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Aid, Service Delivery, and the Millennium Development Goals in an Economy-wide Framework

François Bourguignon
Carolina Diaz-Bonilla
Hans Lofgren

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Abstract

In many developing countries, achieving the Millennium Development Goals (MDGs) by 2015 will require significant increases in expenditures on social services and in foreign assistance. It will also require careful planning of the sector allocation and sequencing of public spending. Especially for low-income countries, the challenges of the MDGs cannot be well understood unless sector issues are seen in the context of constraints at the macro level and in labor markets. To help countries analyze policies aimed at making progress toward the goals, the World Bank has developed a new tool, the Maquette for MDG Simulations (MAMS). Its originality is to fully integrate government services and their impact on the economy within an otherwise standard economy-wide dynamic framework. In comparison with existing approaches, MAMS offers three main advantages. First, the representation of the production of government services—such as health or education—takes into account demand as well as supply factors and the efficiency of these services. It also allows for interactions across the goals, and between the goals and economic growth. Second, it shows how scaling up these services has economy-wide impacts that may change resource allocation in the non-government sector and relative prices, including the unit cost of government services. Third, it shows the tradeoffs across time, including the relative costs and benefits, of front-loading expenditures versus back-loading. The present paper describes the basic features of MAMS and provides an illustration of its applicability for Ethiopia.

This paper—a product of the Development Economics Prospects Group—is part of a larger effort in this unit to develop and apply quantitative tools for analysis of global and national policies. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at hlofgren@worldbank.org.

Aid, Service Delivery, and the Millennium Development Goals in an Economy-wide Framework

François Bourguignon, Carolina Diaz-Bonilla and Hans Lofgren[†]

[†] Development Economics, The World Bank. The authors also would like to acknowledge the initial inspiration of Luiz Pereira da Silva and significant contributions from Maurizio Bussolo, Ahmed Kamaly, Jeff Lewis, Hans Timmer and Dominique van der Mensbrugghe with assistance provided by Denis Medvedev and Shuo Tan. Comments and suggestions have also been provided by Ishac Diwan, Enrique Ganuza (UN), Pablo Gottret, Wafik Grais, Jee Peng, Sherman Robinson (University of Sussex), Agnès Soucat, and Rob Vos (UN). The views and findings in this paper are those of the author and not necessarily those of the World Bank, its Executive Board, or member country governments.

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1. Introduction

The UN Millennium Summit in 2000 witnessed the historic adoption of the Millennium Development Goals (MDGs) by the global community. These goals committed the international community to achieving by 2015 an ambitious vision of development that encompasses not only higher incomes but also broader human development goals related to health, education, and access to water and sanitation. Two years later, in Monterrey, the international community met again to address the challenge of *financing* the MDGs, where it was recognized that a substantial increase in official development assistance (ODA) would be required to reach the MDGs. But it was also recognized that donors and recipients had parallel responsibilities. Aid alone would not be enough – the commitment by donors to providing more resources needed to be matched by policies and programs by recipients that would ensure that incremental assistance was well-used.

Over the last few years, there have been some encouraging signs of progress towards these goals. Many developing countries have accelerated growth and reduced poverty by reforming domestic institutions and integrating their economies into global markets. But this progress has been uneven – so far many countries, particularly in Sub-Saharan Africa, lag behind in growth and remain off track in terms of achieving the goal of halving poverty by 2015. Regarding the other (non-poverty) MDGs, the picture is also mixed. While some countries have made impressive advances towards health and education objectives, others – even some with a strong growth performance – lag behind.

This mixed performance raises important questions. On the one hand, faster growth is certainly a facilitating factor for MDG achievements on the human development (HD) goals. Thus, slow growers might find it difficult to make progress on the non-poverty MDG fronts. However, it is also the case that improved health and educational standards can increase productivity and accelerate growth at a later stage, with positive synergies when service access improves simultaneously in different areas (health, education, water, and sanitation), which ultimately may increase the efficiency of service delivery and/or reduce its cost. To the extent that growth and higher incomes can generate increased funding for services and raise service demand, investing more today in non-poverty MDGs might thus trigger a virtuous circle of growth and human development. On the other hand, growth and human development service delivery may conflict. The need to finance human development investments may crowd out investments and growth in other parts of the economy – with the allocation of government resources between HD and public infrastructure (including roads, power, and irrigation) as a critical policy issue. Another potential source of conflict is that relative costs of government services will rise if productivity growth within the government is slower than in the private economy. The tensions work also in the other direction.

Increased employment of teachers, health personnel, and other skilled workers may drive up wages and reduce the number of skilled workers available for private sector employment, at least in the short and medium run.

Various approaches have been used both to plan or monitor progress toward achieving the MDGs, and to evaluate the additional (or total) public resources, including foreign aid, needed to meet them. Clemens et al. (2004) and Reddy and Heuty (2004) survey a large number of studies that forecast and cost MDGs. As emphasized by Vandermoortele and Roy (2004), however, data availability and simplifying analytical assumptions severely affect the quality of the quantitative estimates in all these studies.

Four major sets of limitations affect studies on MDG achievement. First, many sector studies have focused on individual MDGs, but even some that consider multiple goals often fail to properly account for the interdependencies that exist among different MDGs and among policies designed to reach them. Second, MDG-related policies interact with the rest of the economy (namely the private sector) by altering prices of specific factors (such as skilled labor) and/or their overall supply. Third, inter-temporal equilibrium consistency is seldom checked. Financing needs, debt accumulation, and the inter-temporal sustainability of fiscal policies need to be integrated in a complete study on strategies to achieve the MDGs. Finally, as stressed by Devarajan et al. (2002), the policy and institutional environment is as important a component of success in achieving the MDGs as the availability of public resources or financial assistance. Keeping these potential limitations in mind, we will briefly report on some recent studies and approaches in use at the UN and the World Bank.

The UNDP Human Development Report (2005, pp. 39-48) covers most MDGs, projecting trends for individual countries, aggregated to regions and globally. Policies and linkages between MDGs are not considered. The authors point out that it is problematic to make projections on a goal-by-goal basis given strong links between different MDGs. Nevertheless, their approach may be adequate for their purpose – to highlight the fact that, if current trends continue, most countries will fail to achieve most MDGs. However, it is clearly not designed for analysis of MDG strategies. With the more ambitious objective of helping countries design PRSPs, Wodon and coauthors have developed SimSIP (Simulations for Social Indicators and Poverty), a set of tools that address different aspects of strategy analysis (also applicable to MDGs), including target setting, and assessments of costs and fiscal sustainability (Christiaensen et al. 2002).[1] The tools, which are Excel-based, have the advantage of being user-friendly and analytically simple. The objective of the target-setting module is to assess the realism of targets related to poverty, health, education, and basic water-sanitation access. It provides alternative specifications for forecasting

[1] The tools and related documentation can be downloaded from www.worldbank.org.

these indicators on the basis of econometrically estimated equations that include GDP, urbanization and time as arguments. This analysis needs to be complemented by forecasts for GDP and urbanization. The cost analysis, which covers the same set of indicators (except for poverty), is based on fairly detailed modules that consider input needs and assessments about future wage changes. The module for analysis of fiscal sustainability compares estimated costs of achieving targets to available public funding (based on assumptions about GDP growth, tax collection, and the level of sustainable deficits). The target setting module is clearly a useful tool for assessing target realism. On the other hand, the fiscal sustainability component is relatively weak, reflecting the fact that a set of independent tools cannot capture interdependencies between GDP growth, different MDG targets, program costs (including wage changes), and alternative financing approaches.

