

# Think DEEP

## A Participatory Research Project

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### **Abstract**

DEEP (Distributive Effects of Economic Policy) is an ongoing project of the Integrated Social Development Center (ISODEC), a Ghanaian non-governmental organization, to build a disaggregated dynamic economic model of Ghana's economy to provide a clear understanding of the economywide feedbacks that determine the effects of particular government policies and external shocks on the income and quality of life of the poor and the marginalized.

The model is structured around a Dynamic Social Accounting Matrix framework, which gives a comprehensive, disaggregated map of nominal money flows in the economy. While Social Accounting Matrices are normally used to construct Computable General Equilibrium models, using one to structure a dynamic model is an innovation with substantial advantages.

As the relevance and credibility of the model are established, it should become an essential tool for public sector agencies involved in formulating and advising government on the structural options available for Ghana, as well as a powerful framework for discussion between government and civil society.

**Keywords:** Social Accounting Matrix, Income Distribution, Macroeconomic Dynamics, Development

### **Introduction**

The impact of macroeconomic policies and shocks on the poor is an issue as important for policy as it is analytically challenging. One reason for the latter is

that often the poor are only weakly linked to the formal economy. Therefore, they will not be affected as much by the policies themselves as by the changes in the overall structure of the economy that the policies cause. These structural changes in turn are determined by a number of interacting feedbacks within the economy, limiting the applicability of traditional economic approaches such as regressions or general equilibrium models.

Furthermore, these feedbacks are highly country-specific, calling for detailed case studies using time-series as well as cross-section data. Finally, as in all crucial policy areas, the process of creating successful anti-poverty policies should involve participation of both the local intellectual elite and the civil society.

As meaningful discussions of economic policy require a good quantitative understanding of the Ghanaian economy and in particular the economic context in which the poor live, there is a widespread demand for an adequate model of economic policy and its social impacts among the government agencies such as NDPC and the Ministry of Finance, as well as local research institutions and civil society organizations.

A transparent, integrated dynamic model could provide a framework for discussion and crystallization of the individuals' insights into a coherent view of the economy as a whole, thus advancing both the capacity of the institutions to provide policy advice, and intellectual insight into the economy's behavior.

Furthermore, if the model is built from the start to incorporate both the standard economic perspective and that of the grassroots organizations, it could provide an invaluable context for dialogue between the two perspectives. That such a dialogue has hardly happened to date is not the least due to the enormous difference of the conceptual frameworks underlying the thinking of trained economists vs. civil society organizations. A jointly built model could prove a good way of bridging that gulf.

The author has combined his position as a doctoral student at the University of Maryland with a consultancy for the Integrated Social Development Center (ISODEC), Ghana, to lay the groundwork for a participatory research project with the objective of building a dynamic economic model that realizes the possibilities outlined above.

## **1 A Dynamic Social Accounting Matrix Model**

The DEEP project is developing and using a novel modeling technique, namely a Dynamic Social Accounting Matrix model. This section discusses and justifies the technique.

## 1.1 Reasons for building a dynamic model

While there is a large number of models constructed to estimate the impacts of macroeconomic policies and external shocks on a developing country's economy, most of them are Computable General Equilibrium (CGE) models. This subsections lays out the reasons the present project is opting for a dynamic model instead.

Firstly, it typically takes several years for an economy to fully react to an external shock or a change in policy, as noted e.g. in Killick et al. [1995] and Khan [1990] for the specific case of adjustment programs sponsored by the International Monetary Fund. As a model with clear policy relevance should have a time step not longer than a year, the main assumption of general equilibrium models (namely that the economy finds to a new equilibrium within less than a time step) is thus violated. Particularly for modeling structural adjustment, tracing the temporal dynamics of the transition is essential. Many important economic variables (employment; inflation) are an outcome of interplay of several dynamic processes happening on different time scales.

