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Dynamic analysis of interventions designed to achieve millennium development goals (MDG): The case of Ghana

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ABSTRACT

An increasing number of countries are orientating their development strategies based on the millennium development goals (MDG), a broad set of directives agreed to by the United Nations (UN) in the year 2000. Developing coherent plans to achieve MDG has been complicated by their multidisciplinary nature, and by the complexity of the system being managed. The "system" here is the socio-economic construct within which populations live and operate. In an effort to support this planning process, various approaches have been developed to help realize MDG within specified budgets. The work described here complements the most commonly used approaches by analyzing the impact of alternative interventions in an integrated socio-economic-environmental framework. In doing so, we utilize system dynamics, which is well-suited to support the analysis of dynamic, complex issues such as those that characterize MDG planning. Such an approach allows us to estimate impacts of MDG-related interventions on the economic and demographic development of countries under study, as well as the possible synergies between and amongst selected interventions, e.g., those involving education and health. Results indicate that failure to account for such factors can lead to sub-optimal strategies. Our objective is thus to provide policy-makers with a more comprehensive view of the outcomes generated by alternative MDG interventions, with emphasis on the ability to finance given strategies.

1. Introduction

In the last 40 years, human and economic development has accelerated worldwide, and, has done so at an increasing rate. Nevertheless, a large share of the world's population remains in poverty [1], with developing countries struggling to identify appropriate strategies designed to stimulate growth. Lack of economic growth is often combined with poor human development, which appears to be, at once, a cause and an effect of the lack of economic resources [2]. And, now, environmental degradation and climate change are adding new dimensions to poverty, further complicating the development process.

These past 40 years have also been characterized by what some refer to as the "Washington Consensus" in formulating initiatives for developing countries (DCs) [3]. Within this context, development policies were often dictated by a few international organizations, with little space for DCs to identify their own paths and strategies for change. Such guidelines led to scarce practical results, which are now forcing development policies towards a new paradigm [4]. In an effort to reconsider DCs' needs and priorities, the United Nations (UN) Millennium Summit unanimously agreed, in 2000, on a broad set of development goals known as the Millennium Development Goals (MDG) [5].

MDG are a set of time-bound development goals agreed to by all the world's countries and leading development institutions. The goals cover economic, social, and environmental aspects of development, and are meant to be realized in countries of interest by 2015. Despite having received criticism from a variety of sources, e.g., refs. [6,7], they appear to have made the indubitable contribution of clarifying and quantifying country targets, which have often been only implicitly considered in development agendas.

Under the auspices of the UN, an increasing number of DCs are now orientating their development strategies based on MDG, but, sadly, with only mixed results thus far [8]. The multidisciplinary nature of the goals, and the complexity of the underlying socio-economic system, make it particularly difficult for decision-makers to establish policy priorities, estimate the resources needed, and,

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thus, to actually realize the goals. With such history in mind, the objective of this study is to develop an approach that assists policy-makers in identifying those set(s) of resources and interventions capable of achieving MDG in countries of need. In particular, the proposed approach is applied and tested for the case of Ghana, a country facing major challenges in its progress towards MDG.

2. MDG-based development strategies

In an increasingly dynamic world, public decision-makers are called on to manage highly complex systems. The integrated, socio-economic-environmental systems in which they operate are rich in feedback loops, delays, and non-linearities, with their functioning often escaping our understanding ([9], pp. 3–39). Within this context, mid- and long-term national development planning is a particularly difficult task, where policy-makers must confront countless issues and opportunities, over a time horizon where little can be taken as constant. As a result of such difficulties, it is not unusual that policies lead to unexpected, often undesirable, results [10,11].

During the last three decades, a broad range of computer models have been created to enrich and support our understanding of development processes, and to allow for the testing of alternative policies [12]. More recently, a new set of models has been developed in support of MDG-based strategies and plans. The most commonly used approach has been the UN's MDG-costing, a bottom-up method principally developed by the UN Millennium Project (MP) [13]. This approach basically identifies a country's gaps with respect to each MDG; estimates the unit cost for that intervention(s) required to fill the gap; and then applies this measure to the target population. Eventually, the costs for all goals are summed, while external financial needs are estimated based on the country's ability to generate internal resources.