The different publications of the UN Millennium Project report represent a more detailed sectoral approach (see for example United National Millennium Project 2005). Its main feature is to estimate and add up the costs of specific interventions in areas such as education, health, and public infrastructure. As implemented, this is essentially a fixed-coefficient-fixed-price planning exercise. This approach—rich in detail—has typically ignored or simplified the synergies across the MDGs and, more importantly, the interactions with the broader economy.

Agénor et al. (2005a) apply a novel approach to MDG analysis to Niger.[2] Recognizing the need for an economywide perspective, they combine a macro model with an MDG module. Government spending has different repercussions depending on whether it is identified as being used for education, health, or infrastructure. The MDG module is used for post-calculations of MDGs and other social indicators: poverty, malnutrition, the literacy rate, infant mortality, life expectancy, access to safe water. The determinants of most of these indicators are estimated using cross-section, cross-country data for a sample of developing countries (when feasible limited to sub-Saharan Africa), allowing for links between MDGs. A key strength of their approach is that it requires relatively little data and draws on econometrically estimated parameters. On the other hand, the macro model is highly aggregated: it has only one production sector (meaning that one dollar of additional government demand for investment in infrastructure has the same direct effect on production and imports as one dollar of additional government demand for education) and it does not include intermediate inputs, factor markets, or factor wages (rents). This limits the ability of the model to analyze key aspects of MDG strategies such as the labor market repercussions of scaled-up government services and Dutch disease effects. Its high level of government and labor market aggregation (only one type, “educated labor”, is used in production) makes it more

[2] Agénor et al. (2005b) includes more detail on the macro model.

difficult to draw on it for Public Expenditure Reviews (PERs) and in other contexts for fiscal analysis. Nevertheless, it can provide useful macro insights for strategy analysis and may be developed further to address some of these limitations.

The links between growth, service delivery, and MDG achievements outlined above have demonstrated that a more sophisticated framework is needed. The analysis must consider macroeconomic factors and tradeoffs between objectives. For example, the prospect of significant increases in foreign aid (for most countries in Sub-Saharan Africa, external assistance required to meet the MDGs in 2015 may require more than a doubling of aid flows) leads to concerns over the possibility of "Dutch disease," characterized by an appreciating real exchange rate, a shift of resources towards non-tradables, and lower export growth. A related critical issue is the pace at which large, aid-financed programs should be scaled up. Rapid initial expansion may drive up costs more quickly and could be more expensive in real present value terms. On the other hand, given time lags, especially in education, expanding investment too slowly may make it impossible to achieve the MDGs by 2015. A coherent analytical framework is needed to capture macro-micro linkages, Dutch disease effects, and timing issues.

The need to evaluate and provide policy advice on such tradeoffs – across sectors and over time – has led to innovative research efforts. This paper presents MAMS (Maquette for MDG Simulations), which was produced within a research program on the MDGs conducted at the World Bank. MAMS is an economy-wide framework designed to analyze the interactions between delivery of human development (HD) services (health, education, water, and sanitation), the Millennium Development Goals (MDGs), growth, and foreign aid. The framework is equally applicable to the analysis of the same set of policy issues in the context of PRSs (Poverty Reduction Strategies). MAMS belongs to the class of dynamic general equilibrium models, but has been substantially augmented to capture the key processes that generate MDG outcomes, along with the feedbacks to the rest of the economy.

MAMS does not replace detailed sectoral studies, but instead complements and draws on the research that underpins sector strategies for achieving the MDGs. Without sector studies to provide a strong empirical basis, the analysis of MDG strategies in an economy-wide framework (either MAMS or any other) loses much of its power. By fully embedding such strategies in a comprehensive economy-wide framework, MAMS fills a gap in the toolkit that is available to policy analysts. Especially for low-income countries, the policy challenges related to the MDGs cannot be well understood unless sector issues are viewed in the context of constraints in the macro environment and in labor markets.

This paper is divided into two sections. We will first present the model structure, emphasizing the features that distinguish MAMS from other Computable General Equilibrium (CGE) models, and especially the feedbacks from and linkages between different MDG goals and the rest of the economy. After this we will present a set of simulations that illustrate how MAMS captures some of the MDG issues that we discussed in this introduction. We will conclude with an outline of a possible future research agenda.

2. Model structure and key mechanisms

A key premise of the model is that government spending and MDG outcomes are linked in a dynamic way, with several outside influences. But that relationship is not a simple, invariable one for three essential reasons.

- The returns to scale of government spending vary with the level of service delivery. At low levels, increasing returns may prevail as network effects, learning effects and synergies are predominant. At high levels of service delivery, government spending may suffer from decreasing returns to scale. Water supply, health care, and education can be relatively easily provided in densely populated areas, but become increasingly expensive as coverage expands to remote areas. Also, when mortality rates are already low it becomes increasingly difficult to reduce these rates further. Similarly, if completion rates in education are already high it is difficult to ensure that the last percentages of children complete the program.

- Effectiveness of government spending depends on many variables. For example, spending on education becomes more effective if health conditions improve (reducing absenteeism at schools), if public infrastructure improves (facilitating access to schools), if income levels rise (and parents are less inclined to keep children at home) or if skill premiums increase (triggering a greater incentive to finish formal education). In general terms this means that spending on services becomes more effective if demand conditions for those services are more favorable.

- Costs of service delivery change with macroeconomic conditions. The services are often skill intensive and in many cases also capital intensive. The more intense the MDG effort, the stronger the impact on costs as skilled labor becomes scarcer and financial conditions become tighter. From a general budgetary perspective the impacts on costs are even larger, because changes in macroeconomic conditions do not only affect MDG spending, but also other, non-MDG government spending (as well as the competitiveness of the private sector).

The first two aspects (changing returns to scale and impact of demand variables) are captured in the 'MDG production functions' introduced in MAMS. The last aspect (macroeconomic interactions) is captured as the MDG production functions are incorporated in a dynamic economy-wide general equilibrium framework that also includes detailed fiscal accounts. The dynamic framework not only reflects the key macroeconomic interactions, but also allows forward looking planning to target the MDGs in 2015 and to incorporate autonomous baseline forecasts.

