, the pre-processor reads and converts energy production and consumption to common units (billion barrels of oil equivalent). It checks production and reserve/resource data against each other and adjusts reserves and resources when they are inconsistent. Null/missing production values are often overridden with a very small non-zero value so that a “seed” exists in a production category for the subsequent dynamics of the model (a technique used by the Interfutures model of the OECD). World energy exports and imports are summed; world trade is set at the average of the two and country-specific levels are normalized to that average.

The outputs from processing of agricultural and energy data become inputs to the economic stage of pre-processing. The economic processing begins by reading GDP at both exchange rates and purchasing power and saving the ratio of the two for subsequent use in forecasting. The first real stages of economic data pre-processing center on trade. Total imports and exports for each country are read; world sums are computed and world trade is set at the average of imports and exports; country imports and exports are normalized to that global average. The physical units of agricultural and energy trade are read and converted to value terms. Data on materials, merchandise, service, and ICT trade are read. Merchandise trade is checked to assure that it exceeds food, energy, and materials trade, and manufactures trade is identified as the residual. All categories of trade are normalized. When this process is complete, the global trade system will be in balance. The use in IFs of pooled trade rather than bilateral trade makes this easier, but a similar process could be used for bilateral trade with Armington structures.

The processes for filling the SAM with goods and services production and consumption, and with financial flows among agent-classes follow next. They are the subject matter of the subsequent pages of this documentation.

After the cleaning and reconciliation of data and the filling of holes, the pre-processor aggregates data from the 164 countries into the specified regionalization of the world, a combination of countries/regions. The student edition provides a total of under 20 countries/regions. The professional edition provides up to 65. There is also a full 164-country version with no aggregation. Aggregation approach is variable-specific with four variations: sum, simple average, population-weighted average, and GDP-weighted average. The variable definition file of IFs specifies the appropriate variation for each variable.

## 4.2 Initializations of Flows in the SAM

The matrix below shows the conceptual structure of the universal SAM flow matrix, as it has guided data gathering and model implementation. Although work continues, most of the structure is implemented, as described below.

	Commodities	Household		Firms	Capital		Government	ROW	Total	
		Unskilled	Skilled							
Commodities	AX	Household Consumption, $C_U$ [Household Final Cons Exp-WDI]	Household Consumption, $C_S$		Gross Fixed Capital Formation, CF [Gross Fixed Cap Formation-WDI]	Changes in Inventories, CI [WDI]	Government Consumption, $C_G$ [Genl Govt Final Cons Exp-WDI]	Exports, E [Exports of Goods and services-WDI]	Total Demand	
Household	Unskilled	Value Addition, $V_U$		Dividends/Interest, $DI_U$ [(Firms' VA-Corporate Tax)*SkldLabShr]			SS Benefit, $SW_U$ [Social Sec Contr as % of Exp*UnSkldLabShr-GFSY]	Pension, $P_U$ [Exp on Pension as % of GDP-OECD]	Share of Income Receipts (Workers compensation) [Income Recept-WDI]	Household Income $HI_U$
		Value Addition, $V_S$		Dividends/Interest, $DI_S$ [(Firms' VA-Corporate Tax)*UnSkldLabShr]			SS Benefit, $SW_S$	Pension, $P_S$ Interest, $IP_H$ Interest [Pmt-WDI]		Household Income $HI_S$
Firms		Value Addition, $V_F$					Subsidy to Firms, $SB_F$ [WDI]	Interest, $IP_F$	FDI [WDI] Portfolio Invt, Equity [WDI] Share of Income Receipts (Investment income) [Income Recept-WDI]	Firm Income
Capital		Household Savings, $S_U$	Household Savings, $S_S$ [Tot HH Income-Tot HH Exp]	Firm Savings, $S_F$ [Tot Firm Income-Tot Firm Exp]			Government Savings, $S_G$ [Tot Govt Income-Tot Govt Exp]	Foreign Savings, $S_F$ (Outflow-Inflow)	Domestic and Foreign investment	
Government		Income Taxes, $T_U$	Income Taxes, $T_S$ [GFSY-IMF]	Corporate/Business Taxes, $T_F$ [GFSY-IMF]				Foreign Aid, $FA_R$ [Aid as % of GNP-WDI]	Interest $IP_R$ Interest [Pmt-WDI]	Government Revenue

		SS Taxes, $SS_U$	SS Taxes, $SS_S$ [Social Security Taxes-WDI]	SS Taxes, $SS_F$ [Social Security Taxes-WDI]				Portfolio Invt, Bond [WDI]	Fin. Flow from WB, IMF, others [WDI]	
				Taxes on goods and Services (Indirect Taxes), $T_G$ [WDI]						
ROW	Imports, M [Imports of Goods and services-WDI]	Share of Income Payments (Workers compensation) [Income Pmts-WDI]		Share of Income Payments (Investment Income) [Income Pmts-WDI]			Foreign Aid, $FA_D$ [Aid donation as % of GNP-OECD]			External Flows (Outflow)
							PPG Debt Service (Int + Principal) [WDI]			
Total	Total Supply	Household Expenditures		Firm Expenditures		Investment	Government Expenditures		External Flows (Inflow)	

### 4.2.1 Intersectoral Flows and Value Added

The starting point in generating the flow-based SAMs was to create input-output or technical coefficient matrices for each country. The three hurdles to be overcome were:

- few if any existing matrices have the sectoralization desired for IFs.



- there is no standard or readily available source for all countries
- it is important for longer-term forecasting to consider and represent how matrices might change over time

With respect to all of these issues, it was very useful to be able to turn to the IO matrices collected in the Global Trade Analysis Project, specifically Version 5 of the GTAP database. That database includes extensive data, including IO matrices, for 66 regions across 57 sectors. As in IFs, some of the GTAP regions are individual countries, others are aggregate regions. GTAP heavily represents agricultural sectors, as is consistent with the origins of the now global project at the agricultural economics department of Purdue.

Dimaranan and McDougall (2002) and contributors documented the most recent GTAP data. Remarkably, the project, begun only in 1992, has already produced its fifth version of data and can count 1200 global researchers as part of the GTAP consortium. Although the GTAP data by no means provide everything that was needed for the generation of universal SAMs, the project is aware of the utility of SAMs (Brockmeier and Arndt 2002) and, as we shall see, provided two primary data inputs.

The processing of the IO matrices from GTAP for this project involved several steps. First, the existing matrices from GTAP were collapsed into the six sectors of IFs using a concordance table mapping the 57 GTAP sectors into the six IFs sectors. Like the other steps, this was done with the “pre-processor” of IFs.

Second, a set of nine generic IO matrices were generated to represent the average technical coefficient pattern of countries at different levels of GDP per capita. The generic matrices were calculated as unweighted averages of matrices for all countries with GDPs per capita in categories established by lower-end breakpoints of \$0, \$175, \$375, \$750, \$1,500, \$3,000, \$6,000, \$12,000, and \$24,000. The assumption is obviously that countries at different GDP per capita levels typically use different types of technology. The resultant IO matrices bear this out in ways that seem intuitively plausible. Tables 4.1 and 4.2 show the technical coefficient matrices for extreme levels of GDP/capita, below \$100 and above \$24,000, respectively. Note, for instance, how much lower a share of manufactures goes into the agricultural sector in the richest countries relative to the poorest, and how much more of the IC sector goes back into the IC sector in richer countries.

	AG	RM	PE	MN	SR	IC
AG Sector	0.2624	0.0112	0.0008	0.0846	0.0194	0.0014
RM Sector	0.0041	0.0425	0.1571	0.0499	0.0087	0.0418
PE Sector	0.0048	0.2158	0.0265	0.0735	0.0119	0.0362
MN Sector	0.0522	0.0540	0.0687	0.1652	0.0774	0.0780
SR Sector	0.1847	0.2260	0.2177	0.1797	0.1721	0.1808
IC Sector	0.0026	0.0090	0.0040	0.0058	0.0105	0.0271

**Table 4.1 Generic IO Matrix for Countries with GDP/Capita Below \$100**



	AG	RM	PE	MN	SR	IC
AG Sector	0.3483	0.0005	0.0017	0.0133	0.0107	0.0004
RM Sector	0.0132	0.0366	0.1385	0.0186	0.0063	0.0067
PE Sector	0.0141	0.2660	0.0118	0.0823	0.0040	0.0287
MN Sector	0.0645	0.0614	0.0822	0.1812	0.0670	0.0856
SR Sector	0.1586	0.1786	0.1533	0.2004	0.2399	0.1632
IC Sector	0.0061	0.0093	0.0113	0.0156	0.0169	0.0966

**Table 4.2 Generic IO Matrix for Countries with GDP/Capita Above \$24,000**

Third, these generic matrices are used for two purposes. First, they are used for estimating values for countries in the GTAP data set. Second, they are used in the actual dynamic calculations of the model. As countries rise in GDP/capita, interpolations between matrices above and below their level allow us to gradually change the matrix representing each country. This dynamic character of IO matrices as forecasts unfold is an innovative characteristic of the IFs system; it was developed by the author for use in the economic model of the GLOBUS world modelling project (Hughes 1987).

GTAP also provides data on return to four factors of production in each sector: land, unskilled labor, skilled labor, and capital. These returns represent value added and are very important data for the value added blocks of the SAM. The pre-processor also collapses these values into the six sectors of IFs and computes generic shares of the factors in value added by GDP per capita category, using the same unweighted average technique used for the IO coefficients. Once again the generic value-added shares are used both to fill country holes in the GTAP data set and to provide a basis for dynamically representing changes in those shares as countries develop.

	AG	RM	PE	MN	SR	IC
Unskilled	0.2873	0.1544	0.1763	0.1378	0.2878	0.1721
Skilled	0.0063	0.0264	0.0384	0.0234	0.1325	0.1132

**Table 4.3 Generic Returns to Labor for Countries Below GDP/Capita \$100**

	AG	RM	PE	MN	SR	IC
Unskilled	0.1795	0.2146	0.0854	0.2159	0.2074	0.2054
Skilled	0.0386	0.0842	0.0952	0.1060	0.1715	0.1618

**Table 4.4 Generic Returns to Labor for Countries Above GDP/Capita \$24,000**

Again the changes across the levels of GDP/capita appear very reasonable. Note, for instance, the general shift of return to skilled from unskilled labor and the increase in returns to labor in total for the manufacturing and ICT sectors (at the expense of capital and other inputs).

#### 4.2.2 Other Sector-Specific Flows

The pre-processor then reads other expenditure components (household consumption, government consumption, and investment) as percentages of GDP from data files; it

again fills holes from relationships estimated cross-sectionally. It normalizes the three non-trade expenditures to GDP net of exports minus imports.

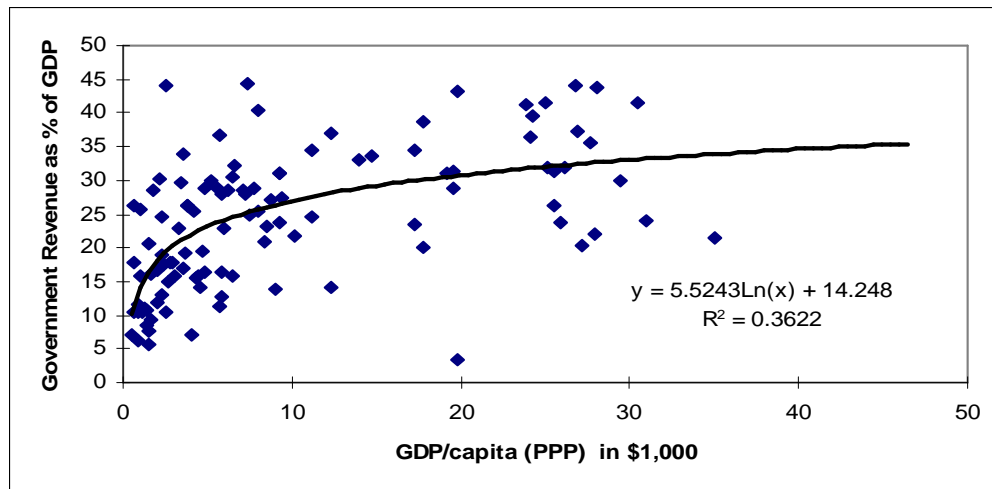
Data on value added as a percentage of GDP in agriculture, industry, manufactures, services, and ICT are read. Value added is assigned to raw materials and energy (this procedure predates the use of GTAP data which could be used for value added in all categories); all value added are normalized to GDP.<sup>7</sup>

Data on household consumption by sector were not available at the time of pre-processor construction. Values are assigned to sectors based on basic relationships to GDP per capita (recognizing the differences between superior and inferior consumption categories). Again, GTAP data could probably improve this process. Similarly, government consumption is assigned to manufactures and services, and investment to manufactures.

In terms of construction of SAMs, all information needed to compute sector rows and columns is available after the creation of the IO matrix, the treatment of trade for the rest-of-the-world cells, the specification of value added, and specification of consumption and investment expenditure totals with assignment to sectors. We can therefore turn to the flows among actors.

#### 4.2.3 Government-Specific Domestic Flows

Government flows are extensive and important, because this is an agent-class that figures prominently in scenario analysis. We begin by reading total government revenues as a portion of GDP. Data holes are filled via the estimated function shown in Figure 4.1.

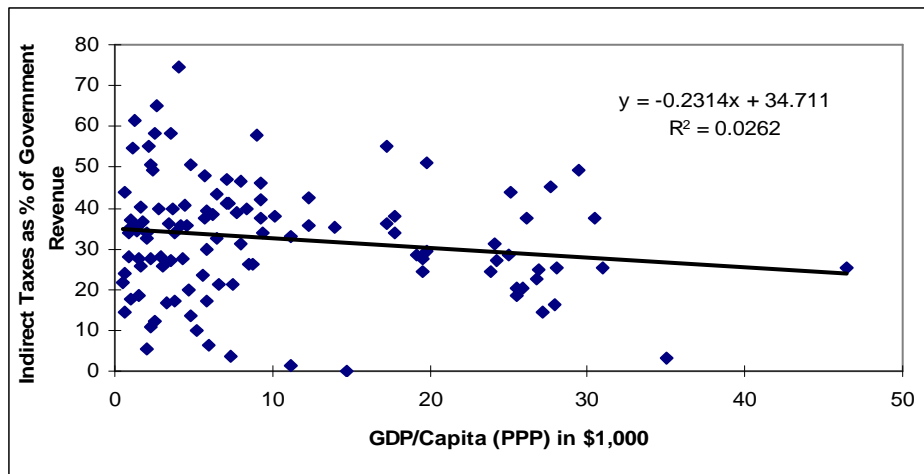


**Figure 4.1. Government Revenue Share as Function of GDP/capita (PPP)**

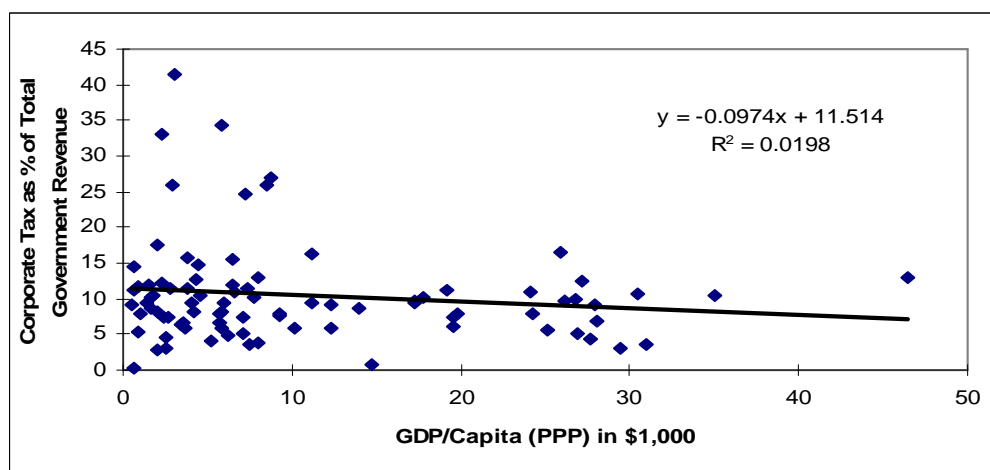
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<sup>7</sup> This step in the activities of the pre-processor appears unnecessary, because value added is recomputed in the first step of the model's actual computations. The step should be reviewed.

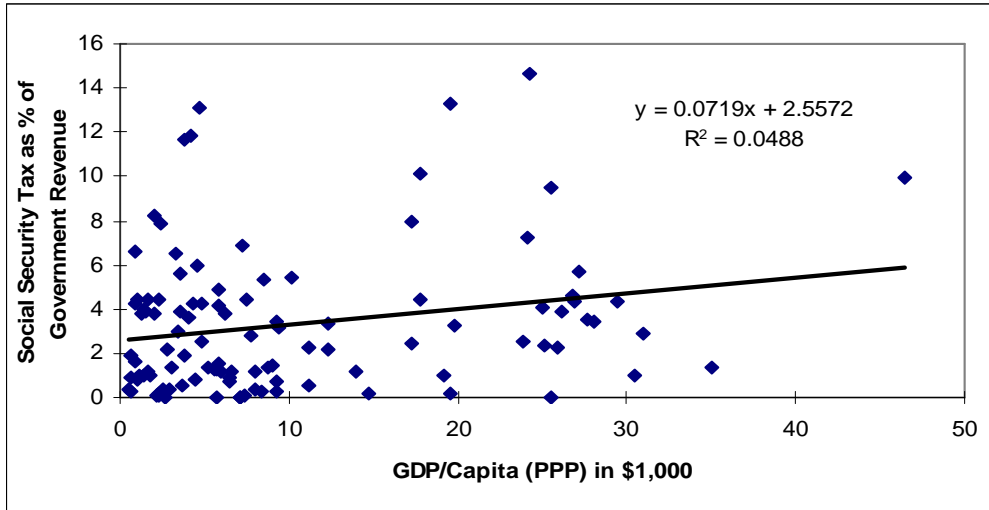
We then turn to the sources of that revenue, simplifying it into four major streams: indirect taxes, corporate taxes, social security/welfare taxes (from firms and households), and household taxes. Figures 4.2-4.4 show the typical share of indirect, corporate, and social security taxes, respectively in total government revenue. Data on total government revenues as a portion of GDP, on indirect taxes as a portion of government revenue, and Social Security/welfare taxes as a portion of government revenue come from the World Bank's World Development Indicators (2002). Data on corporate taxes come from the Government Finance Statistics Yearbook (1999). It is obvious from Figures 4.2-4.4 that there is not a strong relationship between tax shares and GDP per capita. Fortunately, the data on actual shares is quite extensive, so the functions need fill relatively few holes.



**Figure 4.2. Indirect Tax Share of Government Revenue as Function of GDP/capita (PPP)**



**Figure 4.3. Corporate Tax Share of Government Revenue as Function of GDP/capita (PPP)**

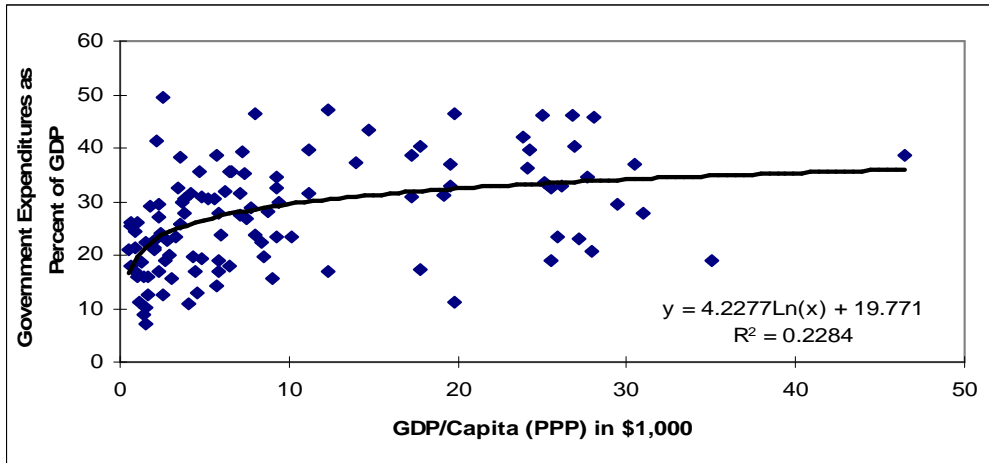


**Figure 4.4. Social Security/Welfare Tax Share of Government Revenue as Function of GDP/capita (PPP)**

The pre-processor computes the household tax share as the residual after the indirect, corporate/firm and social security tax shares are deducted from 100% of total government revenue. At this stage, identical household tax rates are being assigned to unskilled and skilled households (which implies no progressivity or regressivity in the tax rates computed as a share of income); we are looking for data on relative tax burdens, but absence of differentiation is not a bad initial working assumption.