Secondly, making the model dynamic allows one to explicitly calibrate the response times of different components of the system to the time series available. This will be an advance over sequential equilibrium models, as calibrating the model to one time slice does not necessarily provide information on the temporal behavior of the system. In particular, estimates of an elasticity parameter from cross-section data and from time-series often differ substantially.

Finally, many processes of interest are inherently dynamic, with a strong possibility of positive feedback loops, leading to unstable dynamics. Thus, inflation increases costs of living and production, leading to even more inflation in a well-known spiral. In the Ghanaian case, the interviews suggest another strong feedback loop between inflation, currency depreciation and food prices, with inflation leading to depreciation of the currency and thus higher costs of imports, driving up food prices and leading to more inflation.

Inflation, in fact, is a particularly important variable as it connects the macro and the micro levels. On the one hand, it is a key target variable of macroeconomic policy, on the other hand, it can be responsible for erosion of real income that is very much felt by individual households. Thus, understanding the behavior of inflation in time, by directly tracing nominal money flows and price formation, would be a great asset for addressing both income distribution and economic policy questions.

## 1.2 Social Accounting Matrices

A Social Accounting Matrix (SAM) is an ordered listing of all money flows between different sectors of an economy at a specific level of disaggregation. To illustrate the concept, let us start from a simple money flow chart and see how it is represented in SAM form.

### 1.2.1 An Example

Figure 1 is a simplistic representation of money flows in an economy. Blocks denote different accounts, arrows represent money flows between them. The value added generated in the Production block is distributed between firms, households, and government in the Income Distribution block. The resulting disposable incomes flow, according to the demand patterns, partly into the Production block (as final consumption expenditures) and partly into the Financial Sector block as savings. From the financial sector, money is injected back into the product markets through investment expenditures.

Let us now see how such a flow chart would be represented as a SAM. Each of the blocks becomes an account of the SAM, listed in exactly one row and exactly one column. The content of the cell belonging to column A and row B then denotes the money flow from A to B. In our example, the SAM corresponding to Figure 1 is depicted in Table 1. Now all money inflows into the product markets, for

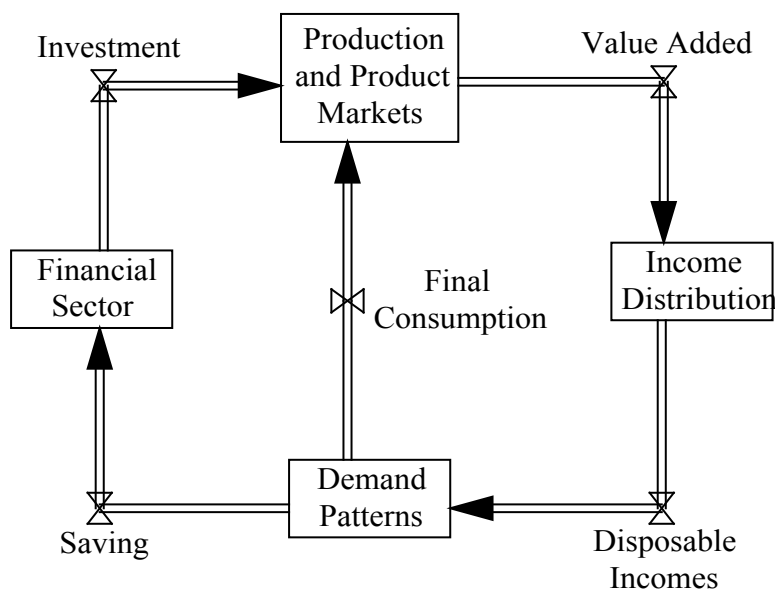


Figure 1: A Simple Money Flow Diagram

instance, are contained in the first row, and all money outflows from the product markets in the first column of the matrix.