The 'production' of the MDGs

MAMS focuses on the subset of MDGs that is most costly and has the greatest interaction with the rest of the economy: universal primary school completion (MDG 2; measured by the net primary completion rate), reduced under-five and maternal mortality rates (MDGs 4 and 5), halting and reducing the incidence of HIV/AIDS and other major diseases (part of MDG 6), and increased access to improved water sources and sanitation (part of MDG 7). Achievements in terms of poverty reduction (MDG 1) are also monitored.[3] Because of their impact on overall growth and, through that, on poverty, investments in public infrastructure are explicitly taken into account. This also allows the modeling of the positive influence of infrastructure on the effectiveness of spending on social sectors.

The modeling of the production of a typical MDG (except for MDG 2 – primary school completion for all – which is discussed later in the context of the education sector) consists of two blocks of equations: the first models the production of MDG-related services; the second defines MDG outcomes as a function of service delivery and other determinants.[4] In the first block, the production of MDG-related services, it is assumed that substitution possibilities between the three broad categories of inputs (labor, capital goods, and intermediate products) are negligible. Assuming fixed input-output coefficients, the inputs required for a level Q of service delivery are:

$$\begin{aligned} L &= \alpha_L Q \\ K &= \alpha_k Q \\ INT &= \alpha_{INT} Q \end{aligned} \qquad (1)$$

[3] MAMS is compatible with any standard treatment of economy-wide modeling of poverty, including representative household approaches, micro-simulation, and more simple relationships based on a constant-elasticity of the poverty rate with respect to GDP or household consumption per capita.

[4] This presentation is simplified, highlighting key mechanisms. For a detailed technical documentation of MAMS, see Lofgren and Diaz-Bonilla (2008a).

where L is the labor requirement (for example teachers or nurses), K is the capital requirement (for example classrooms or hospital beds), and INT represents intermediate inputs (for examples textbooks or medicine).

Aggregate labor L results from the combination of three different kinds of labor: those with less than completed secondary education (N), those with completed secondary education (S), and those with completed tertiary education (T). The elasticity of substitution between the different forms of labor is assumed to be constant and the government is assumed to use the most cost effective combination of different labor types. The demand for specific education categories thus depends on education premiums. Under the assumption of constant substitution elasticity, ω, the demand is given by:

$$N = \alpha_N \left(\frac{W}{W_N} \right)^{\omega} L$$

$$S = \alpha_S \left(\frac{W}{W_S} \right)^{\omega} L \qquad (2)$$

$$T = \alpha_T \left(\frac{W}{W_T} \right)^{\omega} L$$

where W_N, W_S, W_T are the respective wages for workers with less than secondary, completed secondary, and completed tertiary schooling, and W is the average wage across all workers – and the unit cost of aggregate labor, L. The α's are positive coefficients that describe the structure of the labor demand by education category for given unit costs of the various categories.

The capital stock is built up over time through investments and deteriorates at a constant depreciation rate (δ).

$$I_t = K_{t+1} - (1-\delta)K_t \qquad (3)$$

The investment in the current period (t) is chosen such that the required capital stock in the next period, as given by the capital demand equation (1), is achieved. Government capital spending on MDGs will be large when service delivery is expanding and reduces to replacement investment when the level of service delivery is constant.

Intermediate purchases consist of domestically produced products and imported products, with the two linked through a constant elasticity of substitution demand function. As for labor, cost minimization by the government implies that the demand for domestic (INT_d) and imported (INT_m) intermediate inputs takes the following form:

$$INT_d = \alpha_d \left(\frac{P}{P_d} \right)^{\sigma} INT \tag{4}$$

$$INT_m = \alpha_m \left(\frac{P}{P_m} \right)^{\sigma} INT$$

where P is the unit price of the aggregate intermediate input, INT, P_d and P_m are the price of the domestic and imported goods respectively, and σ (≥ 0) is the elasticity of substitution. As before, the α's are positive coefficients.

The second block of equations defines MDG achievements, relating service delivery and other determinants to MDG indicators (for MDGs 4, 5, 7a, and 7b). The changing returns to scale are represented by a logistic curve, showing increasing returns to scale at low levels of development indicators and decreasing returns to scale at high levels of development indicators.

$$MDG_k = ext_k + \frac{\eta_k}{1 + e^{\gamma_k + \beta_k Z_k}} \tag{5}$$

where MDG_k is the indicator used to monitor MDG k; Z_k is an intermediate variable that summarizes the influence of the determinants of MDG performance; ext_k is the extreme (maximum or minimum) level of the indicator (e.g., 1 or 100% for completion rate); β_k shows the responsiveness of the indicator to changes in Z_k; γ_k determines whether increasing or decreasing returns prevail at the starting point; and η_k is used to replicate the initial MDG value and the slope of the function – positive if declines in the MDG indicator denote an improvement (mortality rate) and negative in the reverse situation (for example rates of access to safe water). The intermediate variable, Z_k, is defined by the following Cobb-Douglas relationship:

$$Z_k = Q_k^{\phi_k} \cdot \prod_{i=1}^{n} D_{ik}^{\phi_{ik}} \tag{6}$$

Table 2.1 lists the arguments – service levels, Q_k, and other determinants, D_{ik} – that defined Z_k in the Ethiopia application, for which simulation results are discussed at the end of this chapter. These variables

are identified by sectoral studies underpinned by econometric analysis. They include other MDGs – better access to water and sanitation may improve health outcomes (MDGs 4 and 5) – as well as infrastructure or consumption per capita. For example, a higher level of consumption per capita may certainly influence health achievements positively. Pregnant women who are better fed run less health risks for themselves and for their babies. Among the "other determinants," per-capita household consumption and other MDGs represent demand-side factors whereas public infrastructure can be seen as facilitating both demand and supply.

Table 2.1: Determinants of MDG achievements

		Other Determinants		
MDG	**Per-capita real service delivery**	**Per-capita household consumption**	**Public infrastructure**	**Other MDGs**
4	X	X	X	7a,7b
5	X	X	X	7a,7b
7a	X	X	X	
7b	X	X	X	

Note: The MDGs referred to in this table are defined as follows: MDG-4: Reduce by two thirds the mortality rate among children under five; MDG-5: Reduce by three quarters the maternal mortality ratio; MDG-7a: Halve the proportion of people without sustainable access to safe drinking water; and MDG-7b: Halve the proportion of people without sustainable access to sanitation services. The target year is 2015 and the reference year is 1990. The services related to these MDGs are health (disaggregated by technology), and water-sanitation services. Other determinants should be added if they are important in the context of a particular country study; if any of the determinants listed in the table are unimportant then they can be omitted (or given an elasticity of zero). MDG 2 is covered in the following discussion of education.

In order to implement the first block of MDG equations, data is required on government spending by function (one or more health sectors, water and sanitation, other public infrastructure, and other government) and type of outlay (current vs. capital). Current outlays must be disaggregated into payments to different types of labor (wages) and intermediate inputs.[5] This information, complemented by elasticities of factor substitution, is similar to what is required for other (non-government) sectors in a standard CGE model and can easily be built into the model's Social Accounting Matrix (SAM). In parallel with data on payments to labor, information is also needed on the number of people employed. The information needed for this block can typically be found in sectoral studies and databases of governments, international organizations and other research institutions.