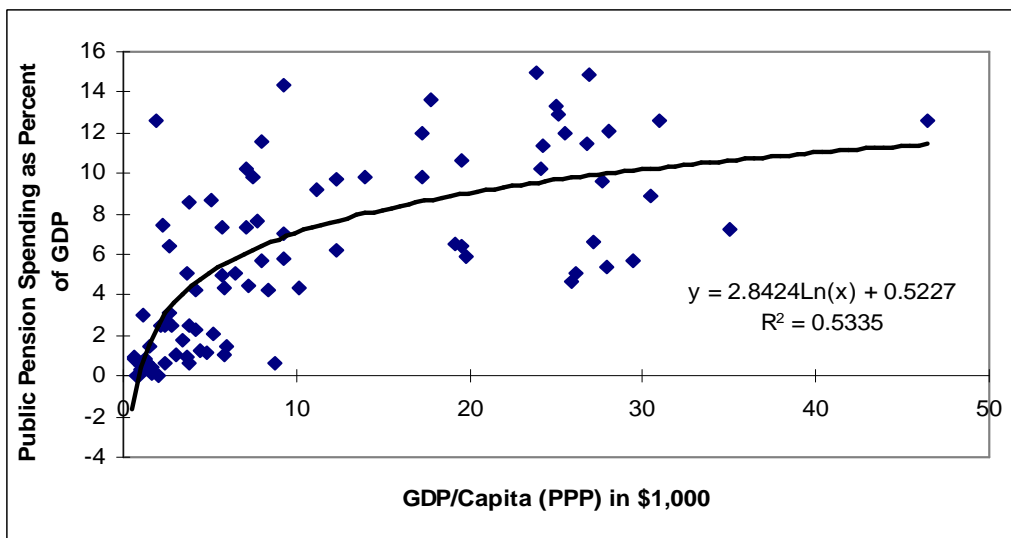
$$HHTaxShr_{r,h} = 100 - IndirectTaxShr_r - FirmTaxShr_r - SSWelTaxShr_r$$

Turning to the expenditure side, Figure 4.4 shows the function estimated cross-sectionally in order to fill the relatively few holes in government expenditures as a portion of GDP (again using data from the WDI 2002).



**Figure 4.4. Government Expenditure Share as Function of GDP/capita (PPP)**

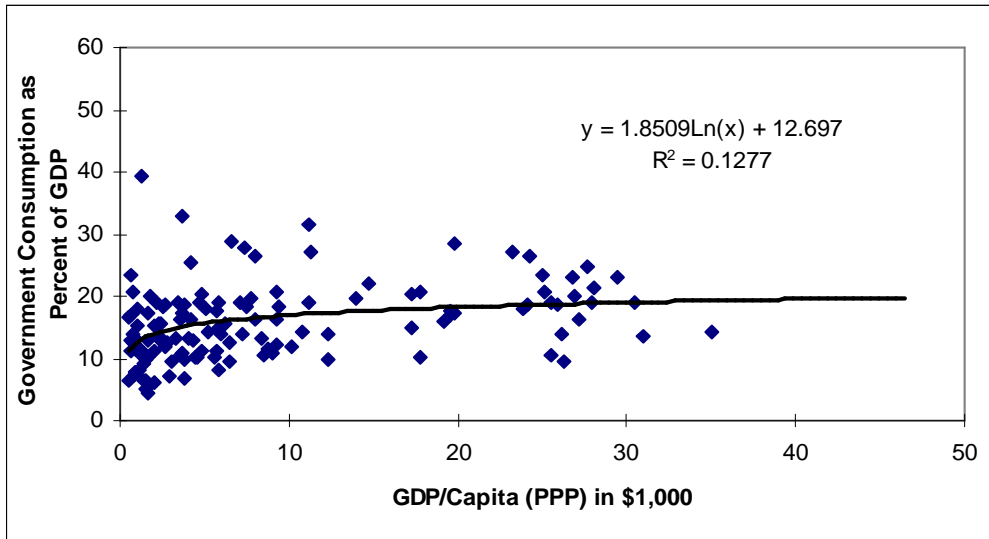
Government expenditures consist of a combination of direct consumption/expenditure and transfer payments. As a general rule, transfer payments grow with GDP per capita more rapidly than does consumption. And within transfer payments, pension payments are growing especially rapidly in many countries, especially more-economically developed ones. Figure 4.5 shows the relationship between GDP/capita and public spending on pensions as a percent of GDP (using data from a World Bank analysis of data drawn from OECD and other sources). This function is used to fill holes in the data set.



**Figure 4.5. Government Spending on Pensions as Function of GDP/capita (PPP)**

Because of its importance in and of itself, and as a check on government expenditure data we also look at government consumption data from the WDI 2002 and again fill holes

with a function estimated cross-sectionally (see Figure 4.6). Normally, of course, total expenditures of government will exceed consumption because of transfer payments and the pre-processor makes sure that expenditures are at least equal to consumption.

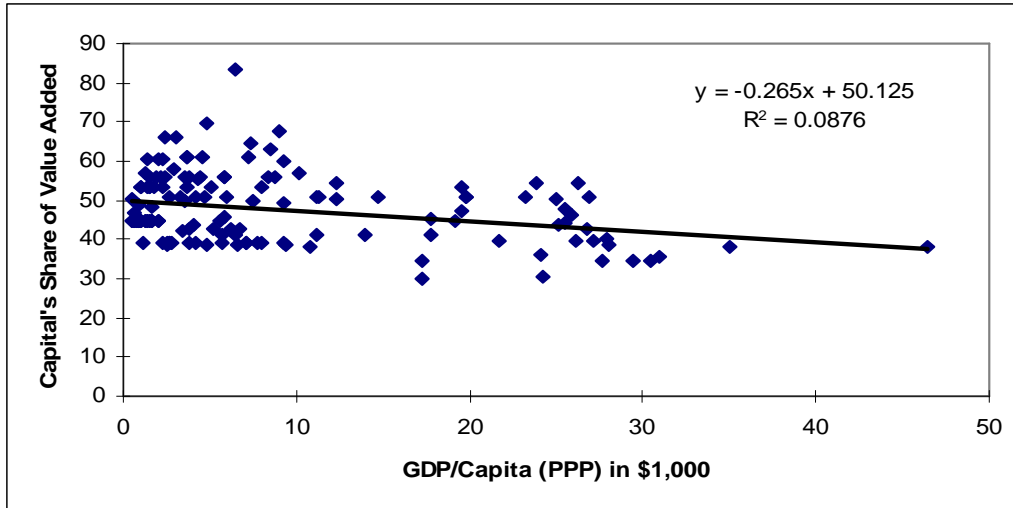


**Figure 4.6. Government Consumption Share as Function of GDP/capita (PPP)**

Before going to the next step we compute actual government consumption (GovCon).

$$GovCon_r = GDP_r * GovConShr$$

The pre-processor turns next to calculations of firm and household income shares in the total value added (summed across sectors the total value added is GDP by definition). Function 4.7 shows the tendency for capital's share to diminish a little at higher levels of GDP/capita, relative to labor's share. The data for that estimation came again from the GTAP database. The function is used to fill holes as necessary.



**Figure 4.7. Capital's Share of Value Added as Function of GDP/capita (PPP)**

The value of capital's share is carried by the Cobb-Douglas production function's capital parameter, alpha (CDALF).

$$FirmInc_r = GDP_r * CDALF$$

$$HHInc_r = GDP_r - FirmInc_r$$

Given shares of total tax revenue provided by firms and households, as well as collections for social security/welfare, the pre-processor can compute tax rates on income as the tax collections divided by income.

$$FirmTaxR_r = GovRev_r * FirmTaxShr / FirmInc_r$$

$$HHTaxR_{r,h} = GovRev_r * HHTaxShr_r / HHInc_r$$

$$SSWelTaxR_r = GovRev_r * SSWelTaxShr / (FirmInc_r + HHInc_r)$$

#### 4.2.4. Household and Firm Flows and Reconciliations, Recalculations

To this point, the pre-processor has computed most of what is needed for the government row and column in the initial SAM of flows. Moving more directly to households and firms is done in the first step of the actual model computations, which is, in essence, and extension of the pre-processor activities (these calculations in the first year of model run rather than in the pre-processor are a convenience that allows a number of the values computed in the first year to be more easily carried forward into the forecasting computations of the model).

Unfortunately, but unsurprisingly, data on IO matrix structures, sector-specific expenditures, and sector-specific value added that come into the first year of model computations are incompatible. Therefore one of the first steps of IFs computations is the computation of sector-specific value added, using sector-specific expenditures and an

inverted IO matrix to compute the gross production by sector. Gross production and the IO matrix are then used to compute value added by sector (VAdd).

Given value added by sector, it is possible to compute household income (before taxes and transfers) by sector, and as important, to divide household income into skilled and unskilled categories. The labor coefficients (LaborF) computed from the GTAP data base and displayed in the earlier Tables 4.3 and 4.4 allow that. Those sector-specific coefficients are weighted by sector-specific value added to compute the total income share going to unskilled and skilled households, respectively. Those shares are then multiplied in turn times the share of labor in GPD (as indicated by 1 minus the all-economy Cobb-Douglas coefficient on capital, computed as a sector-weighted average of the sector-specific coefficients) and that provides household income for each household type. Firm income is simply the remaining GDP (equivalent to the capital share).

$$HHINCSHR_{r,h} = \sum^S Vadd_{r,s} * LaborF_{r,h,s}$$

$$HHIncBTT_{r,h=1} = \frac{HHINCSHR_{r,h=1}}{HHINCSHR_{r,h=1} + HHINCSHR_{r,h=2}} * GDP_r * (1 - CDALF_r)$$

$$HHIncBTT_{r,h=2} = \frac{HHINCSHR_{r,h=2}}{HHINCSHR_{r,h=1} + HHINCSHR_{r,h=2}} * GDP_r * (1 - CDALF_r)$$

$$FirmIncBTT_r = GDP_r - HHIncBTT_{r,h=1} - HHIncBTT_{r,h=2}$$

Given income shares before taxes and transfers, it is possible to compute taxes and transfers, primarily using the tax shares computed in the pre-processor. A weakness of the system at this time is absence of a database to correctly allocate social security and welfare taxes between firms and households; the model now uses the same tax rate for both. That is not terribly significant, however, since firm income net of taxes will end up with households in any case.

$$FirmTax_r = FirmIncBTT_r * FirmTaxR_r$$

$$FirmGOVSS_r = FirmIncBTT_r * SSWelTaxR_r$$

$$HHTax_{r,h} = HHIncBTT_{r,h} * HHTaxR_{r,h}$$

$$HHGovSS_{r,h} = HHIncBTT_{r,h} * SSWelTaxR_r$$

One temporary simplifying assumption is that firms pass through all net income other than taxes to households in the form of dividends and interest (this will be changed very soon). In the absence of data on the distribution of dividends and interests between unskilled and skilled labor-based households, equations assign the overwhelming share of it to skilled households.



$$HHDivInt_{r,h=1} = (FirmIncBTT_r - FirmTax_r - FirmGovSS_r) * .1$$

$$HHDivInt_{r,h=2} = (FirmIncBTT_r - FirmTax_r - FirmGovSS_r) * .9$$

Now it is possible to return to the governmental account, summing total social security and welfare taxes from all sources and adding those to other taxes for a computation of total revenue before consideration of foreign aid (the revenue calculation should produce the same number as did the pre-processor).

$$SSWelTax_r = \sum^H HHGovSS_{r,h} + FirmGovSS_r$$

$$GovRevBA_r = \sum^H HHGovSS_{r,h} + FirmTax_r + SSWelTax_r$$

It is useful also to compute the overall tax rate as an output indicator.

$$TaxRa_r = GovRevBA_r / GDP_r$$

For aid recipients only, the amount of government receipts adjusts government revenues.

$$GovRev_r = GovRevBA_r + AID_r$$

In the first year of the model run, it is possible to compute government consumption using the same function used to fill holes in the pre-processor and then store the ratio of the computed value (EstGovtConsum) to the data/pre-processor value (GovCon). The ratio will be 1, of course, for all countries in which the pre-processor used the function, but will vary from 1 somewhat for countries providing data. The reason for doing this computation is to be able to advance government consumption with economic development in forecasts of subsequent years; the initial year's ratio maintains the tendency for a government to "over consume" or "under consume" relative to the cross-sectional function (a process to be elaborated later).

$$GovConR_r = \frac{GovCon_r}{EstGovtConsum_r * GDP_r}$$

Government to household transfers are the residual of government expenditures and consumption.

$$GovHHTrn_r = GovExp_r - GovCon_r$$

That allows computation of a ratio (GovHHTrnR) of actual transfer payments to the estimated one, analogously to the ratio for government consumption that was calculated above. The transfer payment ratio will facilitate forecasting of social security/welfare payments in future years.

$$GovHHTTrnR_r = \frac{GovHHTTrn_r}{EstGovHHTTrn_r * GovExp_r}$$

IFs divides transfers into pensions (targeting the elderly) and welfare payments (for needs across the population). Total pension payments (GovHHPenT) were calculated in the pre-processor, using data when possible and a function estimated cross-sectionally to fill the holes. In the first year IFs bounds that value so that the citizens above 65 years of age are not receiving an average of more than 100% of the GDP per capita. And another ratio, this time of total government pensions from the pre-processor to pensions estimated from the cross-sectional function, is stored for use in forecasts.

$$GovHHTTrnPenR_r = \frac{GovHHPenT_r}{EstGovtPensions_r * GDP_r}$$

Given total transfers and total pension payments, the total welfare payments are the residual.

$$GovHHWelTot_r = GovHHTTrn_r - GovHHPenT_r$$

Then IFs splits the pensions and welfare payments across household types according to their relative shares of income.

$$GovHHTTrnPen_{r,h} = GovHHPenTot * \frac{HHINC_{r,h}}{\sum^H HHINC_{r,h}}$$

$$GovHHTTrnWel_{r,h=1} = GovHHPWelTot * \frac{HHINC_{r,h}}{\sum^H HHINC_{r,h}}$$

Transfers per capita provide information that will be useful in future years. IFs stores pension transfers relative to the size of the population above 65 years of age and welfare transfers relative to the entire population.

$$GovHHPenPC_r^{t=1} = GovHHPenT_r / POPGT65_r$$

$$GovHHWelPC_r^{t=1} = \sum^H GovHHTTrnWel_{r,h} / POP_r$$

Having completed computations on revenue and expenditure, it is possible to compute the government balance, adjusted by foreign aid donations when given (for donors, the sign of AID is negative).

$$GovBal_r = GovRev_r - GovExp_r + AID_r$$

In subsequent years, the government balance, and more importantly the accumulation of annual government balances into a government debt term (explained later) will give rise to pressure for higher or lower levels of government revenues and expenditures. Those pressures will be conveyed via two multipliers applied to calculations of taxing and spending in subsequent years. Those multipliers are set at “1” in the first year, indicating no change in pressures initially.

$$MulRev_r = 1$$

$$MulExp_r = 1$$

Finally, it is possible to compute gross household income, adjusted by transfer payments and dividends. Again, transfers are divided equally between the two household types.

$$HHInc_{r,h} = HHIncBTT_r + GovHHTrn_r / 2 + HHDivInt_{r,h}$$

#### 4.2.5 International Financial Institution (IFI) Flows

The WDI 2002 database provides information on annual loans from the World Bank in two categories, those of the International Bank for Reconstruction and Development (IBRD) and those from the International Development Bank (IDA). The latter loans tend to have more concessional terms than do the former. Similarly, the database provides information on annual credits from the IMF, dividing them into concessional and non-concessional.

For the purposes of the SAM at this stage, the pre-processor sums the two types of loans and two types of credits into a total annual lending by the Bank and total credit flow from the IMF. Because these values tend to fluctuate substantially from year to year, and because the final years of the 1990s were a rather unusual period in global financial markets, the values set for initialization of forecasts were calculated from 5-year averages of loans and credits received as a percent of GDP from 1996 through 2000, with the average rate then applied to the GDP of developing countries in 2000.

Unfortunately, the data only indicate net flows. For purposes of the dynamics of the model, it will be important to distinguish repayment of loans or credits and interest on loans from new inflows. Net flows from the World Bank were decomposed into estimates of inflows (XWBLNFIN) and outflows (XWBLNFOUT) by estimating the value of repayments (outflows) based on the stock of loans from the Bank; initialization of stocks will be discussed below. The estimate of outflows assumed a 20-year life on loans and therefore 5% annual repayment, as well as a 3% interest rate. These parameters will be made flexible and will be changed as data become available. New inflows are then calculated as net flows minus the outflows. Exactly the same process was followed for IMF credits.

#### 4.2.6 Other International Agent-Specific Flows

The WDI 2002 database provides information on annual flows of foreign direct investment. Again a 5-year average was used to provide a more stable initial condition for forecasting. Fortunately, the WDI provides data both for net receiving countries (XFDIFIN) and net sending countries (XFDIFOUT). But because these do not necessarily yield the same totals for global inflows and outflows, the two sets of numbers were summed for their respective totals, true values were assumed to be the average, and inflows and outflows were normalized to that average.

Exactly the same process of 5-year averaging was used for annual portfolio investment into developing countries. Bonds and equity were summed to obtain a total portfolio investment flow. Unfortunately, the WDI data do not include outflow data for portfolio investment. Given inflow data summed across all recipients, outflows were assigned to more developed countries proportionally to their GDP.

### **4.3 Initialization of Stocks**

Governments, both domestic and international, tend primarily to collect flow information. Because most flows involve some kind of transaction in a given year, they are easier to track than stocks. As argued earlier, however, stocks frequently help determine flows via their relationships to agent-class behavior. Modelers of goods and service markets have long recognized this, and added stocks to their models in spite of data difficulties. For instance, they integrate investment series over time and make assumptions about depreciation in order to estimate capital stocks for the production function. It is often necessary to be similarly creative with respect to the stocks of the broader SAM. Frequently only flows are available, forcing an integration process. In other cases, stocks are only available for a subset of countries (for instance, recipients of portfolio investment), requiring assumptions about the countries of origins of those investments. Specifically, stocks of assets in countries of origin for cross-border flows must be equivalent in total to the liabilities of foreign-owned investment in countries of destination.