A real Social Accounting Matrix differs from the one just presented mainly in the level of disaggregation. Thus, the Ghana 1993 SAM has ten accounts, each divided in two to eighteen sub-accounts, resulting in a 120x120 table.

|                                | Production and Product Markets | Income Distribution | Demand Patterns   | Financial Sector |
|--------------------------------|--------------------------------|---------------------|-------------------|------------------|
| Production and Product Markets |                                |                     | Final Consumption | Investment       |
| Income Distribution            | Value Added                    |                     |                   |                  |
| Demand Patterns                |                                | Disposable Incomes  |                   |                  |
| Financial Sector               |                                |                     | Saving            |                  |

Table 1: *A Simple Social Accounting Matrix*

### 1.2.2 A SAM as an Expression of a Conservation Law

Another way of looking at a SAM is as an expression of a conservation law for nominal money. Here we use the concept “conservation law” in the way it is used in physics, namely as referring to a quantity that is not necessarily constant, but rather a stock whose value can only be changed through a known set of outflows.

A SAM takes advantage of the fact that most economic agents don’t create or destroy money; thus, unlike goods that are produced and consumed, money flows in closed loops with a few well-defined sources and sinks, notably the Central Bank and foreign lenders.

The backbone of a SAM-based model is thus a “plumbing system” of money flows that piece the different parts of the economy together, in particular connecting the real to the financial side, allowing us for example to trace the feedbacks between money supply and output. On top of this plumbing sits the real part of the economy, where the decisions of different agents and their interaction in markets determine which way the money actually flows and how much goods and services one gets in return.

As to date the SAMs were mostly used in equilibrium models, there was almost no place in their structure to represent a change in stocks. In fact, the conventional balancing rule in a SAM is that the sum of each row must equal the sum of the corresponding column, that is that inflows exactly equal outflows for each account. Within this framework, it is also possible to represent accumulation of assets (see e.g. Taylor [1990]), but the representation fast becomes unwieldy.

A simpler way to adapt the SAM structure to the needs of a dynamic model is to include in it stocks as well as flows, that is to include an accumulation account for each row/column pair and set its rate of change equal to the difference between inflows and outflows. The increase in complexity that we incur hereby is minimal, as for most accounts of the SAM the balancing condition still holds

in its original form<sup>1</sup>. However, allowing money to accumulate in some parts of the economy will allow us to directly represent demand for money, as well as to let the consumption demand depend both on the cash stock and the income flow of the household in question.

Thus a SAM framework fits quite naturally into a dynamic context, and the resulting slight increase in complexity is rewarded by increased realism.

### **1.3 Advantages of a Social Accounting Matrix structure for a large dynamic economic model**

While it is thus clearly possible to use a Social Accounting Matrix framework to build a dynamic model, it is a different question altogether whether the endeavor is worthwhile. This section names several advantages that a Social Accounting Matrix structure gives to a dynamic model.

**A clear organizing principle** Large dynamic models have something of a reputation for opaqueness and excess complexity, consisting often of several hundred equations. This complexity can be daunting to the user of the model, and make critique and refinement more difficult.

The same problem is faced by CGE models, where it is mostly solved by ordering the equations in a SAM framework. Each partial description of the economy has a clear, well-defined position within the SAM. It is likely that the same approach will also prove useful in providing structure to dynamic models.

**Automatically enforces accounting identities** A SAM is a method for making one's data internally consistent. While there is a rich array of data for all levels of the Ghanaian economy, its quality is varied. Arranging the data in the grid of a SAM will make one aware of the inconsistencies therein and hopefully also allow to eliminate them by cross-questioning the data.

The approaches of the World Bank and the IMF to macroeconomic policy design also make heavy use of accounting identities. The structure of a SAM will force the model to automatically fulfill these, increasing its credibility from the point of view of the policymakers.

Another use of accounting identities is that they yield a large number of model equations "for free", leaving the modeler free to focus on the few behavioral equations that are country-specific.