[5] The national accounts rarely ascribe value-added to government capital – by accounting conventions, only labor creates value-added in the government sector – making it impossible to derive coefficients of the MDG production functions from value-added shares as is standard practice in the calibration of private-sector production functions. The assumption of Leontief production functions made earlier is justified by that difficulty as well as the lack of information about the substitutability between capital and labor in these service sectors.

For the second block, which translates government services into MDG indicators, information is needed on (a) base-year values and 2015 targets for MDG indicators; (b) extreme values for MDG indicators; (c) a set of elasticities of MDG indicators with respect to the relevant determinants (with one version provided in Table 2.1.);[6] (d) the position of the initial situation (in terms of MDG_k or Z_k) relative to the inflection point (where the function switches from increasing to decreasing returns to scale); and (e) a scenario indicating one set of 2015 values for the arguments of Equation (6) under which the MDG in question is achieved. It is relatively straightforward to collect (a). With respect to (b), the extreme value of the MDG function (ext_k) can be determined by pure logic (e.g. the maximum share of the population with access to a service is 1) or international experience (the minimum observed maternal mortality rate across countries). For (c), it is possible to draw on a growing body of econometric research, in particular in the areas of health and education. Although sometimes contradictory, the findings of these studies provide broad support for inclusion of the determinants referred to in Table 2.1.[7] Econometric estimates of basic MDG elasticities are hampered by the fact that it is difficult or impossible to observe the full functional form – at least among countries for which it can be asserted that MDG outcomes are generated by the same processes. This is because outcomes are concentrated within a limited range that is far from MDG targets and extreme outcome values. Given this, econometric analysis must be complemented with other approaches in order to be able to fully parameterize the MDG production functions. Sectoral studies of MDG strategies and discussions with experts make it possible to determine (d) and (e). Using this information, one can infer from the logistic function the rate at which marginal returns decline, and ensure that MAMS is consistent with sectoral studies. In sum, if data is available for (a)-(e), it is possible to calibrate the η_k, γ_k, β_k and φ_k parameters.[8]

[6] For each argument, these "full" elasticities are the product of two elasticities, the elasticity of the MDG indicator with respect to Z_k (equation 5) and the elasticity of Z_k with respect to the argument in the constant-elasticity function (φ_k and φ_{ik} ; equation 6).

[7] For examples of the literature on health, which support the statements in this paragraph, see Baldacci et al. (2004), Lavy et al. (2004), Anand and Bärnighausen (2004), and Glewwe and Jacoby (1995). Similarly, our statements on education draw on Anand and Ravallion (1993), Mingat and Tan (1998), World Bank (2005a), Deolalikar (1998), Case and Deaton (1998), and Baldacci et al. (2004). For more details, see Kamaly (2006).

[8] A simultaneous-equation model can be solved to generate the values of η_k, β_k, and γ_k that permit the logistic function to (i) replicate base-year MDG_k; (ii) have an inflection point at a specified distance relative to the initial Z_k; and (iii) exactly achieve the MDG for the value of Z_k that is defined by the specified MDG scenario. The preceding assumes that the user relies on exogenous values φ_k and φ_{ik} (elasticities of Z_k with respect to Q_k and D_{ik}). If, alternatively, the user wants to impose the "full" base-year elasticities of MDG_k with respect to Q_k and D_{ik}, then the model has to be extended in two ways: (i) in one set of new equations, these elasticities are imposed; at the same time, the parameters φ_k and φ_{ik} are endogenized; (ii) in a second set of equations, Z_k is defined as a constant-elasticity function of Q_k, D_{ik}, φ_k, and φ_{ik}. It is then no longer possible to impose a value a priori for Z_k since its value depends on φ_k and φ_{ik} , which now are endogenous. Note that the pre-specified scenario is only one out of an infinite number of scenarios that generate the same MDG_k value in 2015. For example, in simulations targeting the MDGs, the actual need for services, Q_k, will vary depending on the evolution of the other arguments, D_{ik},in Eq. 6.

The treatment of education is more complex than that of health and other MDGs. The model gives a complete account of the sector, dividing it into different cycles (or levels): primary, secondary, and tertiary. The primary cycle is needed since it is linked to MDG 2. The higher cycles are needed to link education to the labor market. They are also required to provide a complete picture of the dynamic fiscal consequences of achieving MDG 2 and expanding the educational system. In each grade in each cycle, a student may either pass, drop out, or repeat the grade next year. Students who pass may either proceed to a higher grade within the cycle or graduate from the cycle. In the latter case, they may either continue to the next cycle or exit from the school system. The two-block structure and the functional forms, described above for the other MDGs, also apply to education. However, the second block (Equations 5 and 6) is applied to two types of behavioral outcomes in all cycles: entry rates (to the 1st grade of any cycle, out of the qualified population[9]) and passing rates (from each grade within a cycle). More specifically, in the logistic functions (Equation 5), the left-hand side variables are the shares of students that pass their current grade (one variable per cycle) and the shares, out of the relevant population, that start the first year (also one variable per cycle). The extreme value for all of these variables is one. Other behavioral rates are computed on the basis of the share variables that are defined by the logistic. Rates of repetition and dropout are scaled up or down on the basis of changes in passing rates. The students who pass are split into graduates from the cycle and passers within the cycle assuming that, as entry and passing rates improve, the students who pass eventually become evenly distributed across the grades within the cycle.

Each logistic equation (5) is associated with a Cobb-Douglas equation (cf. Equation 6) where the relevant *Z* variable is defined. The arguments determining *Z's* in education may be similar to those appearing in Table 2.1. In the Ethiopia application, the arguments determining the educational *Z*'s include educational services per student enrolled, per-capita household consumption, public infrastructure, and health performance (proxied by the value for MDG 4). As noted, apart from the service argument, all of these influence the demand side; public infrastructure may also facilitate service supply. The educational equations include an additional demand-side argument, wage incentives (measured by the relative wage gain the student would enjoy if she, instead of entering the labor market with her current educational achievement, would study enough to climb one notch in the labor market).

[9] For the first grade of primary school, the qualified population is everyone in the relevant age cohort (often those who are six years old but this may vary across countries). For the first grades of secondary and tertiary, those qualified are the ones who graduated from the preceding cycle in the previous year. In addition, any cycle can have additional entrants (most importantly slightly older students who start primary school but also potentially other entrants from outside the school system, such as migrants from abroad).

As our indicator for MDG 2 – universal primary school completion (every child should complete a primary cycle of education) – we use the net (on-time) completion rate, i.e. the share of the population in the relevant age cohort that graduates from the primary cycle in the right year. It is computed on the basis of relevant entry and graduation rates. For example, for a four-year primary cycle, the value for MDG 2 in year *t* is the product of the entry rate in *t-3* and the graduation rates in *t-3*, *t-2*, *t-1* and *t*. Rising completion rates in the primary cycle tend to increase the number of students in subsequent cycles, raising demands on services if quality is to be maintained. With a time lag, educational expansion increases the supply of skilled labor in the economy.