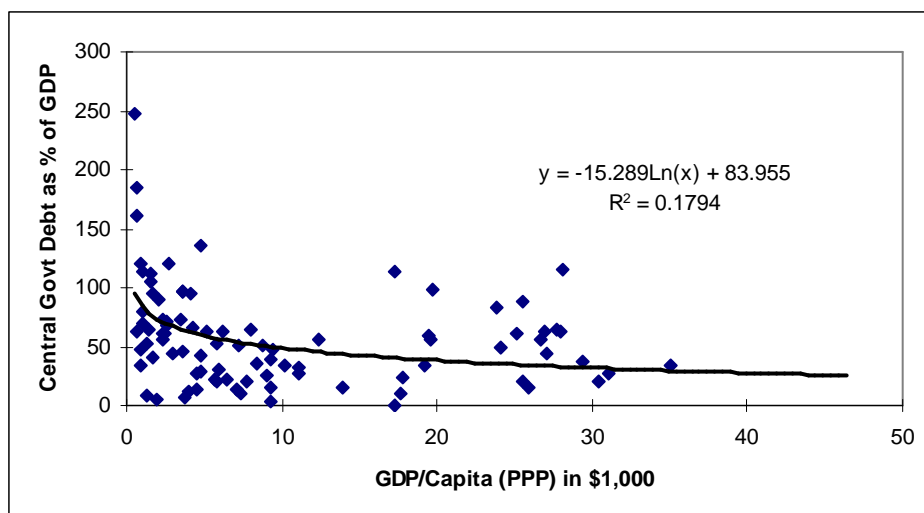
Our stock framework has thus been developed with the asset-liability concept of standard accounting method. The stock framework is also an extension of the social accounting flow matrix, and the cumulative flows over time among the agents will determine the stocks of assets or liabilities for all agents. If the inflow demands repayment or return at some point in future, it is considered as liability for that agent and an asset for the agent from which the flow came. For example, in our framework, if a government receives loans (inflow) from other countries, the stock of those loans is a liability for the recipient government and an asset for the country or countries providing the loans.

The matrix below shows the structure of the SAM stock matrix, most of which has now been implemented. We have tried to maintain consistency between the stock and flow matrices. When we read a particular cell, the figure is an asset for the corresponding column agent, while it is liability for the corresponding row agent.

Asset ↗ Liab ↓	Commodities	Household	Firms	Capital	Government	ROW	
<b>Assets</b>							
Commodities							Comm
Household							Household
Firms		Corporate Bonds/Debentures	Corporate Equity			Private Nonguaranteed Debt	FDI from abroad Portfolio Invt, Bond to abroad Portfolio Invt, Equity to abroad
Capital		HH accumulated Savings	Firms' accumulated Savings		Public Sector Inv/Govt accumulated Savings	Foreign accumulated Savings	Capital
Government						External Debt	Government
						Short Term	Long Term
						Concessional	IFIs NonCessional
ROW			Private non guaranteed debt	FDI to ROW		Loan Short Term	Long Term
			Portfolio Invt, Equity to ROW	Portfolio Invt, Bond to ROW		Reserves	
Total	Comm	Household	Firms	Investment	Government	ROW	

The first step in the initialization of the stocks within the pre-processor is the processing of data on total external debt of countries. The raw data came from the WDI 2002. Null values for developing countries are filled with zeros. Unfortunately, external debt data from the WDI are for developing countries only and there are no corresponding asset data for the lending countries, presumably mostly developed countries. As in other such instances, the pre-processor now assigns the total of external debt of developing countries to developed countries, defined for this purpose as countries with no external debt indicated and GDP per capita of \$10,000 or more. The assignment is proportional to GDP of the more developed countries. Both the presumption that more developed countries are primarily asset holders and the proportional assignment are clearly inaccurate. The rationale for both is that the resultant stock assumptions, on average, are almost certainly better than assumptions that asset stocks of such countries are uniformly zero. Further, the dynamics of the model will be more greatly determined by change in stocks from initial levels than by the absolute values of them. Nonetheless, data on these assets would be highly desirable.

The next step is reading total governmental debt (TotGovtDebt) and filling holes in it. Again the raw data are from the WDI 2002 dataset. Although they are central government debt, most debt is held by central governments. Figure 4.x shows the cross-sectionally estimated function for filling holes.



**Figure 4.x. Central Government Debt as a Function of GDP/Capita**

The next step is the reading of publicly-guaranteed and not-guaranteed debt, both of which are assumed to be held by firms and which are summed to obtain total external firm debt (XFirmDebt). Holes are filled with zeros because levels of debt are often very small and non-reporting often will imply debt levels near zero. Because the data only cover stocks of debt held by developing countries as liabilities, the stocks as assets were once again allocated to developed countries, specifically to firms within them, according to GDP size.

Not all of government debt is external. In fact, especially for developed countries, households and firms often hold much of it. In order to divide government debt between foreign and domestic holders of it, we first compute government external debt. This is done by assuming that households do not have any real external debt, so that all external debt not assignable to firms is governmental external debt.

$$XGovtDebt_r = XDebt_r - XFirmDebt_r$$

The assumption was again made that all of this debt should be assigned as assets to governments in developed countries. Rather than assigning it on the basis of GDP, however, it was assigned on the basis of overseas development assistance (ODA). The WDI 2002 dataset has data on ODA [or did we get it from OECD?]. Because significant portions of ODA come as loans rather than grants, the assignment of the government asset offset of developing government debt based on the size of ODA makes sense.

Governmental domestic debt is calculated as total government debt minus the external stock.

$$GovtDebtD_r = TotGovtDebt_r - XGovtDebt_r$$

The WDI 2002 data set contained data on reserve holdings (XRESERVES). These are read by the pre-processor and null values are assigned zeros.

The pre-processor turns next to lending of the World Bank and credits from the IMF, collectively the International Financial Institutions (IFIs). It again uses WDI 2002 data for initial conditions of total loans held by borrowing countries (XWBLOANS). Nulls are filled with zeros. The same is done for IMF credits (XIMFCREDIT). In both cases, it is assumed that the bulk of funds loaned by the two IFIs come from subscriptions that ultimately constitute assets of developed countries. The pre-processor assigns assets by size of GDP, as with external debt.

Turning to foreign direct investment, UNCTAD's annual World Investment Report had some data on stocks, but they proved very difficult to obtain electronically [Anwar please confirm/deny this sentence]. We therefore turned once again to WDI 2002, in spite of the fact that the source provides only flows. It does, however, basically provide both net inflows and net outflows. Integrating these from 1970 through 2000, on the assumption that there was relatively little FDI prior to 1970, provided estimates of stocks that seemed fairly reasonable when checked against some of the UNCTAD stock data. The result was initialization of FDI stocks from abroad (XFDISTOCK) and FDI stocks held abroad (XFDISTOUT). These do not necessarily yield the same totals for global assets and liabilities. Therefore, the two sets of numbers were summed for their respective totals, true values were assumed to be the average, and country-specific assets and liabilities were normalized to that average.

With respect to portfolio investment, WDI provides flow data on both bond and equity investment. Again these were integrated from 1970 through 2000 to obtain estimates of portfolio stocks held in developing countries (XPORTFOLIO). Unfortunately, the WDI provided only flows into developing countries and again the data fail to account for the source of the flows. Therefore the asset balances were assigned by GDP weight to developed countries (XPORTSTOUT).

#### **4.4 SAM Computation in Subsequent Years**

Although domestic and international elements of the SAM are fully integrated, there is some conceptual benefit in separating the discussion of the dynamics of the two. Obviously, the domestic dynamics do not demand the same attention to global balancing of inflows and outflows that the international dynamics require.

In discussion of both sets of dynamics, it is useful to keep in mind the Structurally-Based, Agent-Class Driven methodology presented earlier. We have discussed stocks and flows. We turn now to the key relations that determine their dynamic relationship. As indicated earlier, those tend to fall roughly into two types: key aggregate relationships and key agent-class behavioural relationships.

#### 4.4.1 Domestic Dynamics Around the SAM

The structural base of the SAM system within IFs has a strong accounting character, with requirements that flows balance within and across countries, and also that stocks of assets and liabilities balance. In addition, however, the dynamic representation of SAMs within IFs introduces the need for equilibrating elements within the underlying structure, just as single-country SAMs are traditionally integrated with CGE models.

In the case of IFs, there are two key equilibrating subsystems linked to the SAM structure. The first is for the goods and services markets that bind together production, consumption, and exchange of goods and services. The production function is a key aggregate relationship in that sector, providing value added by sector, and being responsive to a range of variables including energy shortages and trade openness. In markets for goods and services, inventories and changes in capacity utilization serve buffering roles in the shorter-term, while changes in prices and investment patterns equilibrate markets in the longer-term. This general equilibrium model (GEM) structure is described in the Help system of IFs.

The second equilibration subsystem is for assets and liabilities. Each agent-class accumulates assets and liabilities over time and these, along with immediate income or revenues, determine their behaviour. At this point in the elaboration of the SAM structure within IFs, there is no representation of equilibration processes for households and firms, but there are representations for governments and for aggregate countries in the global financial system. The discussion within this section and the next, focusing on international dynamics, will weave together explanation of agent-class behaviour and equilibrating systems. In this section we begin with household and firm behaviour and then move to government behaviour and asset-liability equilibration.

##### Households

The core computations of the terms for the SAM in years beyond the base are not fundamentally different from those in the first year, but in most cases there are additional terms in them that introduce dynamic elements and/or allow interventions by the model user. The introduction of terms begins with the addition of a skill shift term to the computation of household income shares for unskilled and skilled households. The basis for the term is a presumption that over time there is a greater demand for skilled labor and a commensurately lower demand for unskilled labor. The rate of annual change has been initially set at 1%, corresponding approximately to the core level of change in multifactor productivity (analysis suggests that the rate might be a little low). There is much room for endogenization and refinement of this highly aggregate and rough specification.

Other than the additional term, the equations for computation of household shares of total value added (HHINCS<sub>hr</sub>) and of actual income before taxes and transfers (HHINCBTT) are the same as those used for initialization.



$$SkillShiftMul = 1.01^{t-1}$$

$$HHINCShr_{r,h=1} = \sum^S Vadd_{r,s} * LaborF_{r,h,s} / SkillShiftMul$$

$$HHINCShr_{r,h=2} = \sum^S Vadd_{r,s} * LaborF_{r,h,s} * SkillShiftMul$$

$$HHIncBTT_{r,h=1} = \frac{HHINCShr_{r,h=1}}{HHINCShr_{r,h=1} + HHINCShr_{r,h=2}} * GDP_r * (1 - CDALF_r)$$

$$HHIncBTT_{r,h=2} = \frac{HHINCShr_{r,h=2}}{HHINCShr_{r,h=1} + HHINCShr_{r,h=2}} * GDP_r * (1 - CDALF_r)$$

The flow of computation actually passes back and forth across households, firms, and the government, because each requires information about flows from the other. To simplify the presentation here and to focus on agent-classes, we continue with the central elements of household specification.

One temporary simplifying assumption is that firms pass through all net income other than taxes to households in the form of dividends and interest (this assumption will be changed). In the absence of data on the distribution of dividends and interests between unskilled and skilled labor-based households, equations assign the overwhelming share of it to skilled households.

$$HHDivInt_{r,h=1} = (FirmIncBTT_r - FirmTax_r - FirmGovSS_r) * .1$$

$$HHDivInt_{r,h=2} = (FirmIncBTT_r - FirmTax_r - FirmGovSS_r) * .9$$

Household taxes parallel the first year, but with multiplier additions.

$$HHTax_{r,h} = HHIncBTT_{r,h} * HHTaxR_{r,h} * govrevm_r * MulRev_r$$

$$HHGovSS_{r,h} = HHIncBTT_{r,h} * SSWelTaxR_r * govrevm_r * MulRev_r$$

Ultimately, after also obtaining information from the government concerning transfers to households, it is possible to compute household income adjusted by transfer payments and dividends. Again, transfers are divided equally between the two household types.

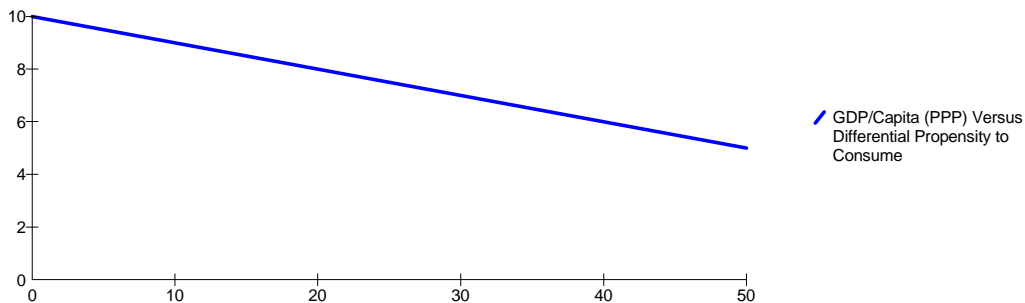
$$HHInc_{r,h} = HHIncBTT_r + GovHHTrn_r / 2 + HHDivInt_{r,h}$$

One of the key behavioural relationships for households is the division of income between consumption and savings. Given historic data, the pre-processor was able to compute an average consumption propensity for each country.

$$AveConsumR_r = \frac{C_r}{\sum^H HHInc_{r,h}}$$

IFs introduces a price responsiveness into consumption propensity over time, as explained in the Help system documentation for the goods and service market. In addition, however, it is important for the SAM to distinguish between consumption propensity of different household categories, currently limited to skilled and unskilled households. If both types of households consumed an equivalent share of income, they would consume at the average rate, as modified by price elasticity.

Almost certainly, lower income, unskilled households have a higher average propensity to consume than do skilled households. In the absence of data-based knowledge about that, IFs currently uses the stylistic, and flexibly changeable function in Figure 4.7 to represent the extent of that differential, assumed to decrease as GDP/capita increases.



**Figure 4.7. Differential Propensity of Unskilled Households to Consume – Increased Percentage of Income Consumed as a Function of GDP per Capita (PPP) in \$1,000.**

The consumption differential from the function adjusts the average rate for unskilled households and allows computation of actual consumption (Consum) of the unskilled and a residual calculation of consumption for the skilled (subject to tests for positive sign and reasonable size, not shown below).

$$AveConsumptionR_{r,h=1} = AveConsumR_r + ConsumDiffR_r$$

$$Consum_{r,h=1} = HHInc_{r,h=1} * AveConsumptionR_{r,h=1}$$

$$Consum_{r,h=2} = C_r - Consum_{r,h=1}$$

The differential propensity to consume is an important feature for scenario analysis, because transfers across household types are one of the key policy levers available to governments.

Savings terms are calculated as residuals for all agent classes, and are determined after all income and expenditure/transfer calculations. In the case of households they are income, minus consumption and net transfers to government.

$$HHSav_{r,h} = HHInc_{r,h} - Consum_{r,h} - HHTax_{r,h} - HHGovSS_{r,h}$$

As noted already, IFs does not attempt to track assets and liabilities of households over time and to add that information to the behavioural representation of them. That might be useful in the future.

### Firms

Turning to firms, basic income before taxes and transfers is most easily calculated as the share of GDP (sum of value added) that households do not receive.

$$FirmInc_r = GDP_r - HHIncBTT_{r,h=1} - HHIncBTT_{r,h=2}$$

Two terms are added to the computation of firm taxes over time, relative to their specialization in the initialization. The first is an exogenous firm tax rate multiplier (*firmtaxm*) that is open for scenario manipulation. The second is an endogenous multiplier of revenue term (*MulRev*) that is determined by change in government balances and debt levels. (By convention, IFs represents completely exogenous terms in lower case script; multipliers available for scenario manipulation end with “m”.)

$$FirmTax_r = FirmInc_r * FirmTaxR_r * firmtaxm_r * MulRev_r$$

Indirect taxes are completely parallel.

$$IndirectTax_r = FirmInc_r * IndirectTaxR_r * indirettaxm_r * MulRev_r$$

Firm payments of social security/welfare taxes to the government have the same types of added terms relative to calculation in the base year.

$$FirmGOVSS_r = FirmIncBTT_r * SSWelTaxR_r * ssweltaxm_r * govrevm_r * MulRev_r$$

Firm savings are a simple calculation of income minus transfers to households and government. Because of the simplifying assumptions about dividends and interest described earlier, these will now be zero; the pass through of firm income to households will be revisited.

$$FirmSav_r = FirmInc_r - \sum^H HHDivInt_{r,h} - FirmTax_r - IndirectTax_r - FirmGovSS_r$$

### Government Revenues

As with households and firms, we can begin understanding government as an agent-class by looking at revenues and then moving to expenditures. Ultimately, we need to return to the balance of those two and to equilibrating mechanisms around the balance.

Various taxes on households and firms were shown above and are aggregated for government revenues, before adjustments for foreign aid. With net foreign aid, we have total government revenue.

$$SSWelTax_r = \sum^H HHGovSS_{r,h} + FirmGovSS_r$$

$$GovRevBA_r = \sum^H HHGovSS_{r,h} + FirmTax_r + SSWelTax_r$$

$$TaxRa_r = GovRevBA_r / GDP_r$$

$$GovRev_r = GovRevBA_r + AID_r$$

### Government Expenditures

Computation of government consumption (direct expenditures on the military, education, health, R&D, foreign aid, and other categories) begins with use of the function to compute an estimated government consumption (EstGovtConsum) as a portion of GDP, using GDP per capita (PPP) as the driver. The initialization discussion showed that function. It carries a behavioural assumption of generally increasing expenditures with increases in GDP per capita.

The estimated value then enters a convergence calculation that IFs uses in a number of instances. In the first year a ratio term (GovConR) was computed that represented the degree to which a country's consumption/GDP differed from the estimated value. That ratio multiplies the estimated term in future years, allowing the function normally to increase consumption/GDP as GDP per capita rises. At the same time, such divergence from estimated functions is almost as often a matter of data inadequacy or of temporary factors for a country as it is of persistent idiosyncrasy. The convergence function allows the country/region's value to converge towards the functional calculation over a period of time (govfinconv), usually quite long. Such convergence also helps avoid ceiling effects (e.g. government consumption as 100% of GDP) as GDP per capita rises.

The second term in the equation below is called the Wagner term, after the discoverer of the long-term behavioural tendency for government consumption to rise as a share of GDP, even at stable levels of GDP per capita. This is built into the consumption calculation through an exogenous parameter (wagnerc) that is multiplied by the number of the forecast year.

$$WagnerTerm = 1 + t * wagnerc$$

$$GovCon_r = Converge(EstGovtConsum_r * GovConR_r, EstGovtConsum_r, govfinconv) * WagnerTerm * govexpm_r * MulExp_r$$

Almost finally, government consumption is further modified by an exogenous multiplier of government expenditures, allowing the user to directly control it by country/region and by an endogenously computed multiplier on expenditures that, parallel to MulRev, reflects the balance or imbalance in government expenditures and the debt level. Finally, and not shown, there is a simple adjustment to reflect the affect that changing levels of foreign assistance receipts can have on consumption.

The division of government expenditures into target categories is described in the Help system of the model. That division is, of course, also a key agent-class behaviour.

Government transfers, as distinguished from direct consumption expenditures, are computed using two different behavioural logics, a top-down one like the one for government consumption, and a bottom-up logic. The bottom-up logic is especially important in the analysis of pensions, because it is responsive to the changing size of the elderly population.