**Data needs for base year calibration are organized in a readily available format** A large, dynamic economic model needs a large amount of data for cal-

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<sup>1</sup>For instance, the factors of production, such as labor, don't keep any money, but pass it to the institution they originate from, such as households.

ibration and validation. It is helpful if it is organized in a way that matches the structure of available data, which is exactly the advantage of a SAM structure.

In our case, a detailed SAM for Ghana for the year 1993 has been compiled by the Ghana Statistical Service. It provides an official reference point for calibrating the model. Combining the SAM with time series available for selected variables will allow us to calibrate the model; the next SAM (for 1998) can then be used for validation.

**Output is organized in a format familiar to economists** The acceptance of a model is enhanced if its output is organized in a widely accepted format. The format of a Social Accounting Matrix has evolved over decades as an accepted way to represent a comprehensive set of economic data. Thus generating a full SAM for every year of simulation should contribute substantially to the model's usefulness to practitioners.

## 2 Implementation

The ideas above are now being implemented in a computer model. The model is being built in Vensim, a dynamic modeling environment. A major advantage of Vensim is its ability to handle time-dependent matrices, which allows to boil down the interrelationships in the full SAM to a manageable number of equations.

All data for the model are stored in Excel spreadsheets separately from the model and read in at runtime, increasing transparency and simplifying the updating of the data.

The first step was to convert the 1993 Ghana SAM compiled by the Ghana Statistical Service into a flowchart form in the Vensim modeling environment.

**The 1993 Ghana SAM as a flowchart** The next two pages contain a representation of the Ghana 1993 SAM in the style of Table 1, as well as the corresponding flow chart. Each of the accounts in the SAM is actually subdivided into 10 to 18 sub-accounts, resulting in a 120x120 matrix. While modeling the dynamics of this large a table could seem intimidating, Table 1 already shows that most of it is empty; and consistent use of matrix notation will allow to describe its dynamics with a manageable number of equations.

**Specifying the Equations** Due to the size of the Social Accounting Matrix, it is impossible to specify all the relationships in a fully realistic way from the start. Therefore, the first step was to construct a fixed-ratio model based on the Ghana 1993 SAM, allowing simple comparative statics experiments.

The next step will take place in July, when in discussion with economists from the Institute for Economic Affairs and the Center for Economic Policy Analysis

|                                   | Products                   | Activities               | Generation of Income               | Primary Distribution of Income | Secondary Distribution of Income | Use of Income          | Capital Accounts        | Capital Formation | Financial Assets | R.o.W. Current Account           | R.o.W. Capital Account           |
|-----------------------------------|----------------------------|--------------------------|------------------------------------|--------------------------------|----------------------------------|------------------------|-------------------------|-------------------|------------------|----------------------------------|----------------------------------|
| Products                          | Payments to Trade Services | Intermediate Consumption |                                    |                                | Final Consumption                |                        | Capital Goods Purchases |                   |                  | Exports                          |                                  |
| Activities                        | Activity Revenues          |                          |                                    |                                |                                  |                        |                         |                   |                  |                                  |                                  |
| Generation of Income              |                            | Factor Incomes           |                                    |                                |                                  |                        |                         |                   |                  |                                  |                                  |
| Primary Distribution of Income    | Net Taxes on Products      |                          | Factors to Institutions Conversion | Property Incomes               |                                  |                        |                         |                   |                  | Net Property Incomes from R.o.W  |                                  |
| Primary Distribution of Income    |                            |                          |                                    | National Income                | Current Transfers                |                        |                         |                   |                  | Net Current Transfers from R.o.W |                                  |
| Use of Income                     |                            |                          |                                    |                                | Disposable Incomes               | More Current Transfers |                         |                   |                  |                                  |                                  |
| Capital Accounts                  |                            |                          |                                    |                                |                                  | Savings                | Capital Transfers       |                   | Sale of Assets   |                                  |                                  |
| Capital Formation                 |                            |                          |                                    |                                |                                  |                        | Investment              |                   |                  |                                  |                                  |
| Financial Assets                  |                            |                          |                                    |                                |                                  |                        | Asset Accumulation      |                   |                  |                                  | Net Capital Transfers from R.o.W |
| Rest of the World Current Account | Imports                    |                          |                                    |                                |                                  |                        |                         |                   |                  |                                  |                                  |
| R.o.W Capital Account             |                            |                          |                                    |                                |                                  |                        |                         |                   | Net Borrowing    | Current Account Balance          |                                  |