The data requirements for education and its MDG are more extensive than for the non-education MDGs: in addition to the information that is needed to cover the production of services (which is identical), it is necessary to know base-year rates and elasticities for a wider range of outcomes, and enrollment numbers in each cycle.

General equilibrium and the dynamics of MDG attainment

The MDG production functions are integrated in a standard, open-economy CGE model in the tradition that goes back to Derviş et al. (1982). The simultaneous determination of MDG achievement, supply and demand of private goods and services, and factor market equilibrium is a key feature of MAMS. Since MAMS is a general equilibrium model, it accounts for numerous important interactions between the pursuit of the MDGs and economic evolution.

Two important such interactions are the economy-wide impact of additional public spending caused by the MDGs and the impact of MDGs on growth. Additional government services needed to reach the MDGs requires additional resources – labor, intermediate inputs, investment funding – that compete with other demands in competitive labor, goods and services, and, possibly, loanable funds markets. This may generate substantial wage hikes for skilled labor given the combination of a small supply (especially in low-income countries) and rapid demand expansion. On the other hand, as (the bulk of) school graduates enter the labor force as skilled labor, MAMS captures the positive impact of education on the growth potential of the economy.

In the loanable funds market of the model, investments in capital for MDG services compete with other investments for available savings. The outcome depends on the mechanisms through which the economy achieves balance between savings and investment. If MDG-related additional public spending is partly financed by foreign resources (grants and/or loans), the impact on domestic private consumption and

investment may be limited or even positive. However, larger inflows of foreign aid tend to generate Dutch disease effects. In the medium- to long-run, the most important determinant of the size of such effects is the import share of the additional spending that these inflows finance – if it is low, Dutch disease effects tend to be strong.[10] In the model, the appreciation of the real exchange rate caused by the inflow of foreign currency provides the incentives required for suppliers to export a smaller share of their output and for demanders to switch from domestic outputs to imports. The resulting increase in the trade deficit is covered by the inflow of foreign currency brought about by aid. As a complement to foreign resources, MDG strategies are, at least in part, financed with domestic resources, either taxes or borrowing. In the model, selected tax rates may be adjusted endogenously to meet targets for government savings or foreign aid. Alternatively, tax rates may adjust in response to changes in fiscal solvency indicators (like the ratio between government debt and GDP) so as to ensure these indicators remain unchanged. Of course, the cost of higher taxes is to reduce private savings and consumption spending, with a negative impact on growth and on efforts to reduce poverty.

The fact that MAMS is a dynamic model makes it possible to take into account that many of the linkages between MDGs, factor markets, and growth operate with significant time lags. The expansion of MDG services may follow different time paths, approaching target levels at constant growth rates or doing so with different degrees of front- or back-loading. These lags are particularly important in modeling progress in education and its impact on the economy. Indeed, the model accounts for the growth and change in the age structure of the population, the multi-year duration of the various education cycles, and the time lags between expansion in the number of students and graduates at low levels of education and changes in the skill structure of the labor force – improved primary school completion rates affect the skill structure of the labor force with considerable delays.

The dynamic structure of the model is mostly recursive. The bulk of endogenous decisions of economic agents depend on the past and the present, not the future. However, some features may be non-recursive. For instance, the government's current investment decisions are driven by future decisions on service provision (in health, education, and other areas). This makes a multi-year simultaneous model solution preferable to the usual recursive algorithm. Quite importantly, this approach makes it possible to simulate highly relevant scenarios under which the government endogenously selects growth patterns for government services subject to the constraint that certain MDGs be achieved by 2015, also considering the roles of other determinants of MDG performance. In this case, the government is assumed to have

[10] For an analysis of Dutch disease effects of foreign aid, see Heller (2005, pp. 5-9).

perfect foresight: its decisions in early periods depend on future decisions and the future evolution of the economy.

To sum up, the model structure has been designed to address four broad groups of issues, each of them crucial to the interaction between growth, aid and MDGs.

- The model describes the mechanisms through which service delivery and other determinants of MDG achievements interact, capturing the roles of the demand and supply sides of MDG services.

- The model can analyze competition over scarce resources (labor, investment funding, and other goods and services) between MDG services and other sectors, as well as the role of MDG services in adding to the resources of the economy via the labor market and by promoting long-run growth in incomes and investments.

- The model captures the impact of alternative foreign aid scenarios on the production of tradables (Dutch disease phenomena) and its role in adding to the pool of savings, thereby mitigating resource competition between MDG services and other sectors.

- The model may be solved simultaneously for the full planning horizon, permitting it to produce forward-looking scenarios and analyze the impact of the sequencing of large programs.

3. MDG strategy simulations for Ethiopia

The preceding discussion shows how MAMS is designed to address key aspects of MDG strategies. This section illustrates some of the features of MAMS through a set of simulations of the evolution of the Ethiopian economy. Inter alia, they address the following questions: what effects do selected MDG strategies have on MDG indicators, economic growth, exports, the labor market, and the roles of the government and the private sector in the economy? How much does it cost to achieve the MDGs? What roles may synergies among MDGs or between MDGs and the economy have in reducing these costs? How are the effects of MDG strategies influenced by the availability of more or less foreign aid? What kinds of trade-offs may Ethiopian policy makers have to face given limited foreign aid and domestic resource constraints?[11]

[11] Different aspects of Ethiopia's MDG strategy are explored in Lofgren and Diaz-Bonilla (2008b), Sundberg and Lofgren (2006).

In order to answer these questions and illustrate key model features, we designed a set of simulations with MAMS applied to an Ethiopian database. The first simulation (Base) corresponds to a simple extrapolation of current trends and will be used essentially as a benchmark for comparison with other scenarios. In that simulation, MDGs are not reached by 2015. On the contrary, the second scenario is designed to reach the MDGs, with foreign aid filling any financing gap. This simulation, entitled MDG-Base, provides a first indication of the effects of pursuing an MDG strategy, including its costs and the need for foreign resources. In two variants on this scenario, we explore the impact of less foreign aid combined with heavier reliance on domestic financing through direct taxes (MDG-Mix) and improved government productivity (MDG-Gprd). Finally, in order to explore trade-offs, we analyze the impact of scenarios with less foreign aid and less government spending either on human development or on infrastructure (with MDG-HDcut and MDG-Infcut, referred to in the Tables, as two examples). In the case resources to reach all the MDGs were not available, this permits calculating what is the cost of reaching a specific MDG in terms of the others. Selected results from these simulations are presented in Tables 3.1-3.6 and Figures 3.1-3.4.