The top-down logic again uses an aggregate function responsive to changes in GDP per capita.

$$WagnerTerm = 1 + t * wagnerc$$

$$GovHHTrnTop_r = Converge(EstGovtHHTrn_r * GovHHTrnR_r, EstGovtHHTrn_r, govfinconv) * WagnerTerm * govexpm_r * MulExp_r$$

The top-down logic also computes an estimate of pension expenditures using a function estimated cross-sectionally, multiplying that by the ratio of empirical/estimated values computed in the first year.

$$GovHHTrnPenTop_r = EstGovtHHTrnPen_r * GovHHTrnPenR_r^{t=1} * MulExp_r$$

The bottom-up logic looks at the number of people above age 65, and multiplies that number by per capita pension benefits in the first year, adjusted for the increase in GDP per capita. Ideally, this calculation should be adjusted for changing retirement ages, which are becoming younger and thereby further increasing pressure for pensions.

$$GovHHTrnPenBottom_r = PopGT65_r * GovHHPenPC_r^{t=1} * \frac{GDPPC_r}{GDPPC_r^{t=1}} * MulExp_r$$

The larger of the two numbers indicates the total pressure in the system for public pensions.

$$GovHHTrnPenResolved_r = AMAX(GovHHTrnPenTop_r, GovHHTrnPenBottom_r)$$

The bottom-up calculation of welfare transfers is parallel to that for pensions.

$$GovHHTrnWelBottom_r = Pop_r * GovHHWelPC_r^{t=1} * \frac{GDPPC_r}{GDPPC_r^{t=1}} * MulExp_r$$

The two transfer pressures are summed and compared with the total, top-down estimate of transfers, with the maximum of the two terms used as total transfers.

$$GovHHTrn_r = AMAX(GovHHTrnTop_r, GovHHTrnPenResolved_r + GovHHTrnWelBottom_r)$$

A proportionate share of the total transfers constitutes pensions, and welfare transfers are the residual.

$$GovHHPenT_r = GovHHTrn_r * \frac{GovHHTrnPenResolved_r}{GovHHTrnPenResolved_r + GovHHTrnWelBottom_r}$$

$$GovHHWelTot = GovHHTrn_r - GovHHPenTot$$

The split to unskilled and skilled households can be affected in subsequent years by exogenous multipliers (default values of multipliers are typically “1”).

$$GovHHTTrnPen_{r,h} = GovHHPenTot * \frac{HHINC_{r,h}}{\sum_H HHINC_{r,h}} * govhhtrnpenm_{r,h}$$

$$GovHHTTrnWel_{r,h} = GovHHPWelTot * \frac{HHINC_{r,h}}{\sum_H HHINC_{r,h}} * govhhtrnwelm_{r,h}$$

It is now possible to sum direct consumption and transfers as total government expenditures.

$$GovExp_r = GovCon_r + GovHHTrn_r$$

#### Government Balance and Equilibrium Seeking

The pieces are now in place for computation of the government balance.

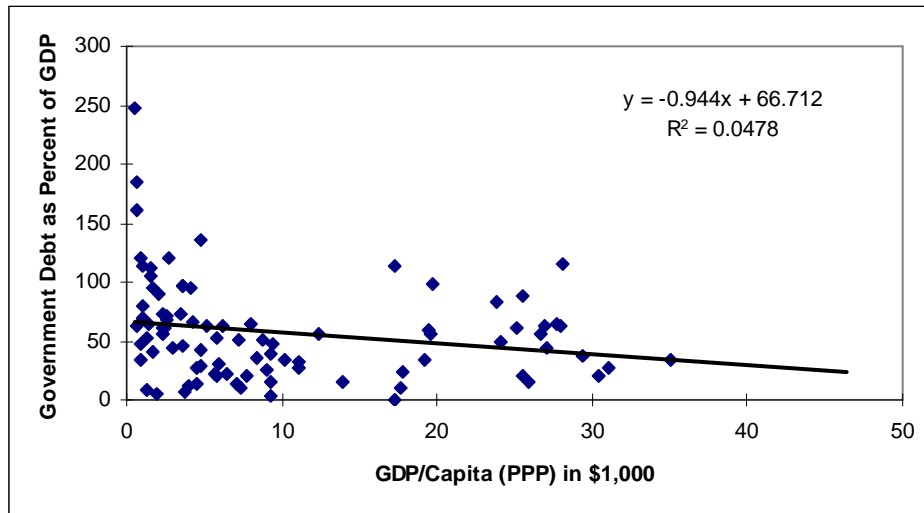
$$GovBal_r = GovRev_r - GovExp_r + AID_r$$

That allows the update of absolute government debt and a calculation of its magnitude relative to GDP.

$$GovDebtAbs_r = GovDebtAbs_r^{t-1} - GovBal_r$$

$$GovDebt_r = GovDebtAbs_r / GDP_r$$

The first step in feeding back government debt level to pressures for increases or decreases in revenues and expenditures is to compute a target for government debt as a percent of GDP with which to compare the actual level. A function relating typical levels of debt to GDP per capita is used as the foundation of that, with the target level being initial ratio, converging over time to the minimum of the initial ratio and the value from the function. Figure 4.x shows debt as a percentage of GDP, once again as a function of GDP/capita (PPP), as estimated cross-sectionally using data from 2000. This function is also used in the pre-processor to fill data holes for initial values of government debt.



**Figure 4.x. Government Debt as Function of GDP/capita (PPP)**

The function is used, along with initial empirical values of government debt when available, to set a rough “target” for government debt as a portion of GDP. As described above, convergence towards the function is assumed over time.

$$GovDebtTarget\%_r = Converge(GovDebt_r^{t=1}, AMin(GovDebt_r^{t=1}, GovDebtComp_r, 100))$$

The tricky part is to get a dynamic system to chase the target over time, adjusting revenues and expenditures annually as it does so. IFs does that in this instance and in others by using an adjustment to feedback parameters based on two terms: an integral term (the absolute distance of the system from the target) and a differential term (the change in values of the target relative to the preceding year). Engineers refer to this process as a PID controller.<sup>8</sup> The two terms are computed as Diff1 and Diff2. A potential GDP term is used rather than the actual GDP of the year in order to protect

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<sup>8</sup> The use of PID controllers in world models goes back at least to the first one developed for the World Integrated Model by Thomas Shook (in about 1974). The processes of their use in IFs have been facilitated by the creation of the adjustment function and by the experimental insight that, in order to maintain a system in equilibrium, the parameter on the second term is normally best set at 2 times the parameter on the first term.

systemic stability over time (use of GDP in the target term can set up oscillations in some feedback loops also involving GDP).

$$Diff1_r = GovDebtAbs_r^t - GovDebtTarget\%_r * GDPPot_r$$

$$Diff2_r = Diff1_r - Diff1_r^{t-1}$$

Once the two terms are available, the PID adjuster routine is called by IFs to convert the difference terms, modified by exogenous parameters, into a multiplier on the cumulatively-computed revenue multiplier term used in equations above.

$$Adjstr(GDPPot_r, Diff1, Diff2, elgrevdebt1, elgrevdebt2, Mul)$$

$$MulRev_r = MulRev_r * Mul$$

In the above specification, the adjuster uses two elasticities for the difference terms. In completely parallel fashion, adjustment is made to the expenditure multiplier. Tuning of the model reinforced the need for the elasticities on the expenditure side to be lower than those on the revenue side (governments are more likely to adjust revenues than expenditures).

$$Adjstr(GDPPot_r, Diff1, Diff2, elgexpdebt1, elgexpdebt2, Mul)$$

$$MulExp_r = MulExp_r * Mul$$

As in the first year, it is possible to compute gross household income, adjusted by transfer payments and dividends. Again, transfers are divided equally between the two household types.

$$HHInc_{r,h} = HHIncBTT_r + GovHHTrn_r / 2 + HHDivInt_{r,h}$$

#### Domestic Closure Between Savings and Investment

As discussed earlier, the SAM structure in IFs is really a combination of an accounting system and an equilibrating system. Just as the equilibrating mechanisms discussed above are important, it is critical to make sure that the accounting balances are maintained. One good measure of ultimate balance is the required, conceptual equality of total savings and investment. Their equality in fact is also reassurance that the goods and service market elements of the model are fully integrated with the broader financial ones.

Savings constitutes the residual term that assures balance between row and column totals for each agent/institution. They are computed in all years, both to balance the SAM and also to provide adjustments to two stock terms, government debt and external debt, that serve as touchstones for equilibrating mechanisms in the dynamics of the model.

The documentation above explained the computations of household savings, firm savings, and government savings. The only element missing for the calculation of total savings is foreign savings.



Foreign savings come in two flavours. The first and basic flavour assumes, like all of the other savings terms, that there are no relative price changes in the economy. It maintains all of the physical balances in the economy of a specific country/region.

$$ForSav_r = X_r - M_r - AID_r$$

The total savings in each country will be the sum of the individual terms. By definition it will equal investment, defined as capital formation plus inventory stock changes. Treatment of physical balances over time, not elaborated here, assure that equality. Looking at the two variables side by side is a good test of the functioning of the SAM.

$$Savings_r = \sum^H HHSav_{r,h} + FirmSav_r + GovBal_r + ForSav_r$$

The second flavour of foreign savings recognizes that in IFs there are relative price changes based primarily on the computation of prices in the two partial equilibrium submodels (food and energy). This second variant takes those into account in computing a relative-price adjusted foreign savings (ForSavRPA) that is then used in computations of international debt and exchange rates. It is time to move to the international side of the SAM.

#### 4.4.2 International Dynamics Around the SAM

The discussion of the domestic side of the SAM representation explained equilibrating dynamics of two kinds: those around goods and service markets and those around financial assets and liabilities of agent-classes, especially government debt. On the international side of the SAM structure, the key equilibrating dynamic centers on the total level of international debt of a country. Changes in foreign reserves and short-term governmental borrowing play important short-term buffering roles. Exchange rates are a key longer-term equilibrating variable.

##### Equilibration Based on Current and Capital Accounts

Conceptual foundations for the dynamics build largely on two concepts, current account balance (CURACT) and capital account balance (CAPACT). Although in terms of definition they are equal with opposite signs, it is more complicated than that. Current account equals the trade balance (TRADEBAL) of exports (X) minus imports (M), plus the net outflow of foreign aid (AID), plus foreign workers' remittances to home countries, plus pension payments to retirees living abroad, plus the rents, interest, profits, and dividends paid on past capital inflows. Capital account equals the net inflow of underlying capital flows (the change in stocks), both long-term and short-term. The long-term includes foreign direct investment; the short term includes hot money in bank deposits and T-bills.

Although the current and capital accounts must balance, the balance often relies in the very short term on residual changes in stocks, namely reserve holdings and reactive government borrowing. These are, in a sense, the equivalent of inventories and capacity

utilization in goods markets. In the longer-term exchange rate and interest rate fluctuations help maintain the balance by affecting the dynamics of the more slowly adjusting trade and financial flows.

IFs brings together most of these elements in its representations of the international financial dynamics around the SAM. It computes the current account balance from the elements indicated above, except that workers' remittances and pension liabilities abroad are not represented.

$$Curact_r = X_r - M_r + AID_r - Interest_r$$

where

$$Interest_r = lir * (IFIDebt_r + FDIDebt_r + PortDebt_r + FirmDebt_r + GovtDebt_r)$$

where

$$IFIDebt_r = XBLOANS_r + IMFCREDIT_r$$

$$FDIDebt_r = XFDISTOCK_r - XFDISTOUT_r$$

$$Portdebt_r = XPORTFOLIO_r - XPORTSTOUT_r$$

$$FirmDebt_r = XFIRMDEBT_r$$

$$GovtDebt_r = XGOVTDEBT_r$$

It computes a limited capital account balance from the elements identified above, except that dynamics around private firm international debt have not yet been elaborated. Moreover, the limited capital account balance purposefully excludes the two equilibrating elements of changes in reserves and short-term government compensatory borrowing.

$$CapActLim_r = IFIFlow_r + FDIFlow_r + PortFlow_r$$

where

$$IFIFlow_r = XFDIFIN_r - XFDIFLOUT_r$$

$$FDIFlow_r = XWBLNFIN_r - XWBLNFOUT_r + XIMFCRFIN_r - XIMFCRFOUT_r$$

$$PortFlow_r = XPORTFIN_r - XPORTFOUT_r$$

The model makes no assumption that it can anticipate a government's relative choice between changes in reserves and changes in short-term government borrowing (XGOVTDEBTB) in order to achieve real balance between the two terms. Instead, it assumes that reserves will grow at a relatively steady rate over time and arbitrarily uses government debt as the buffering mechanism. Total governmental debt is now set as the short-term borrowing plus longer-term IFI credits and loans.

$$XGOVTDEBTB_r^{t+1} = XGOVTDEBTB_r^t - CURACT_r - CapActLim_r + DelRserve_r$$

$$XGOVTDEBT_r^{t+1} = XGOVTDEBTB_r^{t+1} + XIMFCREDIT_r^t + XWBLOANS_r^t$$

Total external debt is the sum of governmental indebtedness and firm debt.

$$XDEBTRPA_r^{t+1} = XGOVTDEBTB_r^t + XFIRMDEBT_r^t$$

Exchange rates are a function of external debt, using a PID controller mechanism to maintain relative balance with a target of zero over time.

$$EXRATE_r = F(PIDController, XDEBTRPA_r)$$

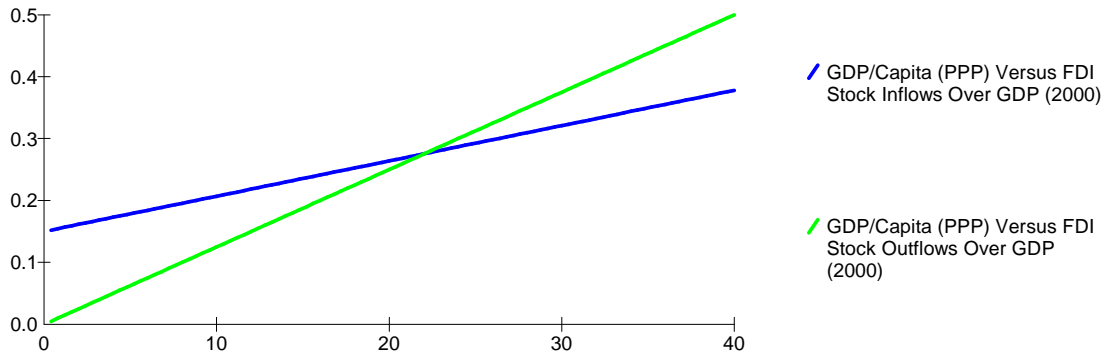
#### International Flows Controlled by Firms and Households

The rest of this section will outline the logic of representation of the primary capital flows, namely foreign direct investment, portfolio investment, and IFI loans/credits. Ideally, each of these would be responsive to equilibrating mechanisms. In reality, that is not always the case. FDI and portfolio flows can be, in fact, somewhat perverse, moving from fear or greed in opposite directions to the needed balances. IFI loans/credits are more likely to assist in balancing, but critics content that IMF credits, in particular, can also exacerbate imbalances in the short run.

It is important, however, to understand that IFs is not intended to be a model of shorter-term financial systems in which such overshoots or collapses will occur, but rather of longer-term patterns and unfoldings. The latter orientation frames the way in which IFs represents actor-class behaviour.

Firms are primarily in charge on both ends foreign direct investment. In general, of course, the pattern is likely to be that firms direct FDI from relatively capital-rich countries to relatively capital-poor ones. Figure 4.x below reinforces that presumption by showing the patterns found in the IFs database (using FDI flow data from WDI). The less steeply-sloped line is the relationship between GDP per capita at PPP and the inflows of FDI as a percentage of GDP. The more steeply-sloped line is the relationship between GDP per capita at PPP and the outflows of FDI as a percentage of GDP. Both lines are upward sloping and, in fact, countries are simultaneously larger sources and targets of investment, even relative to GDP, as they develop. Yet, roughly speaking, countries are net recipients until GDP per capita is somewhat above \$20,000 and net sources thereafter.

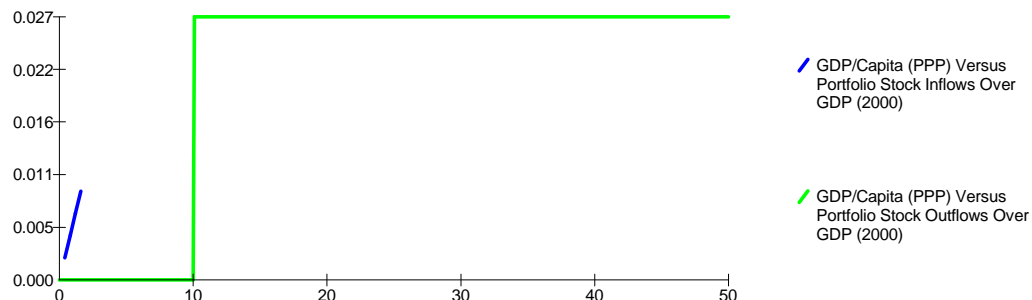
IFs recognizes that these patterns will not be universal. Thus the algorithm that determines investment outflows is one that builds in the historic pattern of an FDI source, but that assumes convergence over long periods of time, such as a century, towards the generic pattern. The same is true for recipients. It would probably be reasonable to posit that both lines would shift to the right over time as the average per capita levels of global GDP increase. We have not built that presumption into the model at this time.



In addition to the relative behaviour of firms in states across the system, another behaviour issue is the overall pattern of increase or decrease in FDI flows relative to the size of the global economy. Over the last several decades FDI has grown steadily as a portion of the global capital stock and global economy. Economic historians are, however, quick to point out that the turn of the 20<sup>th</sup> century was a period of enhanced globalization of capital and that those flows then retreated for most of the 20<sup>th</sup> century before advancing again. And this century has already seen retreats relative to the year 2000. Thus the base case presumption built into IFs, based roughly on patterns of the late 1990s, is of growth in FDI flows at a rate that exceeds economic growth but that converges towards GDP growth by 2010.

Both systemic pattern and country-specific ones can be altered via scenario intervention. [need to introduce WFDISTOCKM for the systemic intervention].

The algorithm behind portfolio flows, again involving firms in large part but also introducing behaviour of households, is essentially the same. In the absence of data on outflows, the model uses a simple step-threshold function, in which outflows do not begin for countries until GDP per capita reaches \$10,000. As with FDI inflows, portfolio inflows rise from very low levels of GDP per capita [there is a problem with this display]. And again, model users can intervene to change either systemic growth of portfolio flows or individual country/region patterns.



At this point there is no representation of dynamics for direct firm borrowing and lending across country borders. That should be developed.

#### International Flows Controlled by IFIs

The representation of IFI flows is now considerably simpler than it will evolve to be. Currently, returns of funds to the World Bank and the IMF are assumed to be at the rate of 5% of principal each year, with 3% real interest payments, about the rate of global economic growth. Total available assets of the World Bank and the IMF (XWBLOANSTOT and XIMFCREDITTOT) grow at exogenously specified rates, *xwbloanr* and *ximfcreditr*, respectively. New lending and credits to countries is specified to continue at rates necessary to maintain their initial share of the global portfolio of the respective institutions.

The next steps in development of the algorithms for IFI behaviour will be taken when additional information is available. How fast have the assets pools of the two institutions been growing? How much of the assets come from open-market borrowing (firms/banks), how much comes from increased subscriptions by member states, and how much is global money supply growth in the form of SDR creation? What are the patterns of lending to countries over time? How do those patterns change with development level? What other factors (e.g. assessed governance capability) drive those patterns? What are the patterns of lending across target areas within recipient countries?

In addition to building a considerably more sophisticated algorithm for the IFIs, development will emphasize creation of a number of policy leverage handles for intervention by model users via scenario analysis.

#### **4.5 Concluding Comments: SAM and the Broader Model**

The universal SAM structure in IFs is at a relatively early state of development (it has come into being over the last year). At this point there is an increasingly strong empirical basis, but there are also more arbitrary assumptions and rough edges than will be the case as it evolves. Fortunately, refinements and extensions are much easier than creating a new set of structures.

The dynamic functioning of the broader economic model has not been discussed here in any detail. The key or dominant relationships in that model center on the production function (see the documentation in the Help system of IFs). In addition to the Cobb-Douglas production function with endogenization of multifactor production following Solow-Romer, a few other features should be noted. The division of total household consumption into sectoral values uses a linear expenditure system with Engel parameters representing superior and inferior goods. The system that brings together production and consumption sides of the model is not an equilibrium system that is solved in all time steps as in a typical CGE model, but rather an equilibrium-chasing system. Inventories are allowed to rise and fall in each sector, but changes in sectoral price levels feed back to investment and consumption decisions so as to equilibrate inventories (and prices) over time. The use of variable inventory levels is not only closer to the real-world processes of economic change, but allows easier and faster recursive model solution.