Table 2: The Structure of the Ghana 1993 Social Accounting Matrix



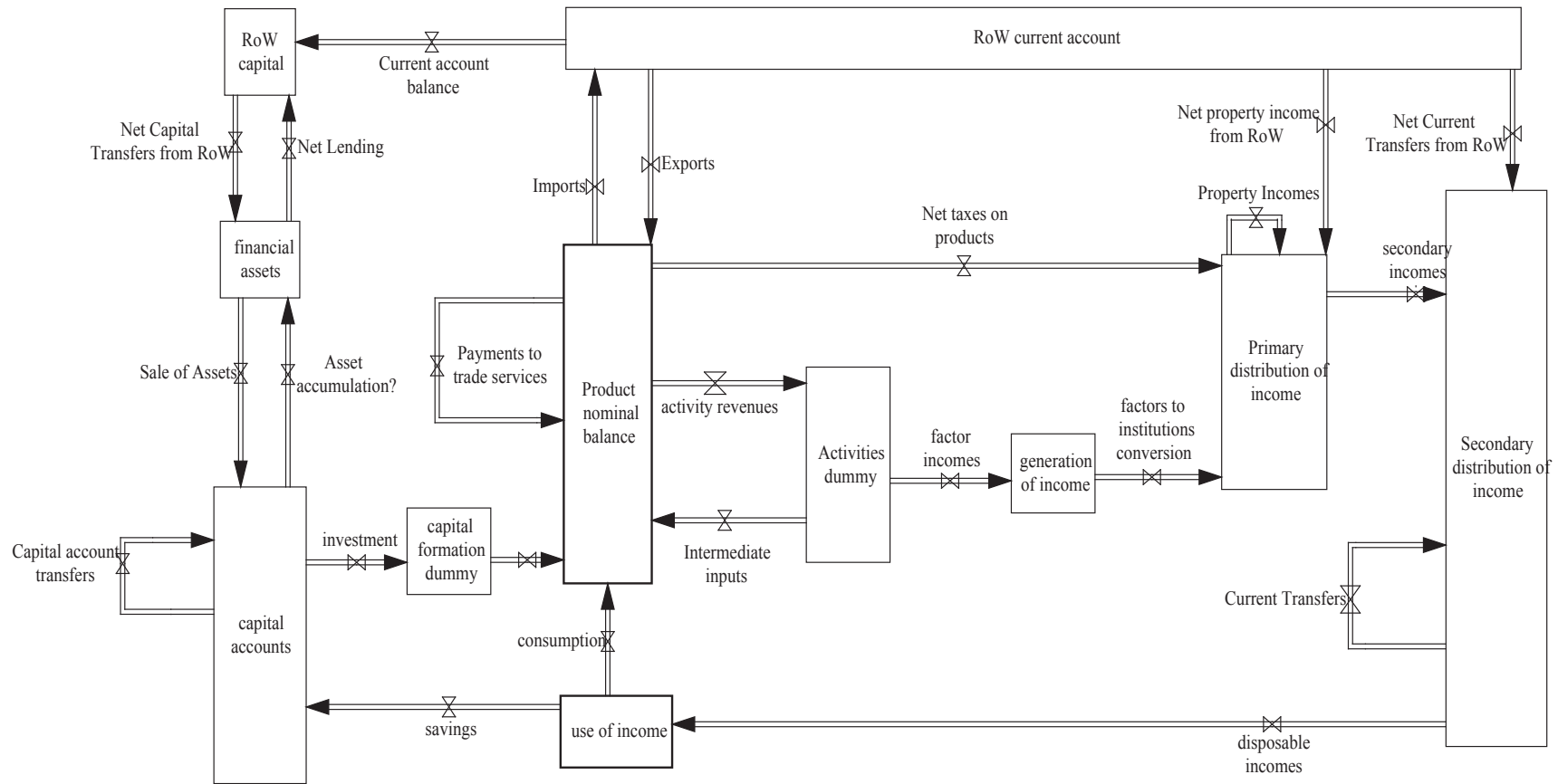


Figure 2: The Ghana 1993 Social Accounting Matrix as a Flow Chart

(two major Ghanaian think tanks) the author will specify a minimalist dynamic framework, to be iteratively refined based on peer review and user feedback.

**Calibration/validation** As mentioned before, the data to be used for calibrating the model will be the 1993 Ghana SAM combined with selected time series for years 1993 to 1998. The time period from 1998 onwards will be used for validation. The year 1998 is chosen mainly because the Ghana Statistical Service is about to compile a SAM for Ghana for that year, which will be an important validation checkpoint for the model.

Another way of testing the model's quality will be an extensive sensitivity analysis, which can be easily performed in Vensim.

**User Interface** While Vensim provides a powerful environment for building the model, ISODEC is also building a simplified user interface for the model using Visual Basic. This will allow to distribute the model as a standalone Windows application, and to build professional-quality custom interfaces for specific users, lowering their time cost of learning to use the model. Using Visual Basic also allows to embed live Excel-generated graphs and maps into the user interface, producing high-quality graphical output with little programming effort.

### **3 Model-Building Process**

A model only has a chance of being used if it is built from the start to incorporate the perspectives of the potential users. This is especially true for a model which is intended to serve as a means for dialogue as well as policy analysis.

The DEEP effort is well positioned to incorporate the different perspectives of its potential users. It is currently based at ISODEC - a non-governmental organization with a commitment to building a credible research capacity in economic policy issues; from its inception onwards it has been periodically exposed to review and criticism by representatives of the Ministry of Finance, the Bank of Ghana, the National Development and Planning Commission, and local research institutions. Here is a short description of the model building process until now.