Under MDG-Base, we impose full achievement of the education, health and water-sanitation MDG targets. We monitor the evolution of MDG 1 using a simple constant-elasticity relationship between the headcount poverty rate and real GDP per-capita.[12] Foreign aid in grant form is assumed to fill any financing gap. This scenario constitutes a strong and extended economic shock. Tables 3.3 and 3.4 show that achievement of these targets requires very rapid expansion in the provision of the MDG-related government services, and therefore of both current and capital public spending. In water and sanitation, current public expenditures increase at an average annual growth rate of 21 percent, whereas capital spending increases at 40 percent. Both in primary education and infrastructure, the current and capital growth rates are, respectively, 15 and 24 percent. Of course, these rates of growth are also those of inputs in those services, that is, for instance, numbers of teachers and classrooms in primary education. As a result of this acceleration in public spending for the MDGs, the GDP share of the government (measured by the sum of government consumption and investment) is almost doubled, increasing from 29.1 percent in 2005 to 57.6 percent in 2015 – see Table 3.2. Compared to the Base scenario, annual real GDP growth accelerates strongly for government activities (from 4.0 to 8.7 percent) and more moderately but yet substantially for the private sector (from 3.5 to 5.2 percent; see Table 3.2). In comparison with the Base simulation, the Present Value (PV) of total foreign aid over the 2006-2015 period is more than quadrupled, reaching US$31 billion. In the final year, 2015, foreign aid is US$81 per capita or 37 percent

[12] GDP per capita was preferred to household consumption per capita given that GDP is much less influenced by the level of foreign aid in a given year, i.e., providing a better indicator of the long-run capacity of the economy to sustain a flow of household consumption.

of GDP (Table 3.5). This huge inflow of foreign aid causes the onset of Dutch disease, which manifests itself in an appreciation of the real exchange rate, depressed exports, and larger imports, thus allowing the economy to fully use the foreign currency inflow that comes with foreign aid.

Figure 3.1 shows the expansion of foreign aid per capita in the various scenarios. It can be seen that it increases monotonically, except for a decline in 2011. The latter reflects two factors. First, at this point in time, the period of big investments – in schools and teacher training – to support rapid expansion in primary education comes to an end, reducing government spending needs. Secondly, the model captures an Ethiopia-specific threshold effect based on expert assessments: private-sector productivity is boosted due to the fact that the public infrastructure capital stock exceeds a threshold above which productivity-enhancing network effects are triggered in the private sector**.**

Part of the huge increase in public spending due to the pursuit of MDGs is due to changes in unit costs caused by the increase in the demand of several types of goods and services. Of particular importance are wage developments, which depend on what happens in the educational system (influencing supply) and government services (driving demand changes). Labor supply growth by workers with little or no education (the bulk of the labor force) declines given that an increasing share of the children – by 2012 close to all – pass primary school, with many continuing beyond this level (see Table 3.6). As a result, GDP growth is affected negatively in a first stage. For the more educated (but much smaller) segments of the labor force, supply growth accelerates gradually as more students graduate from higher cycles. Demand for more educated labor in government services grows quickly throughout most of the simulation period, especially up to 2012 (the year in which everyone in the primary cohort has to start the cycle and after this manage to successfully proceed through the different grades, graduating in 2015), whereas demand growth for this type of labor in the private sector is relatively steady. The combined impact of these demand and supply side changes is relatively rapid wage growth for the least educated throughout the period (albeit starting and remaining at a low level) whereas, for the two more educated groups, wages grow rapidly up to around until 2012 and, after this, starts declining, as the supply of skilled workers starts to accelerate. Comparing MDG-Base to Base, private sector employment expansion for more educated labor is minor (given competition from the government) whereas its employment contraction for the least educated labor type is similar to that of the government. However, private sector GDP growth under MDG-Base is boosted by more rapid productivity growth. Figure 3.2 shows the evolution of wages for one of these segments, the segment that has completed secondary but not tertiary education, both for MDG-Base and other simulations.

In our analysis, the costs of achieving the MDGs are influenced by the fact that MDG achievements do not only depend on the supply of relevant services but also on progress in terms of a set of other determinants: other MDGs, availability of public infrastructure, household consumption per capita, and wage premia (influencing educational decisions). In order to assess the role that such "synergies" can play in influencing costs, we compared the costs for MDG-Base with the costs of primary education, health, and water sanitation in three separate scenarios where MDGs were achieved in each of these areas separately.[13] The results – not reported here – indicate that the present value of total costs in these three areas is 22 percent higher when the MDGs are pursued separately compared to the costs for MDG-Base, where they are pursued simultaneously. The differences are primarily due to savings in health. This suggests that bottom-up costing exercises that do not consider the economy-wide context of MDG strategies may be misleading, often overestimating the costs.

The scenario MDG-Base clearly looks unfeasible. It is unlikely that donors will be willing to provide foreign aid in the required amounts. Moreover, such a huge expansion of foreign aid and the government GDP share would most likely generate severe governance problems.[14] Given this, we need to consider alternatives. The next scenario, MDG-Mix, considers one alternative. It has been constructed to address the following question: In a setting with less foreign aid, what would be the consequences of pursuing the same MDG targets (in health, education and water-sanitation) and maintaining the same real growth in other areas of government spending (including infrastructure)? MDG-Mix is identical to MDG-Base except for the fact that the increase in foreign grant aid relative to the base scenario is only half as large; in per-capita terms, foreign aid reaches US$51 in 2015, see Table 3.5. The PV of total foreign aid 2006-2015 falls from US$30.9 billion to US$20.2, Figure 3.3. As a result of less foreign aid, the appreciation of the real exchange rate is less pronounced whereas export growth increases and import growth slows down. Direct tax collection adjusts to assure that government receipts are sufficient to cover government spending. The increase is huge, going from a share of GDP of 6.3 percent in 2005 to close to 25 percent in 2015. Such an increase has a strong dampening impact on growth in household factor incomes, consumption, savings and investments, resulting in slower growth in the private capital stock and private GDP, the latter falling from 5.2 percent under MDG-Base to 4.3 percent under this scenario. Government demand (the sum of government consumption and investment) reaches almost 70 percent of GDP,

[13] In other words, the cost of primary education was defined as the cost of government spending in this area when only MDG2 was targeted, the cost of health on the basis a government health spending in a simulation where only MDGs 4 and 5 were targeted, and the cost of water and sanitation on the basis of government costs in this area when MDGs 7a and 7b were targeted.

[14] It should be noted that the share of the government in total domestic final demand (absorption) is much lower, around 41 percent, than in GDP. This is due to a large trade deficit, which permits absorption to reach 142 percent of GDP. The same observation applies to the other MDG scenarios.

exceeding the highest share in the world.[15] As a result of slower GDP growth, the MDG target for poverty reduction is not met. Compared to MDG-Base, more rapid growth is needed in government spending in education, health, and water-sanitation services in order to achieve the MDG targets. This is due to slower growth in per-capita household consumption, i.e. a source of weaker synergy effects, influencing the demand side for different government services.

Although the scenario MDG-Mix has a more realistic outcome for foreign aid, it has the drawbacks of reducing private and over-all GDP growth, achieving only a subset of the MDGs (MDG 1 is far from being reached) and generating an even larger government share in GDP.