Similarly, we have not discussed the demographic model in any detail. It, too, has several important features. Although it uses standard 5-year population cohorts, it also maintains single-year cohorts internally so as to prevent numerical diffusion across single-year time steps. It has a basic representation of HIV/AIDS, using the most recent UNAIDS data, including a basic (generic) specification of the age-specific impact of AIDS deaths on populations. It further has a representation of migration, again with a generic specification of the age structure of migrating populations.

In addition to structural elements, one of the important features of the International Futures modelling system is the ability via the user interface to display easily both historic data and forecasts and to create fairly quickly scenarios with one or multiple parameter changes. The next chapter takes advantage of some of this capability to provide some very early analysis of the two social issues identified earlier: pension funding in developed countries and more general social protection in developing countries.

## 5. Analysis

Note: the analysis presented here was developed for the January, 2003, version of this document and not updated in the most recent version.]

The purpose of this chapter is to begin an analysis that will continue over some time. The combination of full demographic model, extensive economic model, and SAM representation provides capabilities that allow extensive analysis of social issues. This chapter lays some initial foundation for such analysis, focusing first on issues around aging and pension plan funding and second on broader issues of social safety nets and social protection in the developing world. The focus in this chapter is on the base case of the model, leaving scenario analysis for Chapter 6.

### 5.1 Pensions and the Aging in Chapter 2 of the Great Demographic Transition

For most of the last five decades, any discussion of a population crisis had a very clear referent. After World War II the population growth rates of most economically Less Developed Countries (LDCs) rose sharply in the face of rapid declines in mortality and, initially, little or no decline in fertility. Demographers understood that declines in fertility towards an equilibrium were ultimately likely to occur as they had in Europe, but the pace of such adjustment was uncertain and the economic and social consequences of rapid population growth in the interim were understood to be significant and, on the whole, detrimental.

LDCs like India began programs to accelerate fertility declines, supported initially by the United States and with continued support by other developed countries. The United Nations and a variety of non-governmental organizations further contributed to the development of a global regime that continues to focus on the completion of what might be called chapter 1 of the great global demographic transition: the transition from high death and birth rates to low death and birth rates that began in the early 1800s in Europe and has now spread around the world. In fact, the pace of change has surprised many demographic forecasters and long-term world population forecasts have been falling for some time.

As the 20<sup>th</sup> century began to draw to a close, however, the referent of the expression “population crisis” began to be less clear. Below replacement fertility rates have become common in large numbers of countries in the economically more-developed world and life expectancies have continued to climb.

Even under circumstances of replacement fertility rates, dependent populations of retirement age were certain to grow in many countries relative to dependent populations of youths. Fertility rates below replacement have accelerated that shift in relative size. Moreover, it is simple to extrapolate cohort structures and see that many countries now face absolute growth in total dependent population, concentrated very heavily in retirement years.

It might be reasonable to label the period that we are entering “chapter 2” of the great global demographic transition. Like chapter 1, a significant and, in fact, growing

imbalance will characterize the first phase of chapter 2. In chapter 1 the growing imbalance was a surplus of birth to death rates, which lead to overall growth in population and especially major growth in the relative size of youth populations. In phase 1 of chapter 2 the growing imbalance is a deficit of births relative to replacement rates, which is begin to give rise to overall decline in population and especially rapid relative growth of aging populations. In phase 2 of chapter 1 there was an equilibrating movement of birth rates toward death rates. We would expect a similar equilibrating adjustment later in chapter 2, this time of higher birth rates. Yet the demographic effects of the first phase of the current chapter are very likely to dominant patterns of the next 50 years, with growing imbalance throughout much of it.

Demographics change sufficiently slowly and demography is sufficiently well-developed so that the forecasts of the first phase of chapter 2 are now well-known, even if the mechanisms by which the transition to the second and equilibrating phase might occur are very much in dispute (see O'Neill and Balk 2001; Bongarts and Bulatao 2000). Although it would be folly to declare certainty concerning the pattern of growth in imbalance, we have very much moved now into a period of attempting to understand and address the consequences of growing imbalances.

As the imbalances grow and the awareness of them becomes even more pervasive, the alarm concerning them is becoming more strident and the proposals for addressing issues more active. One of the most obvious consequences of a growing aged population comes from the fact that the economically developed world has spent more than a century (at least since the days of Bismark) developing a governmental support system for retired citizens. While government also has a fiscal responsibility for dependent-aged youth (primarily education), the fiscal responsibility for retirement-aged population has come often to be of greater magnitude, involving both pension and health benefits. Therefore the current focus of concern is on governmental financial capability to address the growing imbalances (see the literature references in the first chapter of this report).

Our intent here is to add to this growing discussion with analysis that is possible using International Futures (IFs). As discussed above, that model incorporates, among other modules, a full cohort-component representation of population, a general equilibrium-seeking model of economies, and a social accounting matrix representation of financial flows across households, firms, and the government. It draws upon a data base for 164 countries and can allow us to look at those countries individually or in flexible aggregations.

Such a model adds value to analysis in three ways. First, it facilitates the analysis of uncertainty around mid- and longer-term forecasts of the magnitude of the issue by allowing us to develop scenarios based in differing assumptions concerning key driving variables: in particular the pattern of future fertility and the longevity of the aged population, but also secondary drivers such as migration patterns.

Second, it allows undertaking a fairly wide and integrated analysis of the consequences of the changing demographic patterns. As with other studies, a significant focus here will



be on fiscal implications of aging. The availability of a social accounting matrix representation will, however, also allow analysis of the possible broader consequences for the resources of households and firms (and possible changes in savings/investment patterns). Similarly, the integration into the system of an economic module will allow investigation of some of the economic consequences of changes in the size of the labor force. It will be useful also to speculate about the implications of the changes for the advance of productivity in impacted economies.

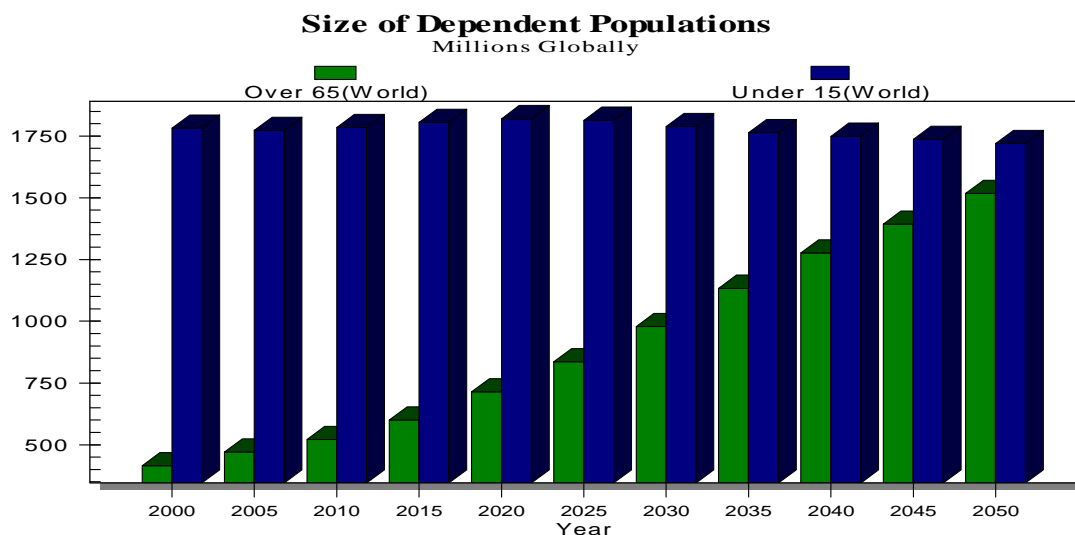
Third, the modeling system will facilitate probing of the consequences of some of the recommendations made for addressing the challenges of the transition. What might be policy leverage with respect to fertility? With respect to retirement ages, women's participation rates, or human capital development? With respect to migration?

This paper, and particularly early drafts of it, present the beginnings of analysis that will unfold over time.

### 5.1.1 The Demographic Context of the Aging/Pension Issue

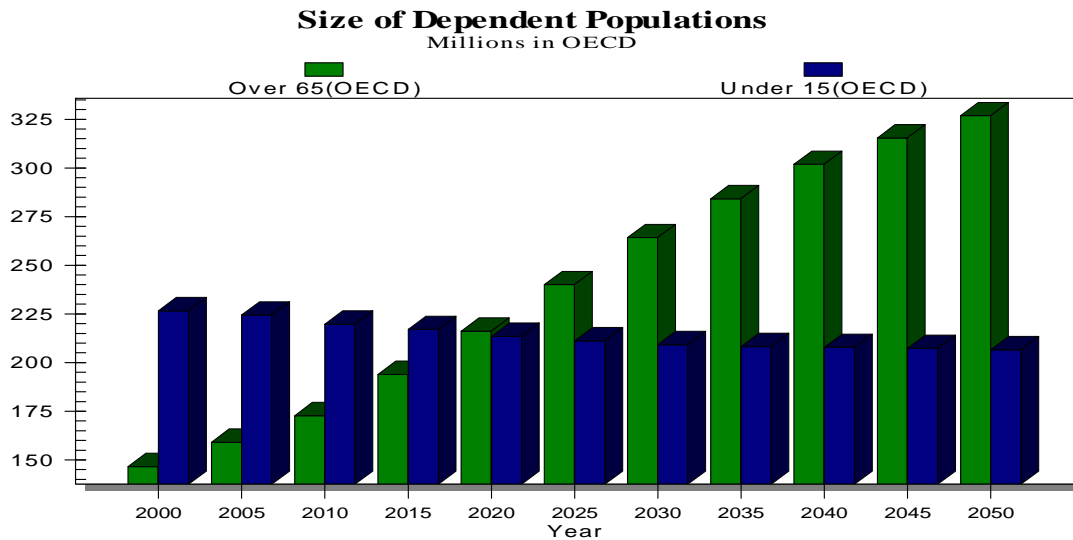
A useful beginning focus is on dependency ratios, looking at where dynamics of demographic and economic systems appear to be taking the world (at the same time, recognizing two primary uncertainties around retirement age and longevity and further uncertainties around fertility transition and migration). Analysis in Chapter 6 will return to the global, regional, and selected country forecasts of this section with alternative assumptions about retirement, longevity, and fertility.

The base case of IFs shows clearly the unfolding of aging/pension issues at a global level. Two types of dependent population will be of approximately comparable size by 2050.



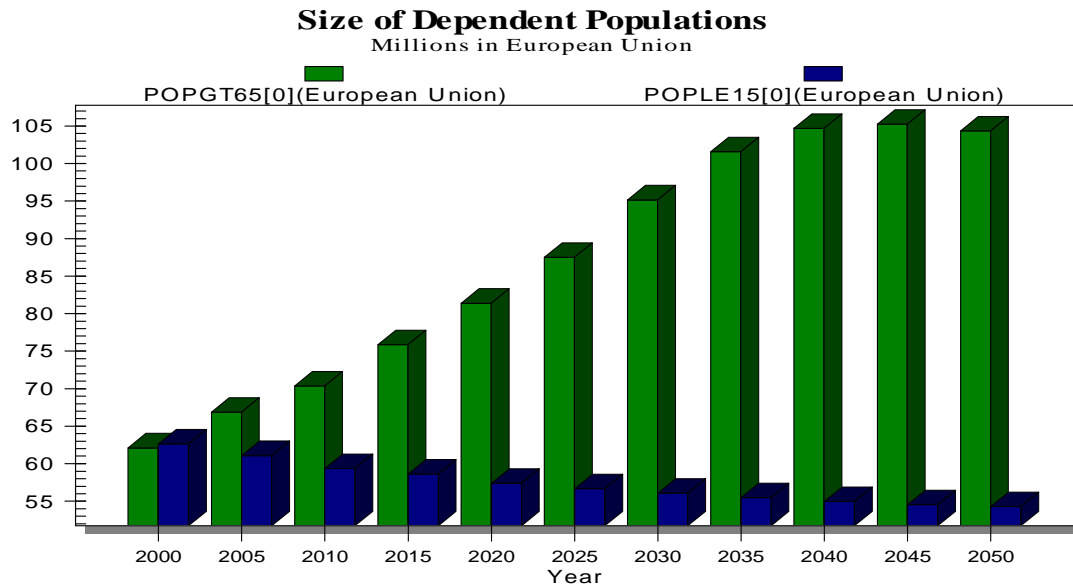
**Figure 5.1 Size of Global Dependent Populations: Over 65 and Under 15**

The pension issue is, of course, especially great in OECD countries where the dependent population curves will cross in 2-3 decades and the aged population will just keep growing.



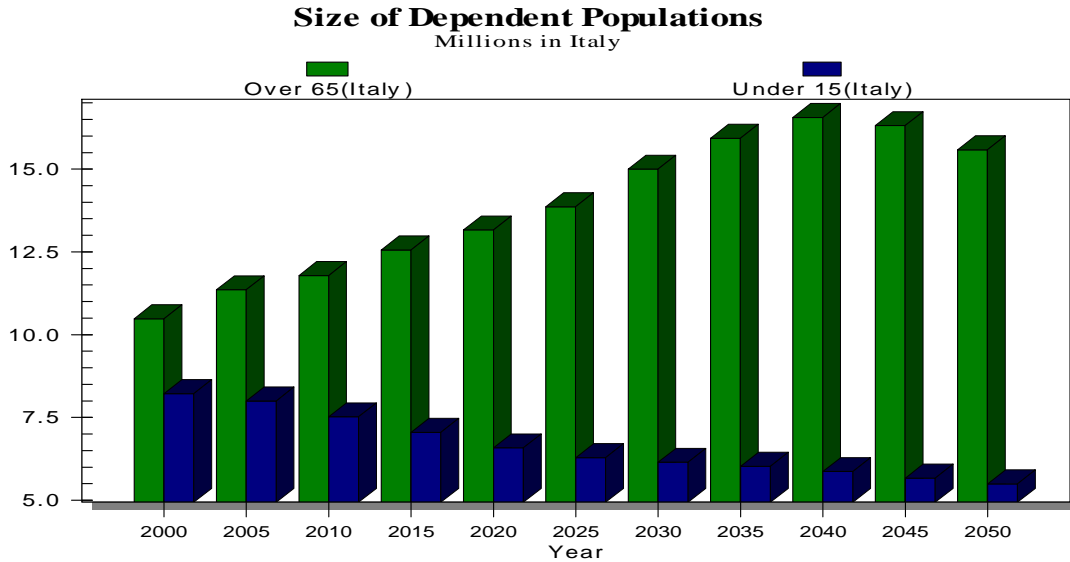
**Figure 5.2 Size of OECD Dependent Populations: Over 65 and Under 15**

In the European Union the future is already arriving in this decade as the aged population exceeds the young dependent population.



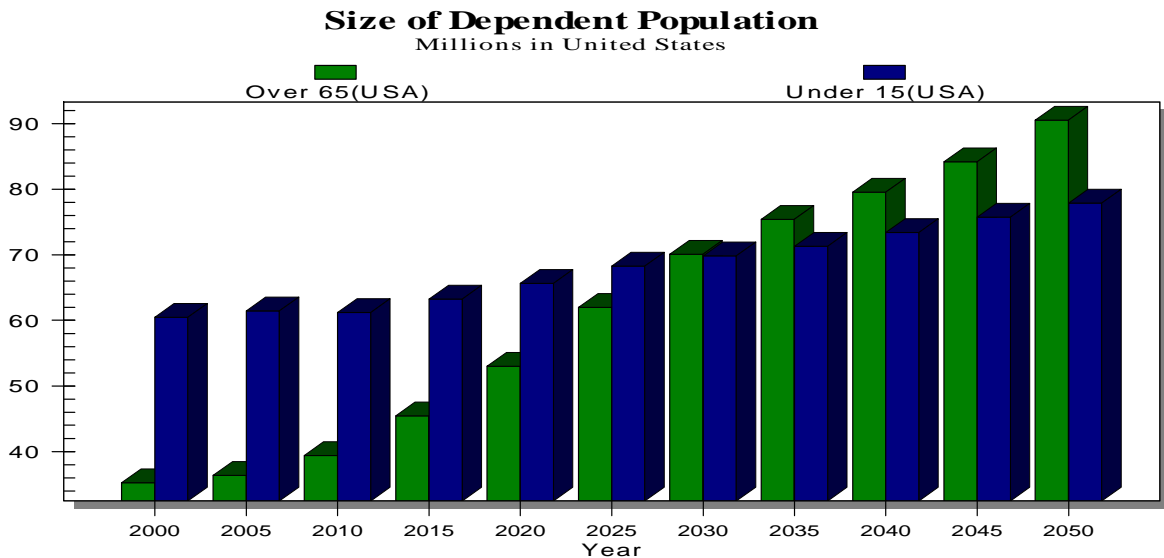
**Figure 5.2b Size of OECD Dependent Populations: Over 65 and Under 15**

Italy is leading the way within Europe. Within two decades the retired population will be two times as great as the young population. The pattern for Japan is similar.



**Figure 5.3 Size of Italian Dependent Populations: Over 65 and Under 15**

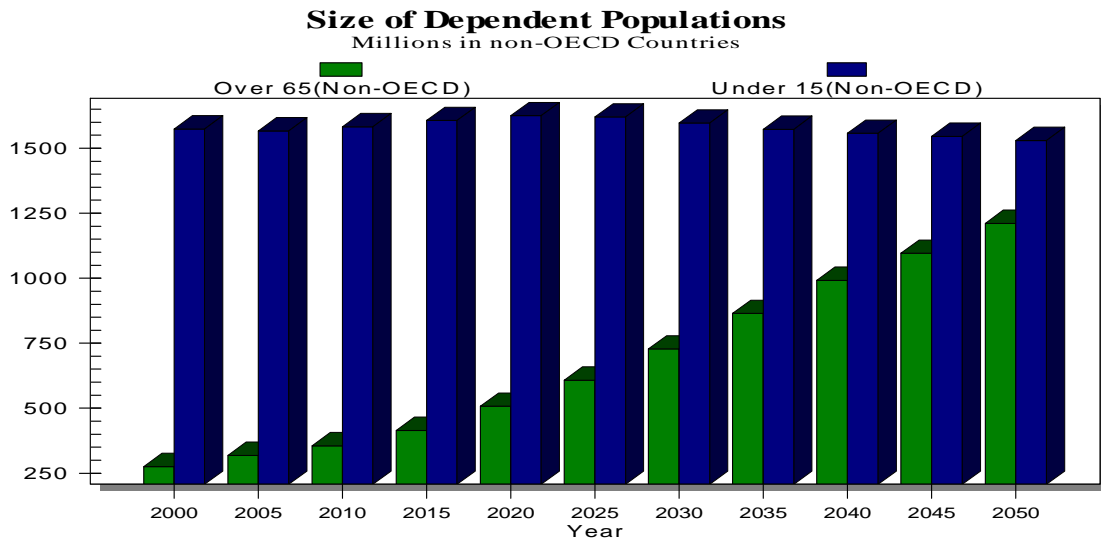
In contrast, the United States is likely to have continued slow growth in the youth population through the first half of the century and it is the relative *growth rate* of the aged population compared to the young dependent population, not its relative *size* that is most striking in the next two decades. Perhaps the most striking thing about the aged dependent population in the U.S. is that, given all of the concern about funding social security in the United States and given the fact that much of that population has considerable independent resources, there is so much (justifiable) concern about funding social security in the United States; taken together, all of that greatly reinforces the concern about funding pensions in the European states profiled above.