Using the MDG-costing approach, the UN Millennium Project conducted a comprehensive cross-country analysis of those interventions and investments required to achieve MDG in selected pilot countries [14]. The study proposed a series of spreadsheet-based models for calculating costs of appropriate MDG-related interventions.[2]

These models are practical and rich in detail, but rely on exogenous assumptions for economic and demographic growth. As a result, they tend to not address two major issues of interest: (1) impact of MDG interventions on the economic and demographic development of the country(s) under study; and (2) the possible positive and negative synergies between various MDG interventions. Given the long-term nature of MDG-based planning, these omissions might very well lead to inaccurate, or, at least less accurate, estimates of the necessary resources, and, eventually, to the development of sub-optimal strategies.

Most recently, the World Bank developed a Maquette (model) for MDG Simulation (MAMS) that provides improved assessment of the impact of MDG interventions on a country's overall economic development [15]. The model on which this approach is based consists of a dynamic computable general equilibrium (CGE) module coupled with an MDG component. The former calculates the main macroeconomic balances, while the latter uses a series of logistic functions to measure progress on goals based on services provided to key sectors.

The principle advantage of MAMS' economy-wide approach vs that of MP is that it allows for the design of MDG strategies, with special focus on absorptive capacity constraints. Further, the calculation of progress on MDG can account for cross-sectoral impacts. However, demographic development in the model is exogenous, and, thus, MAMS is unable to capture any cross-sectoral feedback that results from changes in the target population.

In order to address selected limitations of the MAMS and MP approaches, we developed an integrated simulation model for MDG planning based on the Threshold 21 (T21) model [16]. T21 provides a broad representation of the fundamental social, economic, and environmental aspects of the development process, and thus offers the ideal initial platform to develop a comprehensive approach to MDG analysis. Our T21-MDG approach *endogenously* represents economic and demographic development, thus allowing for analysis of the major system-wide impacts of MDG interventions. Such an approach, in particular, provides a dynamic and long-term perspective. It thus looks at positive and negative synergies between policies while explicitly considering implementation delays.

The T21-MDG model is here implemented using System Dynamics (SD), which focuses on the relationship between structure and behavior of complex dynamic systems [17]. In the past, SD has been employed to analyze a wide range of developmental issues in countries at various stages of development [18–20]. The method is particularly well-suited for the current application as it enables an effective representation of the elements of dynamic complexity – feedback loops, accumulations and non-linearities – that are at the heart of our investigation [21]. Further, SD helps maintain a meaningful degree of model transparency, which affords a deeper understanding of the system under study [22], and is thus able to enhance policy-makers' confidence in the model.

The work described in this paper thus complements, and builds on, the MAMS and MDG-Costing approaches. In the next section, we describe the structure of the proposed model for Ghana and its underlying assumptions, and present results of key validation tests. In Section 4, we analyze and discuss results from the simulation of various MDG interventions in Ghana; while in Section 5 we provide a summary of our findings and conclusions.

3. The proposed model

As noted above, the approach developed for this study is based on the Threshold 21 (T21) integrated development model from the Millennium Institute [16], which we expand in order to simulate a broad range of MDG interventions. The additional components developed here focus on mechanisms for implementing the interventions of interest. In doing so, they track the costs of such interventions, while estimating potential financing from available sources. Further, the expanded T21 (T21-MDG) allows us to individually and simultaneously simulate a greater variety of MDG interventions, and to capture their effect(s) on a given country's population and economy.

Although it deals with many interactions, the resulting T21-MDG model is quite transparent in its structure and assumptions. In particular, it is implemented using a stock and flow method, where causal relationships amongst variables are graphically displayed, allowing a clearer understanding of each sector's activity. Fig. 1 provides a schematic representation of T21-MDG's structure, which is composed of three spheres – society, economy, and environment – wherein each sphere contains six sectors. Each sphere's sectors can interact with others, both within that same sphere as well as with any others. The result is an integrated system wherein the major aspects of development are interrelated. In this type of system, MDG interventions directed to a specific sector may eventually affect socio-economic-environmental development of the entire system.

Three pilot countries were considered in the original MP study – Ghana, Tanzania, and Uganda. They were chosen based on their

[2] Current versions of these models may be downloaded from http://www.undp.org/poverty/tools.htm (Accessed February 21, 2008).