To explore the potential for government productivity in facilitating progress toward the MDGs, we constructed a second alternative scenario that has more rapid government productivity growth but otherwise is identical to MDG-Base (MDG-Gprd). Under this scenario, the productivity of government labor and intermediate input use improves by an additional 1.5 percent per year whereas government investment efficiency grows at the same annual rate.[16] Compared to MDG-Base, the result was noteworthy declines in foreign aid needs (to $26.5 billion; $61.9 per capita in 2015) and in the GDP share for the government (to 52.6 percent) whereas the deterioration in terms of poverty reduction, private consumption growth, and GDP growth is minor. In an additional simulation, not reported elsewhere in this chapter, we let the productivity improvement of the government be doubled, to 3 percent per year. The results is a further strengthening of these outcomes: the PV of aid declines to $22.7 billion and the government GDP share in 2015 falls to 45.7 percent, without any significant impact on poverty reduction. However, while these scenarios highlight the importance of improving government efficiency, it should be noted that such efficiency gains may be particularly difficult to bring about in the context of rapid government expansion.

The above simulations exemplify the type of questions that MAMS can address under scenarios that achieve MDG targets. They suggest that, in the face of constraints (on foreign aid, domestic resources, and the scope for productivity improvement), the government may have to confront difficult trade-offs, adjusting downwards the MDG targets it strives to achieve by 2015. If not, taxes and government spending may become excessive or unreasonable relative to the total size of the economy, with a negative impact on private sector development and household consumption. The remaining scenarios analyze

[15] In 2002, the most recent year with a comprehensive data set, the largest GDP share for the sum of government consumption and investment in any developing country was 65.5% (for Eritrea). Very few countries exceeded 40%. Note, moreover, that this percentage does not include major redistribution schemes (like PYG pension systems or health insurance) as in the countries with the highest share of public spending over GDP.

[16] For MDG-base, the rates of total factor productivity growth are 1.1 percent for the government (only for labor) and private health services and 1.9 percent for the rest of the private sector.

trade-offs between spending on infrastructure and human development in a setting with reductions in foreign aid relative to MDG-Base. Under the scenario MDG-HDcut, the government receives 85 percent of the aid under MDG-Base. It maintains its spending on infrastructure, while cutting spending on MDG human development targets (here defined to include primary education, health, and water-sanitation). Compared to MDG-Base, GDP growth is virtually unchanged. The required reduction in domestic final demand (driven by the fact that, with less foreign aid, the country has to live with a smaller trade deficit) is spread quite evenly across private and government consumption and investment. The key result is that, for the human development MDGs, the country achieves 91.6 percent of the increase required to meet the MDGs whereas, for the poverty objective, 102.6 percent of the required drop is achieved (i.e., a slight overachievement). On the other hand, if the country maintains a 100% achievement rate for its human development MDGs while cutting spending on infrastructure, 89.3 percent of the required fall in poverty MDG is achieved. The driving force behind this outcome is that, during the simulation period, spending on infrastructure has a considerably stronger impact on GDP growth than spending in the human development area – annual GDP growth for MDG-HDcut is very close to MDG-Base whereas, for MDG-Infcut, there is a significant slowdown (by 0.5 percent in annual growth). This is partly because of the lag in the effect of human development on growth. Figure 3.4 provides a broader perspective on trade-offs between human development and poverty reduction in the face of foreign aid constraints. It summarizes trade-offs for a larger set of simulations with alternative cuts in foreign aid – the simulations along each curve have identical levels of foreign aid in the final year and, in PV terms, for the period 2006-2015.

4. Concluding remarks

This paper has described the design and application of the MAMS model, intended to focus on strategies and tradeoffs related to efforts to achieve the MDGs over the next decade. The scenarios that we have presented exemplify the use of MAMS. Other examples of issues that MAMS can address include the effects of front- or back-loaded increases in government MDG services, reallocation of government spending from unproductive areas, foreign debt forgiveness, and alternative allocations of resources between government and the private sector in the context of a fixed foreign aid envelope. In settings less focused on full achievement of the MDGs, for example growth analysis, MAMS provides results for MDG indicators along with more standard economic indicators, making it possible to maintain a focus on poverty and human development. It offers the possibility of simulating the effects of the level and, more importantly, the structure of public spending, using a level of disaggregation rarely found in economy-wide modeling – see Tables 3.3-3.5.

One virtue of the MAMS framework is that it provides a comprehensive perspective on the MDG challenge through its representation of the entire economy. The analysis highlights the fact that changes in wages and exchange rates influence domestic relative prices and the domestic purchasing power of foreign aid, thereby invalidating simplistic costing and aid forecasting exercises. Unlike such exercises and strict sectoral approaches, MAMS facilitates an examination of how the different goals complement one another, while at times competing for resources. Moreover, by focusing explicitly on the goals themselves, rather than simply on more resources, MAMS supports efforts to move away from traditional reliance on measuring "inputs" (such as teachers hired or foreign aid received) to measuring "outcomes" (the goals themselves). This in turn encourages greater attention to the need to consider the appropriate sequencing of resources, priorities, and policies to reach the MDG targets.

Currently, the MAMS framework is being applied to 6 countries in Africa and 18 countries in Latin America (in a project managed by the UNDP). This suggests that is a valuable tool for strategy analysis in a wide range of countries, not only low-income countries, for which it was initially designed and where the economy-wide interactions between development, external aid and the MDGs are strongest.

The MAMS framework has particular operational appeal for the World Bank. The government of Ethiopia has drawn on results from MAMS in its MDG strategy document (FDRE 2005a and 2005b) and the World Bank is drawing on MAMS simulations in its country-level dialogue on Ethiopia's poverty reduction strategy as well as in on-going studies on aid, labor and population. Similarly, the IMF uses results from MAMS in the formulation of its MDG scenarios for Ethiopia (IMF 2006, pp. 3, 5, 6, 9, 11, 16). MAMS has also provided inputs to several recent World Bank and IMF documents on MDGs, aid, fiscal policy and growth (World Bank 2005b, pp. 164-165; World Bank and IMF 2004, p. 38; World Bank and IMF 2006, p. 8; Patillo et al., 2006, p. 42). In our dialogue with the government of Ethiopia and other partners inside and outside the World Bank, we have found that issues related to labor and education, synergies, long-run macro issues (including growth and financing), and trade-offs between human development and infrastructure are of particular interest. We have also learned that it is important to view model-based analysis and the development of a multi-purpose database as part of an on-going process based on multiple tools, in our case substituting a simpler macro framework for MAMS when the micro foundations of scenarios were not available in the same degree of detail as required for MAMS.

As more countries move ahead with ambitious Poverty Reduction Strategies that are built around accelerating progress toward achieving the MDGs, availability of an operational tool for integrating detailed sector analysis within an economy-wide framework to capture the interactions between and tradeoffs among MDG-related and other expenditures is invaluable. Properly used, MAMS can provide a

vehicle for enriching the dialogue among the different partners in the development community to establish coherent long-term strategies for achieving the MDGs.