**Figure 5.4 Size of U.S. Dependent Populations: Over 65 and Under 15**

In non-OECD countries the pattern looks, unsurprisingly given their demographic weight, like that of the world as a whole. Even in developing countries the aged population is

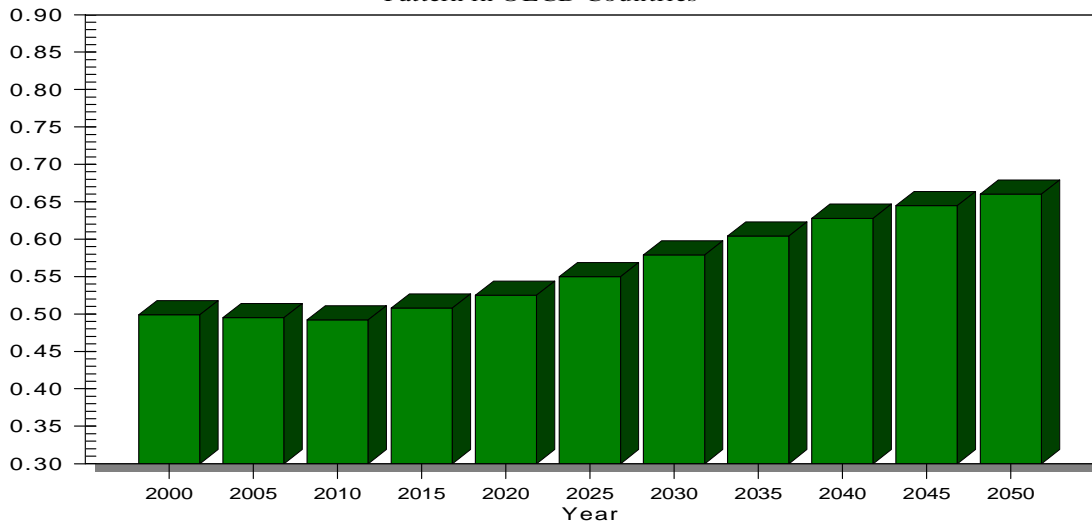
growing rapidly. Just as the LDCs of the world increasingly must address simultaneously malnutrition and growing levels of obesity, they increasingly will be tackling the issues of chapter 2 in the demographic transition even before they complete chapter 1.



**Figure 5.5 Size of LDC Dependent Populations: Over 65 and Under 15**

Many discussions about demographic patterns and economic growth potential focus on the number of working-aged individuals per member of dependent population groupings, or the inverse of that, the size of the two dependent populations relative to the number of workers. Looking at the latter for OECD countries, Figure 5.6 shows that the ratio of total dependent population to working-aged population will grow by about 15%, and do so at an accelerating rate after 2010. As shown above, however, it is aged population that is really growing and, for government, that is a more significant fiscal issue.

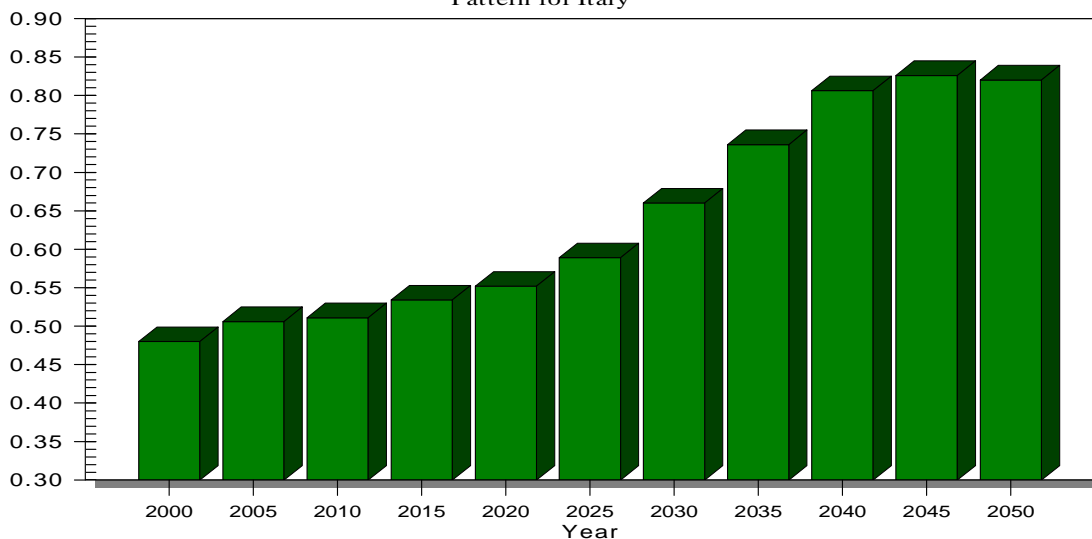
**Dependent Populations Relative to Working-Aged**  
Pattern in OECD Countries



**Figure 5.6 Ratio of Total OECD Dependent Population to Working-Aged Population**

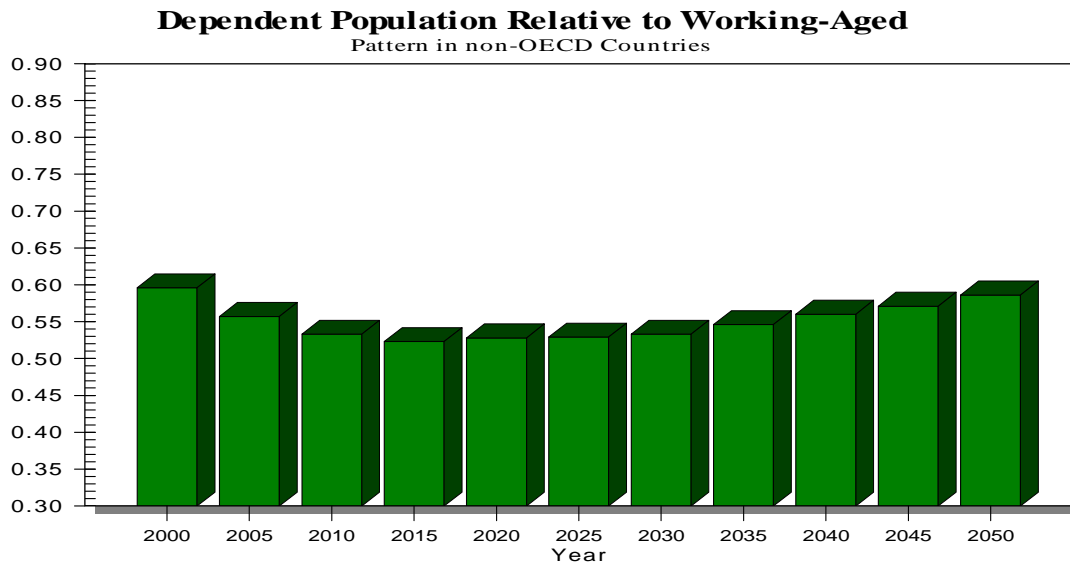
Because of having had very low birth rates for some time, Italy has had and still has a total proportion of dependent population to working-aged that differs little in aggregate from the OECD total, in spite of a heavier proportion of aged within the dependent population. Strikingly, however, the ratio of total dependent populations to workers will begin to grow rapidly even with continued significant decline in young people. Italy will experience very large increases in the ratio before the middle of the century and especially large rates of increase beginning in about 20 years.

**Dependent Populations Relative to Working-Aged**  
Pattern for Italy



**Figure 5.7 Ratio of Total Italian Dependent Population to Working-Aged Population**

Some economists have argued that a number of LDCs will actually obtain a fillip to economic growth in the next two decades because of the decreasing size of young dependent populations as fertility continues to drop. On the surface this argument seems plausible, because it correctly assesses the impact of rather stable numbers of young people in non-OECD countries and their decreasing share of total population. It will be interesting, however, to analyze in LDCs whether the shift in character of dependent population to a more aged one will carry costs that offset the lower burden of total dependent population (see Figure 5.8 for the total “burden” ratio). As suggested later in this chapter, the shift from young dependent population to old dependent population actually has the potential for increasing total governmental costs.



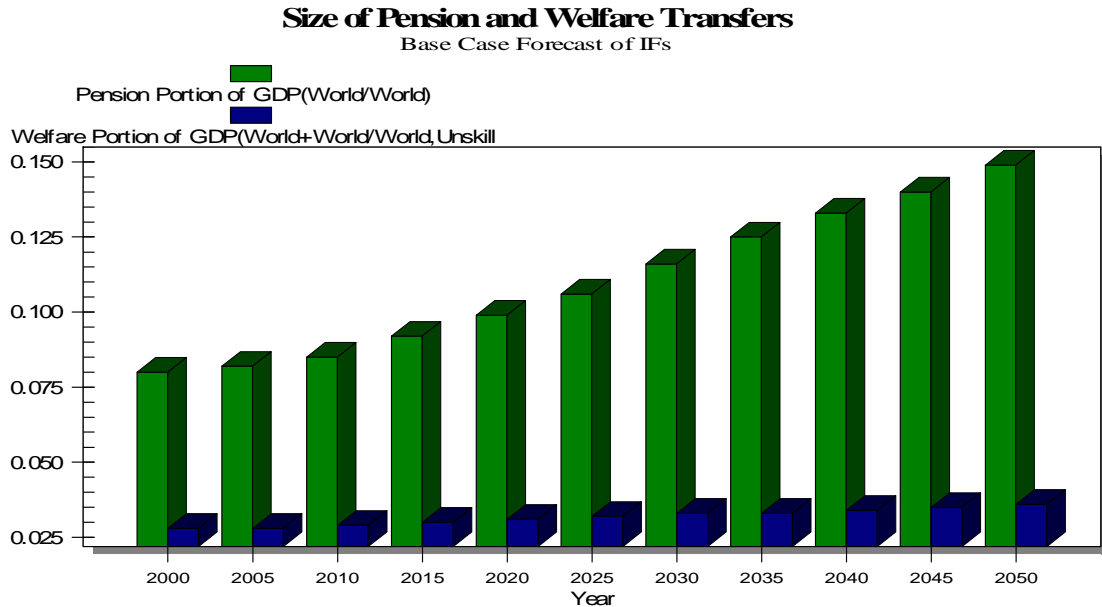
**Figure 5.8 Ratio of Total LDC Dependent Population to Working-Aged Population**

Another policy issue that many analysts raise concerns the option that more economically developed countries will have to raise migration rates as a way of offsetting the growing burden of pensioners and slower growth in domestic labor forces. Those who migrate do, in fact, tend to be relatively young and on the surface, ignoring brain drain issues, it implies a possible win-win development between developing and more economically-developed countries. There are, of course, many social and cultural issues associated with migration that have already begun to suggest the unlikely character of substantial reliance on migration within much of Europe.

#### 5.1.2 Insights from Social Accounting

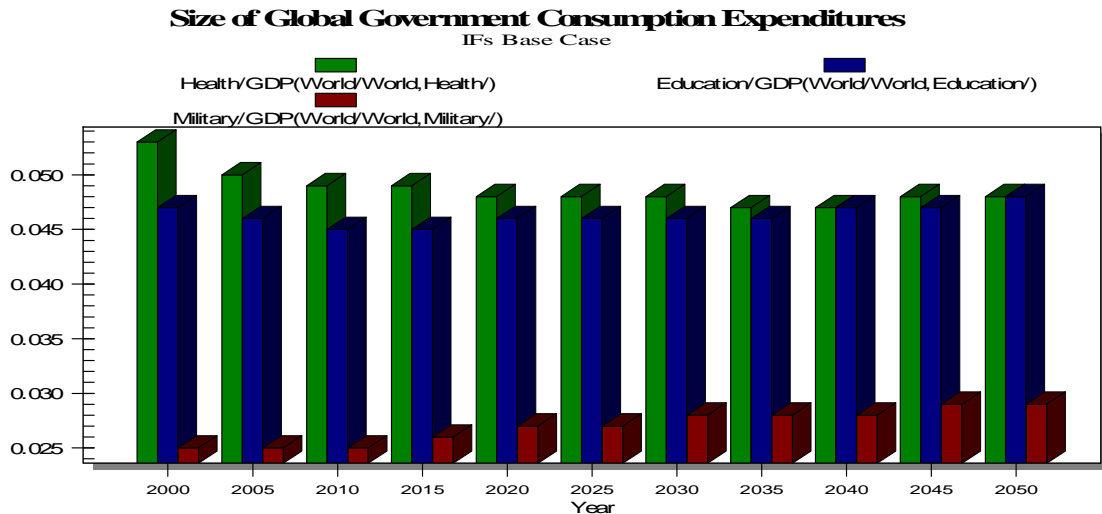
Having surveyed the demographic landscape of the issues, analysis can move to the financial side, taking advantage of the economic submodel and SAM structures of IFs. Figure 5.9 is a base case forecast of total global transfers from governments to households. Two aspects of that graph are striking. First, there is the significantly greater magnitude of transfers associated with pensions than of transfers associated with other welfare expenditures (defined here to include unemployment compensation and all other direct transfers not directed explicitly at the elderly). Second, the pension

expenditures, already exceeding 8 percent of GDP, may well rise to as much as 15 percent of GDP globally.



**Figure 5.9. Forecast of Global Pension and Welfare Transfers**

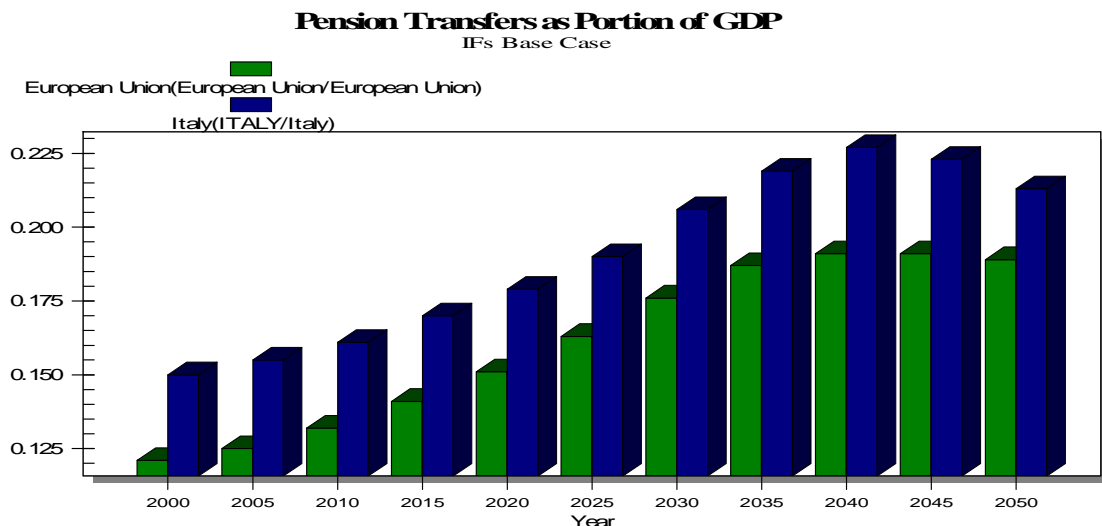
Making the significance of current and forecast levels for pension expenditures even clearer, Figure 5.10 shows other significant expenditures of government, namely those on health, education, and the military (often collectively labelled as parts of government consumption). There are again several striking elements of that graph. First, the military expenditures, although taking about 2.5% of global GDP now and greater levels in the forecast, are actually smaller than expenditures on health and education. Second, pension transfers as a portion of GDP are already large compared to either health or education spending (education spending gives a rough idea of the costs to central governments of the young dependent population), and promise to become much larger. Third, there appears in the forecast to be some “crowding out” of health and education spending as the expenditures on pensions rise. These two figures are as important to subsequent discussion of the issues of a global safety net and global social protection systems as they are to the discussion of pension systems.



**Figure 5.10 Forecast of Governmental Consumption Expenditures on Health, Education, and the Military.**

Much further discussion and analysis of the above two graphs would be useful. For instance, the pressure that public pension payments are beginning to put on governments, especially in developed countries, will lead to a variety of changes that help make the above forecasts self-denying. One such change will be the shifting of pension responsibility from governments to individuals; another will be the transformation of pay-as-you-go, defined benefit systems into pre-funded and defined contribution systems.

Nonetheless, the sheer magnitude of increasing pension expenditures is dramatic. Figure 5.11 shows once again that all of the issues will be even more significant in the European Union as a whole and countries like Italy in particular. Italian pension expenditures already take 15% of GDP and could rise well over 20%.

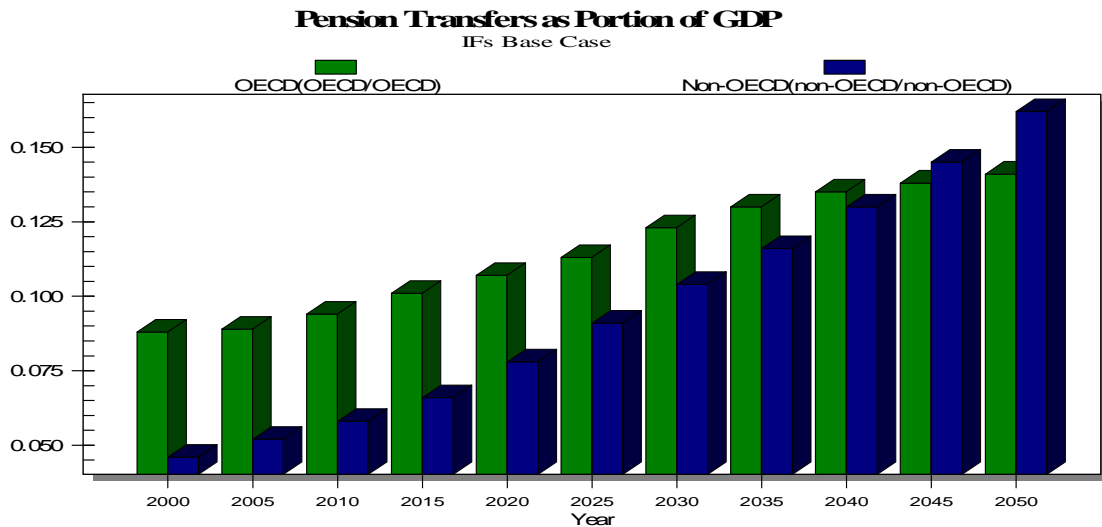


**Figure 5.11. Pension Transfers as a Portion of GDP.**

Also of real importance, the crowding out issue is of significance not just for OECD countries. Figure 5.12 shows again the base case forecast of pension transfers as a portion of GDP, this time differentiating OECD from non-OECD countries. Rather

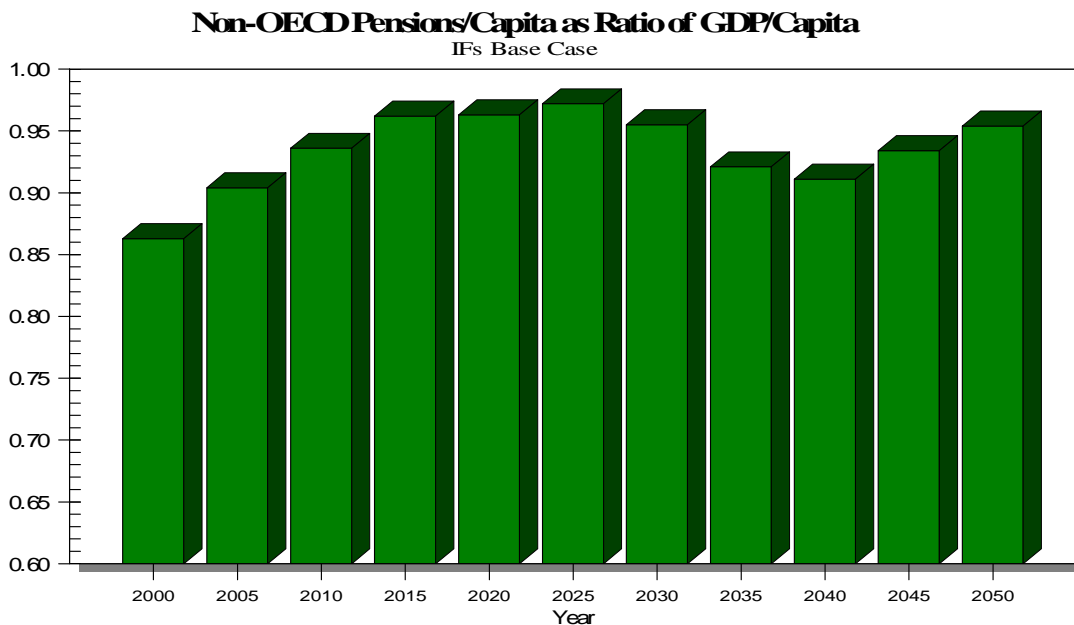


surprisingly, the rates of transfer grow even more rapidly in the non-OECD countries and rise by mid-century to roughly the same portion of GDP as in the OECD countries.