#### **3.1 Process to date: Consultative**

From the outset of the project in Summer 2001 through the present, model conceptualization and building were done by the author in his dual capacity as a macroeconomic modeling consultant to ISODEC and a PhD student at the School of Public Affairs, University of Maryland, based on discussions with his advisors at UMD as well as ISODEC staff.

With ISODEC's assistance, the author could also draw continued advice from Dr. Bawumia, Special Advisor to the Governor of the Bank of Ghana and Dr. Ashong

of the Center for Economic Policy Analysis, Accra, Ghana, and present it to other Ghanaian economic experts on several occasions.

While providing the author with rich information on the Ghanaian economy and the interests of the potential users, this kind of consultative process was still not entirely satisfactory from the point of view of future adoption of the model. While conceptually the model drew on the expertise of the many people mentioned above, its actual equations were still the work of only one person.

This situation has changed in April 2002, as the model was presented to a selection of representatives of diverse government agencies and local think tanks.

### **3.2 From Consultative to Participatory**

After attending the presentation of the DEEP project hosted by the Institute for Economic Affairs on April 12, 2002, senior researchers from the National Development Planning Commission (NDPC) as well as the Institute of Economic Affairs (IEA) and the Center for Economic Policy Analysis (CEPA) have agreed to take active part in the model construction process by founding the DEEP Technical Support Group. The group's members are senior representatives of the above institutions who will meet weekly to discuss specific issues arising during the construction of DEEP, with a view to using the end product in their own research and policy analysis. Senior officials from the Ministry of Finance and the Bank of Ghana have also expressed interest in joining the DEEP Technical Support Group.