**Figure 5.12. Pension Transfers as a Portion of GDP.**

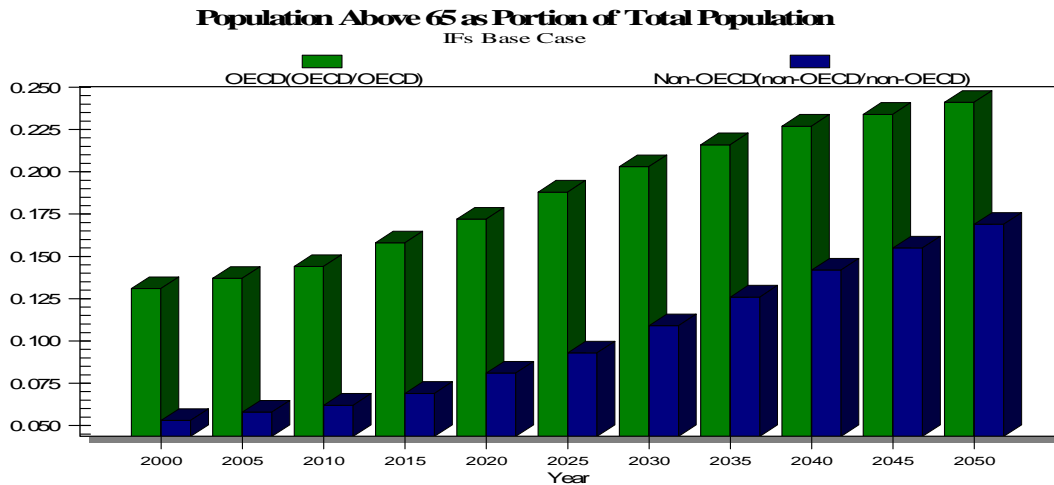
How can this be? It is not because the LDCs are likely to become much more generous with pension spending relative to their GDPs/capita. Figure 5.13 shows the ratio of pension spending per individual over 65 to GDP/capita. The IFs forecast of that ratio is probably a bit too high (it should probably be decreasing because many LDCs actually treat their retired government employees relatively more generously than do richer countries), but the ratio is relatively stable.



**Figure 5.13. Pension Transfers as a Portion of GDP.**

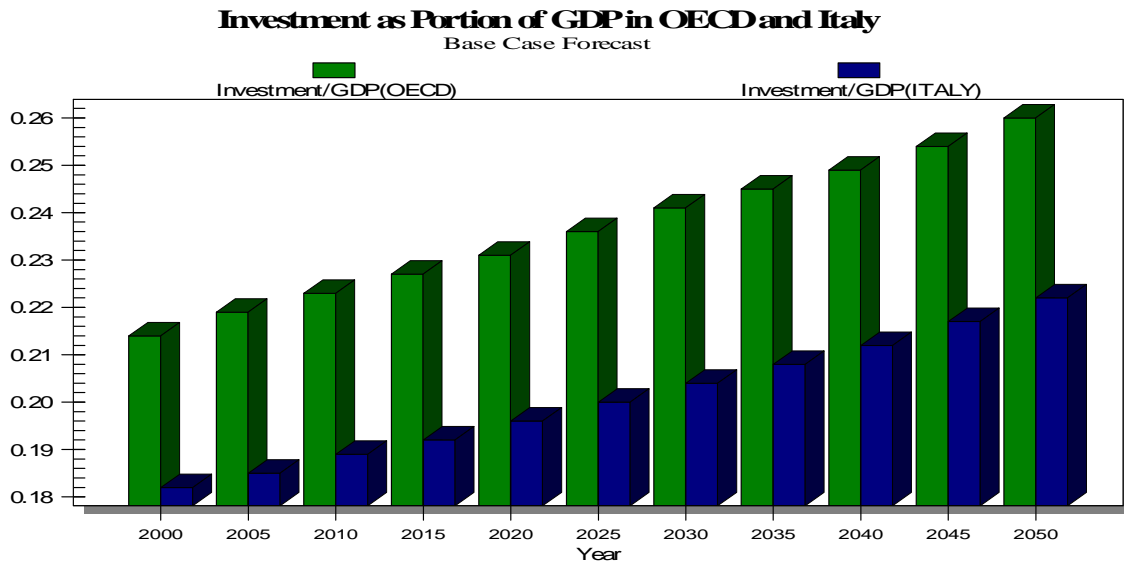
Instead, the explanation for rapid increases in the pension expenditures of LDCs goes back to the earlier observation that LDCs are going to begin to experience a key element

of the second chapter of the demographic transition (population aging) even before they complete the first chapter (fertility declines commensurate with earlier mortality declines). Figure 5.14 shows how much faster the aged population share is growing in non-OECD countries than even in OECD countries. Ironically, the crowding out effect could be even larger in poorer countries.



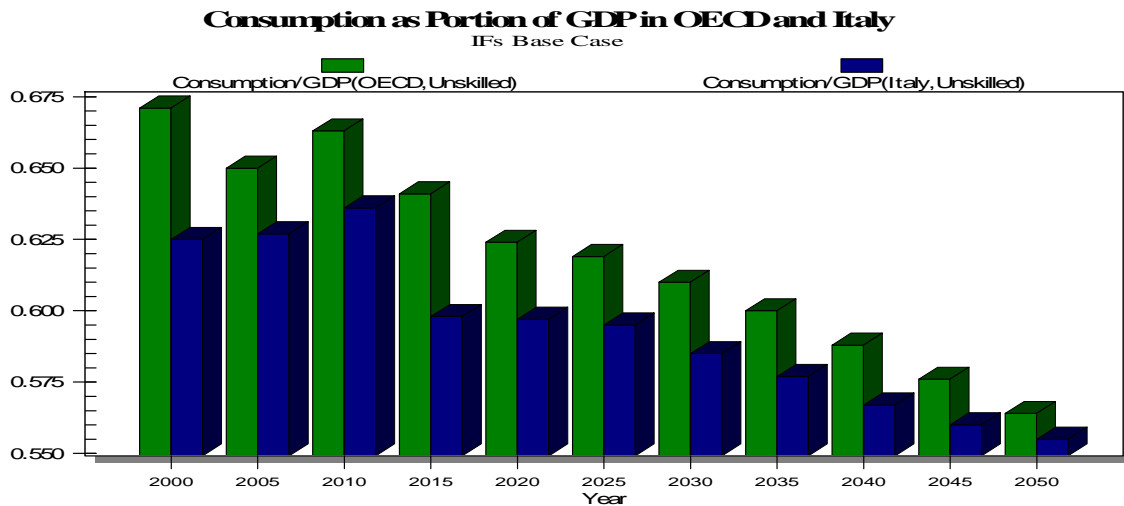
**Figure 5.14. Population Above 65 as Fraction of Total Population**

Crowding out and hard trade-offs are not restricted to the pattern of government expenditures across categories. The issue of governmental expenditures crowding out other expenditures is a very large (and controversial) one. Most often the argument made is that government expenditures can crowd out investment and slow economic growth. Figure 5.15 shows the base case forecast values of investment as a portion of GDP in the OECD as a whole and Italy specifically. The figure suggests a forecast that seems, and is, incompatible with the expansion of government pension spending and therefore total government spending seen in figures above. The implementation of the SAM in IFs now provides government transfers, even pensions, to households, not to specific age categories within them. And it does not yet represent the life cycle pattern of savings and consumption that makes the elderly much more likely, on average, to consume additional income than are the middle-aged. These enhancements must be made to allow better analysis of possible crowding out of investment.



**Figure 5.15. Investment as a Portion of GDP**

Even in advance of those enhancements to IFs, Figure 5.16 shows the kind of crowding out of other expenditure categories that can occur when government (or investment) increases its direct spending. The base case is showing significant reductions of consumption as a portion of GDP in unskilled households.



**Figure 5.16. Consumption as a Portion of GDP**

This very early analysis of the pension issue will be revised and extended, as the SAM representation within IFs is improved. It is, nonetheless, very suggestive. The aging of populations, even in LDCs, is almost certainly going to reshape government expenditure patterns and broader economies in significant ways. Ironically, the impact may by mid-century be as great for LDCs as in richer countries and even, relative to economic capability, greater. We turn next to some equally early analysis that focuses more heavily on developing countries.

## 5.2 A Global Social Safety Net in Chapter 2 of the Great Economic Transition

Whereas the economically more developed world is approaching a struggle with the growing financial problem around pensions, countries within that world still have in place very strong social safety nets and broader social protection systems. In contrast, most developing countries have yet to put in place any significant safety net. And, as we have seen, it is only a matter of another 3-4 decades before they will be facing some of the same demographic pressures that are just beginning to challenge much richer countries. Is it truly reasonable to expect that the world can meet Millennium Summit Goals and many other statements of intent to educate populations, provide adequate water and sanitation, and support urgent needs of individuals who now struggle and often fail to survive on daily incomes of \$1 or \$2 or less?

There are some signs of hope and some reason to believe that it is possible. The probability of continued global economic growth is a strong reason for hope, in and of itself. And there is hope especially in the potential for solid growth in LDCs.

Just as large gaps arose between fertility and mortality rates in the great demographic transition of the last 200 years, beginning with European countries and spreading around the world, large gaps also arose over that period between the GDPs/capita of European and other countries. More specifically, the GDPs/capita of the European countries and the settler states of Europeans (notably the United States, Canada, Australia, and New Zealand) moved from about twice those of the rest of the world to levels of 15-20 times those of the rest of the world at market exchange rates (to about 6-8 times the rest of the world at purchasing power parity).

And just as we are moving into chapter 2 of the demographic transition, there is evidence that we are moving into chapter 2 of the economic transition. Although it is controversial, there is good reason to believe that the aggregate size of the economic gap between North and South, in ratio terms, has begun to decrease. The substantial drops in fertility in the South and the resultant window of opportunity with respect to dependent-aged population in the South (see again Figure 5.8) and the processes of technology transfer with globalization are forces that may well drive substantial narrowing of the gap in the first half of the 21<sup>st</sup> century. It must also be recognized, however, that HIV/AIDS, environmental degradation, and other factors could also retard such narrowing or even lead to further widening. And it must be understood that the narrowing of North-South gaps is a reflection in particular of growth in Asia, while Africa continues to slide further behind the rest of the world.

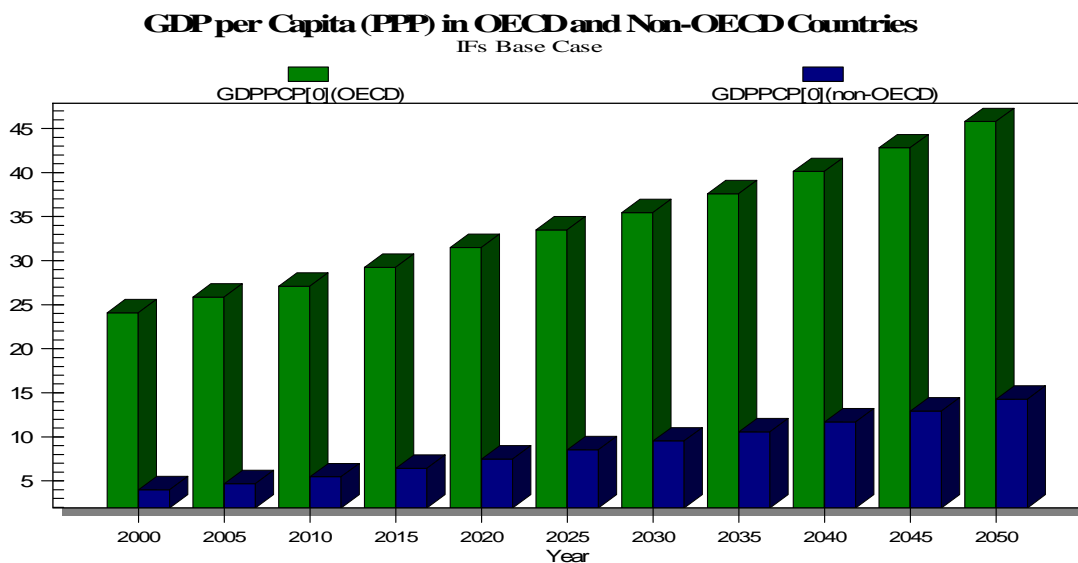
The base case of IFs, to be discussed below, is built on forecasts of continued basic economic progress in developing countries. Chapter 6 will expand our horizons with potential scenarios that are less optimistic (and others that are more optimistic).

### 5.2.1 The Context of the Social Protection/Safety Net Issue

In the base case of International Futures, economic growth per capita continues in both richer (largely OECD) and poorer countries (largely non-OECD). Figure 5.17 shows the base case forecast of growth in GDP per capita (using purchasing power parity) for both OECD and non-OECD countries.

The rates of economic growth in the forecast are actually a little conservative relative to rates in the last 40 years of the 20<sup>th</sup> century. Specifically, global GDP during that 40 year period increased by a factor of about 4.1, while GDP per capita at PPP increased by 2.36. The rates that underlie Figure 5.17 are such that, in the 40 years from 2000 through 2040, the global GDP will increase by a factor of 3.2 and GDP per capita at PPP will increase by 2.08.

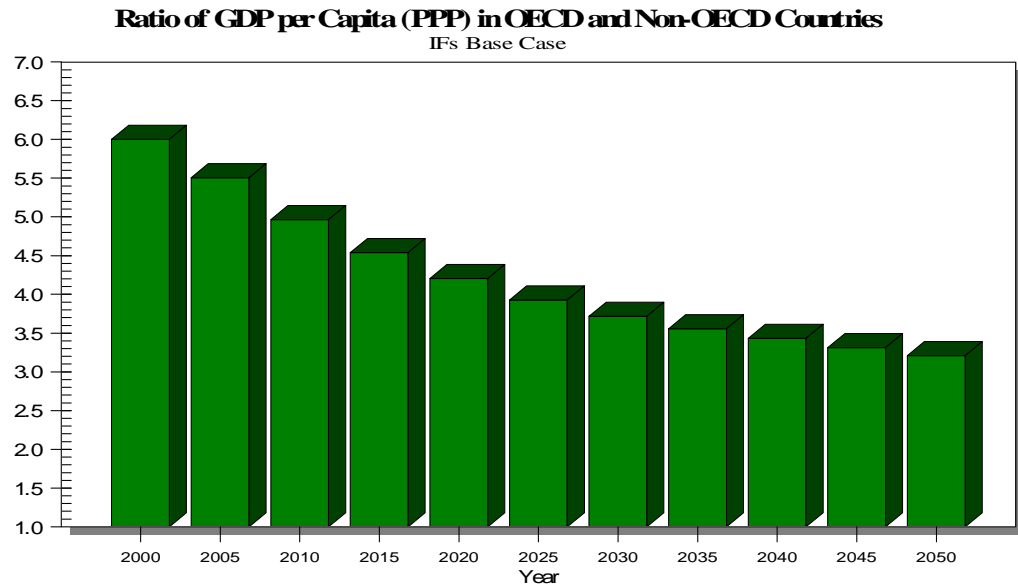
Slower demographic growth in more developed countries is one reason for a more conservative total growth forecast, and are further a reason for anticipating a relative shift in growth towards the South. Between 1960 and 2000, the GDP per capita at PPP increased for OECD countries by a factor of 2.84; the forecast is for an increase in the next forty years by only a factor of 1.67.<sup>9</sup> In non-OECD countries the historic increase was a factor of 2.74; the forecast is for an increase of 2.91 in the next forty years. Again, this is by no means the only possible demographic-economic scenario that could serve as a base line for analysis of a global safety net. It is, however, both a credible one and one that scenarios with IFs can easily change.



**Figure 5.17 Patterns of Global Growth in GDP per Capita (PPP)**

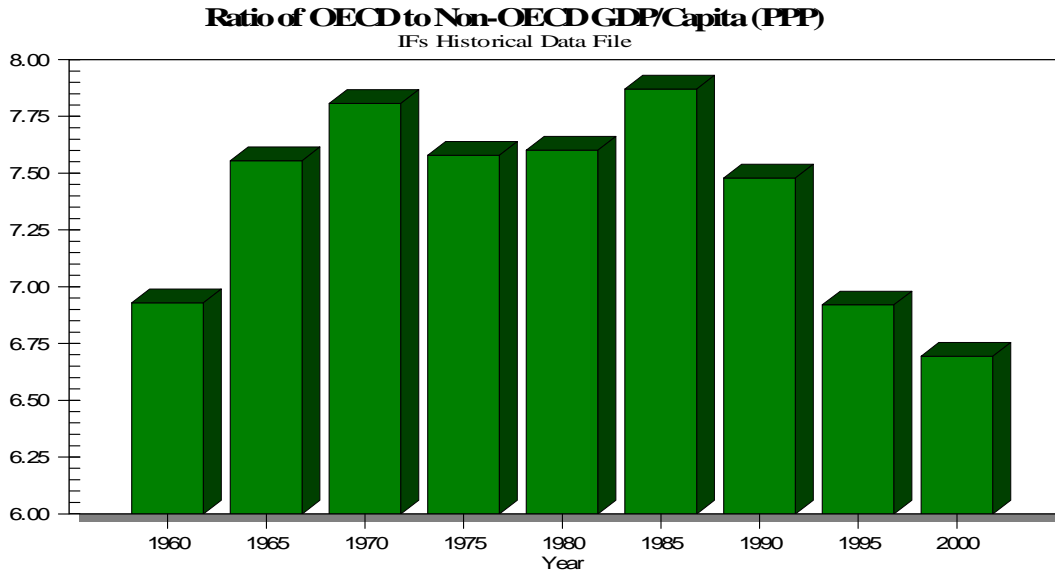
<sup>9</sup> Angus Maddison (1995 and 2001) has provided some of the very best analysis of historic growth. He refers to the age that includes the 1960s as the “Golden Age,” and in addition to pointing out the unparalleled character of rapid growth during it, is skeptical about the ability of the world to match it in coming decades.

The slightly unorthodox character of the base case scenario is more evident in Figure 5.18, which shows the ratio of GDP per capita in OECD and non-OECD countries. That ratio in the IFs base case is narrowing, as indicated above.



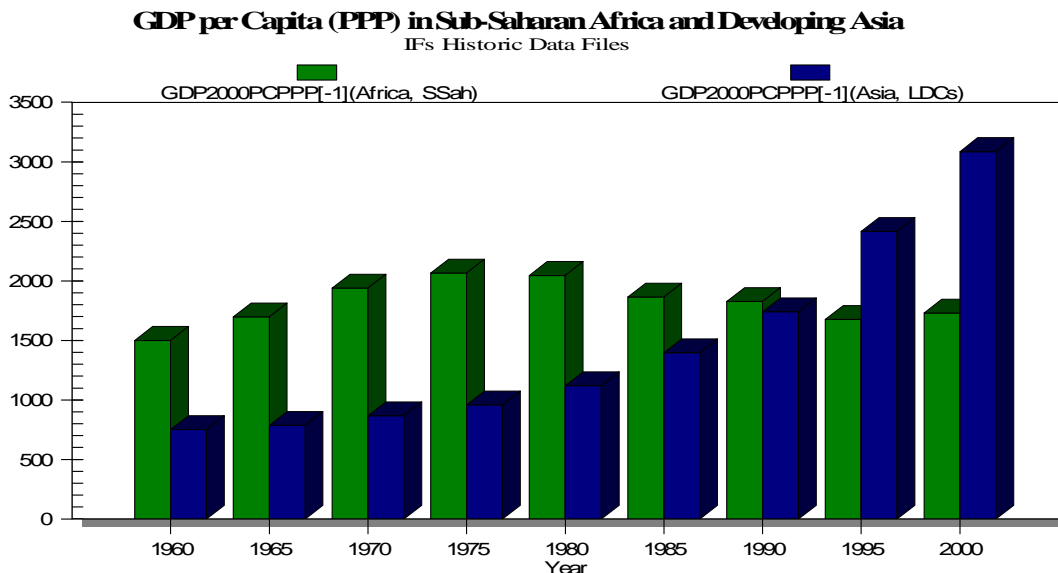
**Figure 5.18 The Global Ratio of North/South GDP per Capita (PPP)**

Figure 5.19 shows some of the historic basis for anticipating such narrowing of the North/South gap in ratio terms. Whereas that gap increased steadily throughout essentially the entire era since the early industrial revolution, it seems to have stabilized in the 1970s and 1980s and actually to have decreased in the 1990s in spite of the “New Economy” of the more developed countries.



**Figure 5.19 Historic Change in the Global Ratio of North/South GDP per Capita (PPP)**

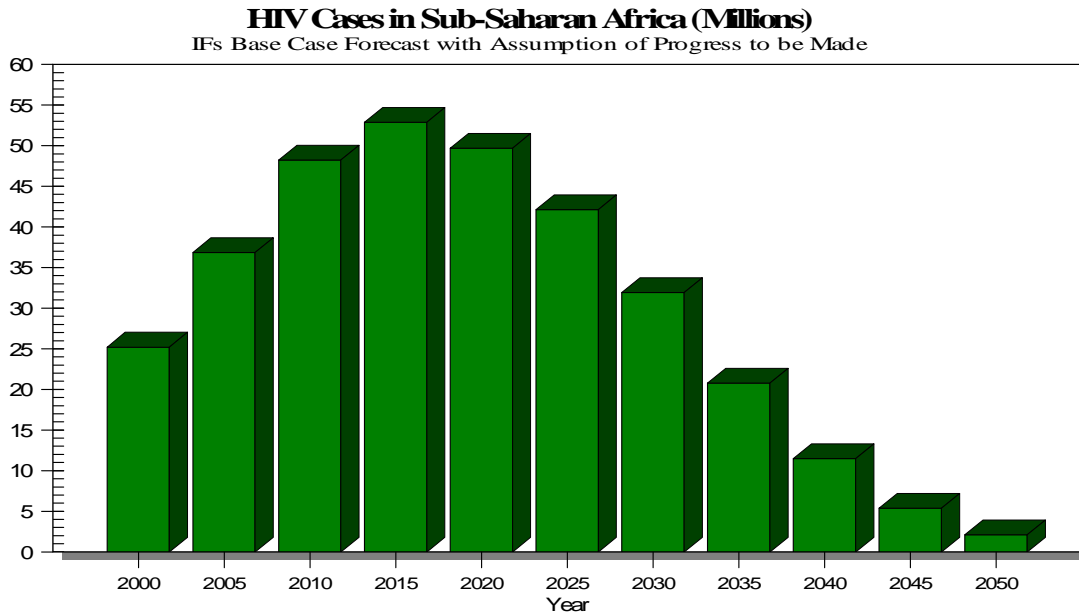
It is important to understand also, however, that the reason for the historic decrease in ratio of North-South GDP per capita was an economic break-out by countries in the Asia-Pacific region, including the giants of India and China in recent years. In contrast, there has actually been a decline in the aggregate GDP per capita of sub-Saharan African states in the last two decades.



**Figure 5.20 Historic Change in the GDP per Capita (PPP) in the South**

As we further address issues around a global safety net, it will be very important to maintain a focus on the great differences in potential for implementation of a safety net that Figure 5.20 conveys. The very large and growing burden of HIV/AIDS in Africa is

another element of that differentiation in prospects and potential (although Eberstadt 2002, building on CIA analysis, has forecast that the burden will increasingly spread to China and India in the Asia-Pacific region, as well as to Russia). Figure 5.21 conveys the current base case forecast in IFs of HIV cases in Africa and the Middle East, a forecast that obviously and arbitrarily introduces growing progress against the disease in the 10-20 year time horizon.



**Figure 5.21 A Forecast of HIV Cases in Africa and the Middle East**

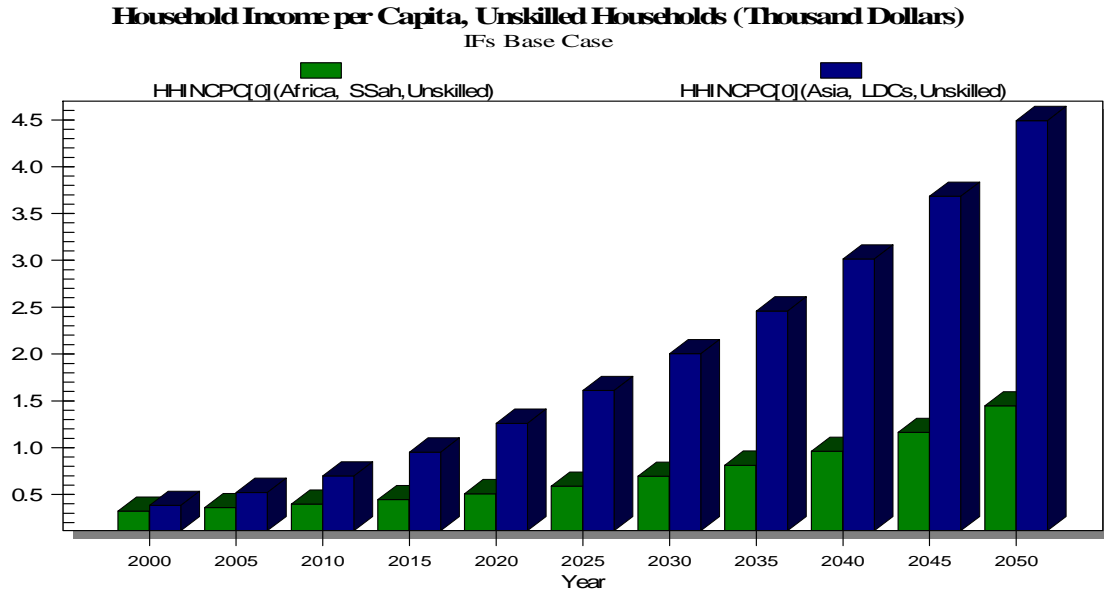
In short, the demographic-economic context for extending a global safety net to the developing world is considerably more complex and uncertain than is the more predominantly demographic context for meeting pension demands in the developed world (as discussed earlier). Scenarios, to which Chapter 6 returns, will be as important in this analysis as are policy interventions.

### 5.2.2 Insights from Social Accounting

Even before turning to scenario analysis, however, it is useful to take a quick look at some of the kinds of capability that a SAM-based analysis can bring to the investigation. Figure 5.22 directs our attention to the unskilled households in the Sub-Saharan Africa and Developing Asia regions. It is often pointed out that more than a billion people around the world live on incomes of less than \$1/day (UNDP 2002:18). That is sometimes hard to see in country-level data that show relatively few countries with GDP per capita of less than \$500 (at PPP). The differences in income between skilled and unskilled households in LDCs are, of course great and the SAM's differentiation of households into skilled and unskilled subsets lets us look specifically at the most impoverished. When we focus our attention on unskilled households (using GDP per capita at exchange rates), we see that even after the remarkable economic success of recent years, the average incomes of Asian-Pacific unskilled households are approximately \$1/day (the numerical average value for those unskilled households in

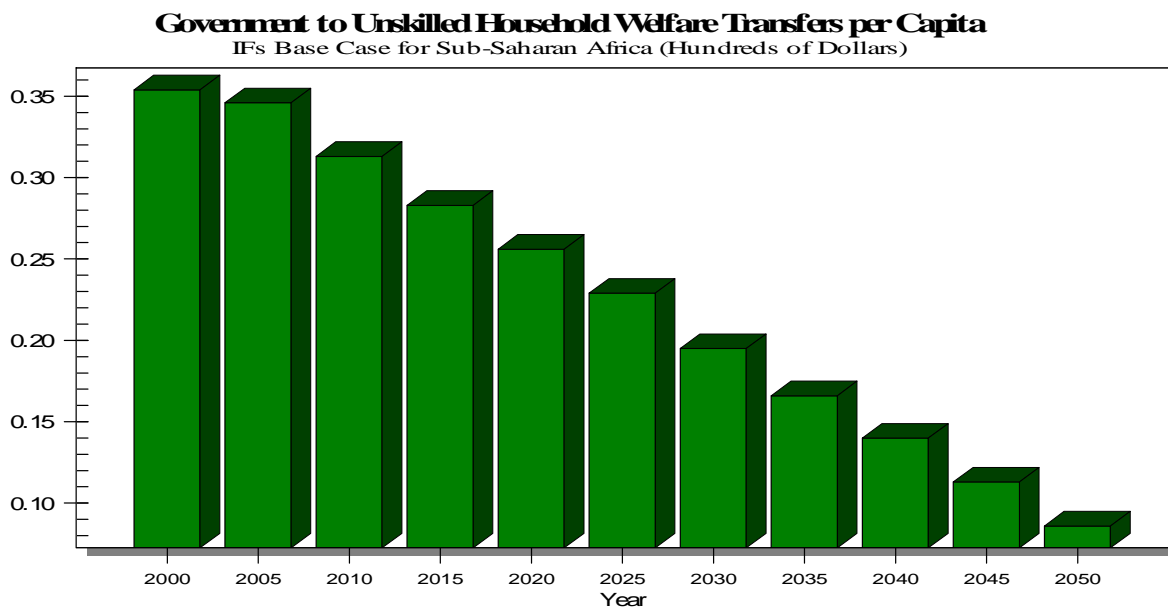


2000 is actually \$383, across countries with a total population of 3 billion) and the household incomes of the unskilled in sub-Saharan Africa are even lower. Further, the forecast for growth in unskilled household income in sub-Saharan Africa, given the decline of the last 20 years, may be optimistic.



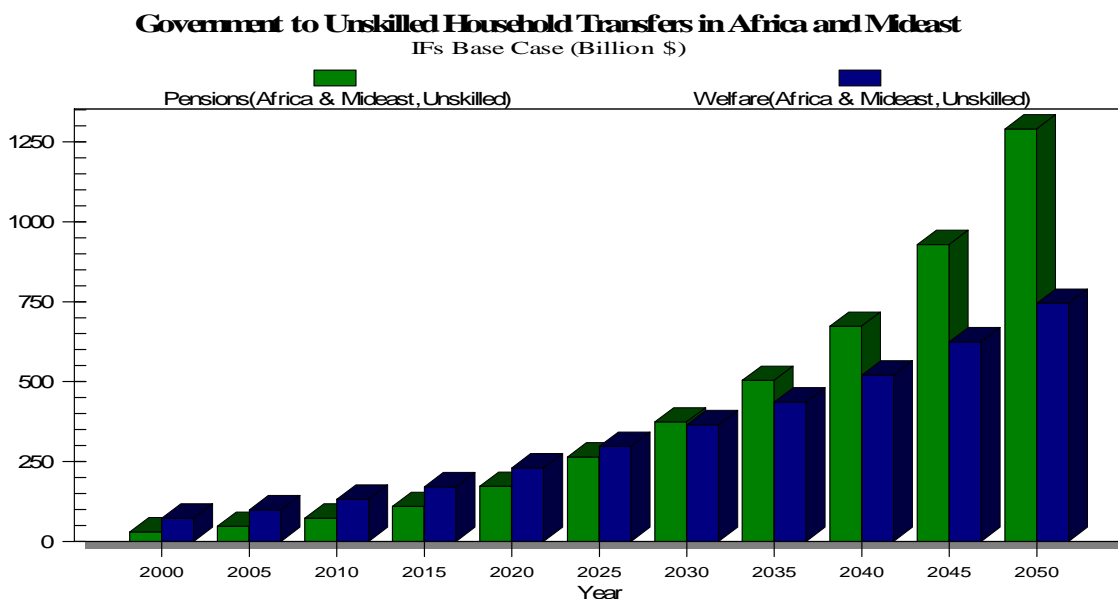
**Figure 5.22 Unskilled Household Income per Capita in LDCs**

Nor are base case forecasts of per capita welfare transfers to unskilled households of any significant magnitude. Figure 5.23 shows that they are tiny and, moreover, suggests that that they might actually decrease in the future, a result that is likely again a crowding out effect.



**Figure 5.23 Government Welfare Transfers per Capita in Africa and the Middle East**

Figure 5.24 presents a somewhat more optimistic picture, however, because it returns our attention from welfare transfers to total transfers (including pension funds). As we saw earlier, the growing old populations of developing countries (not, obviously, those in the most severely-AIDs stricken countries) will be requiring, and may receive greater assistance. Figure 5.24 suggests that, in the current base case of IFs, pensioners do much better than broader populations, an initial set of assumptions that probably should be challenged.



**Figure 5.24 Total Government Transfers in Africa and the Middle East**

The purposes of this chapter have been (1) to convey some of the context of meeting social needs of rich and poor countries in the first half of the 21<sup>st</sup> century and (2) to provide some very early insight into how analysis with IFs, including a SAM structure, can unfold. Although the initial analysis here is subject to very considerable extension and refinement, it already conveys the magnitude of the challenges in attempting to create safety nets in LDCs. Alternative scenarios, to which we turn now, will further explicate both the range of uncertainty that exists around those challenges and the policy leverage that social actors have with respect to them.

## 6. Scenarios

This chapter will be drafted over the coming months. It will have several components:

1. An identification of key uncertainties that affect/frame analysis of social support for human development. It has already been suggested above that demographic and economic uncertainties may be the most critical for the analysis (unless otherwise indicated, there are scenario handles in IFs for structuring alternative scenarios on the following key uncertainties):
  - In demographics these will include demographic patterns of extension in longevity (major extensions would dramatically change the entire pension issue); changes in fertility rate for developed countries from currently low and below replacement levels (will those rates rise again to replacement rates or sink further?); progress against HIV/AIDS (or lack of it and possibly even other plagues).
  - In economics these will include rates of technological change and the diffusion of it (have we shifted long-term productivity rates up by 1% with ICT as some claim or not as others argue?); and the extent of globalization (could the backlash forces reverse it? – globalization is not as fully represented as it could be in IFs, because we have trade, but not FDI and portfolio financial flows).
  - Other issue areas treated within IFs might also be useful in developing framing scenarios. For instance, in energy the rate of progress towards less expensive renewable energy technology could have affects that propagate across the economic system, as could environmental issues such as carbon emissions and water availability (water availability is represented in quite basic fashion in IFs).
2. An identification of primary policy leverage points that affect/frame analysis of social change. It has already been suggested above that a number of these will relate to the activities of the actors/institutions represented within the SAM. Again, unless otherwise noted, levers exist in the IFs interface for:
  - Governmental actors play key roles with decisions around total spending and revenue levels; allocation of spending between direct consumption/expenditures (such as health care, education, and the military), on one hand, and transfer payments, on the other; and allocations of expenditures within categories (e.g. between health care and education, between primary and tertiary education, or between pensions and more general social welfare).
  - Households play important roles with respect to the trade-off between current consumption and savings/future consumption

- Firms could play important roles, most prominently also on trade-offs between re-investment and profit distribution; that capability is not yet present in IFs.
- External states plan key roles with decisions on foreign aid, loans, debt forgiveness (debt forgiveness is not yet a policy handle in IFs).

Key uncertainties and primary policy leverage points sometimes overlap or interact (changes in governmental fiscal policy, for instance investment in R&D, could affect productivity growth rates).

We will develop a set of bright and dark scenarios for general framing and explore the sensitivity of outcomes to policy changes over a range of interacting alternatives. In the process of doing this, we will clearly keep in mind goals, such as the basic goal of enhancing HDI levels, or the broader set of the Millennium Summit goals.<sup>10</sup> We will also keep in mind the possibility that some darker scenarios should emerge from policy wrong-turns (consider, for example, the failure by Mbeki to address HIV/AIDS in South Africa).

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<sup>10</sup> The possibility of being able to link up IFs to the CARS system of RAND would great facilitate this scenario and outcomes exploration.

## 7. Next Steps

Some of the next steps have been identified throughout this draft, but many have not. A number of these activities can proceed in parallel:

- Additions of terms that have been added to the model to the specialized displays of SAM flows and stocks:
  - Flows: XFDIFIN, XFDIFOUT, XPORTFIN, XPORTFOUT, XWBLNFIN, XWBLNFOUT, XIMFCRFIN, XIMFCRFOUT
  - The addition of these flows presumably will not balance without tying to foreign savings
  - Stocks: XPORTFOLIO, XPORTSTOUT
  - Flows and Stocks: breakout of IFI row and column from ROW
- Enhanced representation of agent-class behaviour:
  - Especially IFIs. Tie to new data on WB and IMF Addition of parameters for IFI inflows (loan repayment periods, interest rates). Addition of loan forgiveness options. Capital raised on open markets.
  - Also life-cycle consumption patterns for households so that the propensity to consume on pensions is appropriately represented as considerably higher than that of income accruing to younger populations
- Other model enhancements:
  - Linking XGOVTDEBT back to govt domestic debt (now domestic is initialized but held constant)
  - Add worker remittances as flows, using new data table from Anwar on remittances
  - Need to continue working on multiple households; Inglehart or WB
  - Pass through of firm investment to households should be revisited. Firm earnings retention should be tied ultimately to (a) depreciation of K plus (b) new investment.
  - Not linking firm savings in any way to I. Consider it.
  - More policy levers, including multipliers on IFI flows
  - Review representations of current and capital account
    - Add dynamics around firm lending?
- Developing and exploring a range of scenarios (high priority). In that process, there will inevitably be discoveries about model behaviour that lead to refinements and extensions of the system.

In addition, there are some elements of enhancement that may be less obvious from the above text. One of the most important is a clearer representation of the dynamics of labor supply and demand and their interaction, using the unskilled/skilled labor categories. Some of the dynamics for labor demand are already present in the relationships developed from GTAP data between labor payments by sector and GDP per capita. More can be done here. A basis for representing labor supply exists in the educational model of IFs and the differentiation between primary, secondary, and tertiary educated populations; in fact, an initial representation of changing labor supply has been

introduced. A preliminary representation of labor supply using this formulation suggests that skilled labor supply grows too rapidly relative to labor demand unless it is assumed that significantly decreasing portions of those with secondary education are skilled in more developed than in less developed economies. The reasons for refining these labor demand and supply representations include better tying of decisions about education to broader development, but also include the potential of having a labor market representation that provides some insights into the potential for increasing or decreasing inequality within countries.

Extensive scenario analysis needs to be undertaken as a test and an end in itself, starting with the update of the earlier analysis section. The data, structures and other capabilities within IFs will now support extensive analyses of social change. Some of those capabilities are truly unique among forecasting systems. This paper is a living document that will grow and change substantially over coming months. Feedback is always appreciated.

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