## **4 Outlook**

As the project is still in the inception phase, it does not yet provide firm research results to analyze. This section is a brief outline of the range of issues that the model will address and the potential uses to which it could be put.

### **4.1 Examples of Policy Issues DEEP Will Address**

Using a dynamic SAM approach offers us the advantage of easier tracking the interactions between the real and the monetary sides of the economy. It is for example possible to simulate a cash injection from the central bank and watch it work its way through the economy with time, looking at both output and price effects.

Thus, the author already implemented a simple markup price formation mechanism that, while not yet calibrated to any data, reproduces the dynamics of cost-push inflation (arising e.g. from oil price increases), tracing the propagation of price increases through the different sectors of the economy.

Another interesting insight a SAM approach offers is analyzing the strength of linkages between different sectors of the economy, e. g. the structure of the extra demand generated by an increase of cocoa prices. Tracing the flows of money also allows us to endogenize multiplier effects of, for example, government spending and thus numerically investigate the dependence of the sectoral multipliers on, for example, import tariffs.

As a SAM has a high degree of disaggregation (distinguishing in the case of Ghana fourteen household types, for example) a dynamic SAM model can explicitly represent the income flows and expenditure decisions of different population groups such as food farmers, private sector employees, and informal sector self-employed. These are linked to the more traditional macroeconomic agents like government and manufacturing firms through markets for food and formal and informal goods and services. Output, income and employment of each population group are then determined in the corresponding market, together with prices, allowing for example to study tax incidence.

We will base our macroeconomics in the structuralist tradition, because of its emphasis on issues of income distribution and underutilization of productive capacity, both of great relevance for the developing world in general and for the Ghanaian situation in particular, although mostly glossed over in neoclassically-inspired models currently dominant at the World Bank and the International Monetary Fund. A focus on Keynesian-like demand effects will allow to represent for example the recessionary impacts of stabilization programs that are often neglected or understated in analyses by the International Monetary Fund.

## **4.2 Potential uses for DEEP**

The DEEP project's goal is to create an integrative, dynamic social accounting framework as an instrument for

- Integrating different stories about specific parts of the Ghanaian economy, such as the informal agricultural sector, in a dynamic model.
- Create dialogue between civil society groups, local research institutions, and government agencies about the distributional impacts of government policies and external shocks.
- Create a coherent, dynamic picture of the Ghanaian economy incorporating the perspectives of the above groups and institutions.

The model will be made freely available to the public both in printed form, source code and as a standalone user-friendly Windows application.

The goal of ISODEC is to share the ownership of the modeling process with government agencies and local research institutions, bringing the following benefits:

**Dialogue between government and civil society groups** It could also become a common frame of reference for dialogue and cooperation between civil society groups such as ISODEC and the government agencies.

**Inter-agency communication** The DEEP framework could provide a shared framework for analysis of economic issues among a number of government agencies. The process of refining the model to suit each agency's needs would provide opportunities for institutional capacity building and dialogue within and between government agencies such as the Ministry of Finance, the Ghana Statistical Service, Bank of Ghana, National Development Planning Commission, Internal Revenue Service, and Customs.

**Training** The ability of the model to simulate the reaction of different sectors of the economy to specific government policies could be used to train government staff in policy design.

**Revenue Projections** The disaggregated representation of the money flows in the model could be used to project government revenues, in particular their reaction to external shocks and government policies such as changes in tax rates.

**Prediction and Monitoring of Impacts** Once the model is operational and evaluated by local and international experts and Ghanaian government agencies, it would provide an indispensable tool for an evaluation of impacts of fiscal and monetary policy on specific segments of the economy and specific population groups defined by their income, region, occupation, etc.

Summing up, the aim of the DEEP project is to facilitate a cross-institutional open process of learning, dialogue, and capacity building, centered around building a dynamic model of the Ghanaian economy.

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