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Tables

Introductory notes on figures and tables

The tables and figures present the results from five simulations described more fully in the text:

Base	Business-as-usual scenario
MDG-Base	Core MDG scenario
MDG-Mix	MDG scenario with smaller increase in foreign aid
MDG-Gprd	MDG scenario with increased government productivity
MDG-Infcut	MDG scenario with reduced spending on infrastructure (human-development focus)
MDG-HDcut	MDG scenario with reduced spending on human-development (growth focus)

Model closure rules are important for understanding some of the key results. There are three essential closure rules. First, tax rates and government borrowing are fixed and gaps in public financing (of both current and investment expenditures) are financed through foreign grants. Second, the real exchange rate is flexible. In a setting with fixed capital account items, changes in foreign grant aid affect the trade balance; for example, an increase in foreign aid typically leads to a real exchange rate appreciation. Third, private investment spending is flexible, defined as total savings net of spending on government investment. Changes to private investment will come through changes in private incomes (influencing private savings), government investment (ceteris paribus, more government investment crowds out private investment) and/or changes to the unit cost of investment. The domestic CPI is the model numéraire.

The model's base year is 2002 and thus 2005 levels are simulated (but are identical in all simulations). Unless noted otherwise, most of the results are presented as annual average (compound) percent change over the 10-year period spanning 2006-2015.

Table 3.1: Impacts on MDG indicators[1]

(Levels in 2015, save for first column)

MDG indicators	2005	*Base*	*MDG-Base*	*MDG - Mix*	*MDG - Gprd*	*MDG - Infcut*	*MDG - HDcut*	*Target*
		Rate in 2015						
MDG 1: headcount poverty rate (%)	33.8	27.8	18.7	22.6	18.6	21.3	18.6	19.2
MDG 2: 1st cycle primary net completion rate (%)	29.1	48.1	99.9	99.9	99.9	99.9	93.8	100.0
MDG 4: under-5 mortality rate (per 1,000 live births)	156.2	110.5	68.0	68.0	68.0	67.9	79.0	68.0
MDG 5: maternal mortality rate (per 100,000 live births)	580.0	387.2	217.5	217.5	217.5	217.2	260.1	217.5
MDG 7a: access to safe drinking water (%)	24.4	26.4	62.5	62.5	62.5	62.5	59.5	62.5
MDG 7b: access to improved sanitation (%)	12.0	14.1	54.0	54.0	54.0	54.0	50.6	54.0

Note: 1.The 1990 values are: 38.4 (MDG 1); 24.0 (MDG 2); 204.0 (MDG 4); 870 (MDG 5); 25.0 (MDG 7a); 8.0 (MDG 7b). The targeted changes relative to the 1990 value: 50% cut (MDG 1); reach 100% in 2015 (MDG 2); 2/3 cut (MDG 4); ¾ cut (MDG 5); 50% cut in share without (MDG 7a); 50% cut in share without (MDG 7b).

Source: World Bank staff simulations with the MAMS model.

Table 3.2: Impacts on macroeconomic indicators

(Levels in 2005, average annual percent compound growth rate, 2006-2015)

	2005	*Base*	*MDG-Base*	*MDG - Mix*	*MDG - Gprd*	*MDG – Infcut*	*MDG - HDcut*
	mn US$	**Real annual growth 2006-2015 (%)**					
Absorption[1]	10,153	3.5	8.5	6.5	7.8	7.6	7.9
GDP at market prices	8,528	3.5	5.7	4.8	5.9	5.2	5.7
Private consumption	6,734	3.1	5.4	1.8	5.0	4.7	5.5
Government consumption	1,458	4.0	8.4	8.6	8.4	8.7	6.8
Private investment	942	4.4	8.5	3.0	7.6	7.2	8.3
Government investment	1,019	4.0	20.0	20.3	18.2	17.9	18.4
Exports	1,283	3.7	-1.0	1.1	1.0	-0.7	0.6
Imports	2,908	3.4	12.8	9.1	10.7	11.2	11.4
GDP at factor cost (total)	7,704	3.6	5.5	4.7	5.5	5.0	5.5
GDP at factor cost (private sector)	7,101	3.5	5.2	4.3	5.3	4.6	5.4
GDP at factor cost (government)	603	4.0	8.7	8.8	8.6	8.9	7.3
Real exchange rate (index)	1.0	0.2	-3.4	-0.9	-1.8	-2.9	-2.5

	2005	*Base*	*MDG-Base*	*MDG - Mix*	*MDG - Gprd*	*MDG – Infcut*	*MDG – Hdcut*
	percent	**Percent of GDP in 2015**					
Absorption[1]	119.1	118.6	141.7	137.4	137.6	138.7	138.5
Private consumption	79.0	76.0	72.1	58.6	72.9	71.2	74.3
Government consumption	17.1	17.9	22.1	24.4	19.0	23.9	19.0
Private investment	11.0	12.1	12.0	8.9	12.1	11.5	12.5
Government investment	12.0	12.6	35.5	45.5	33.6	32.0	32.7
Exports	15.0	15.6	5.7	9.7	8.1	6.4	7.3
Imports	-34.1	-34.2	-47.4	-47.1	-45.7	-45.1	-45.9

Note: 1. Absorption is the sum of private and public consumption and investment.

Source: World Bank staff simulations with the MAMS model.

Table 3.3: Impacts on government current expenditures

	2005 mn US$	*Base*	*MDG-Base*	*MDG - Mix*	*MDG - Gprd*	*MDG - Infcut*	*MDG - HDcut*
		Real annual growth 2006-2015 (%)					
1st cycle primary education	95.1	4.0	15.6	15.9	15.7	16.4	9.3
2nd cycle primary education	68.0	4.0	12.9	12.9	12.9	12.9	12.9
Secondary education	55.9	4.0	11.2	11.2	11.2	11.2	11.2
Tertiary education	51.3	4.0	13.1	13.1	13.1	13.1	13.1
Low-tech health	22.0	4.0	14.7	15.5	14.7	16.0	8.3
Medium-tech health	31.0	4.0	11.9	12.6	11.9	13.0	6.8
High-tech health	110.7	4.0	15.5	16.4	15.5	16.9	8.8
Water and sanitation	16.3	4.0	21.4	21.9	21.5	21.9	20.4
Public infrastructure	17.0	4.0	15.4	15.4	15.4	12.3	15.4
Other government	990.8	4.0	4.0	4.0	4.0	4.0	4.0
	percent	**Percent of GDP in 2015**					
1st cycle primary education	1.1	1.1	2.7	2.8	2.2	3.0	1.5
2nd cycle primary education	0.8	0.8	1.5	1.6	1.2	1.6	1.5
Secondary education	0.7	0.8	1.2	1.2	0.9	1.2	1.1
Tertiary education	0.6	0.7	1.2	1.3	1.0	1.3	1.2
Low-tech health	0.3	0.3	0.6	0.7	0.5	0.7	0.3
Medium-tech health	0.4	0.4	0.6	0.7	0.5	0.7	0.4
High-tech health	1.3	1.4	3.0	3.7	2.7	3.6	1.7
Water and sanitation	0.2	0.2	0.8	0.9	0.7	0.9	0.7
Public infrastructure	0.2	0.2	0.5	0.5	0.4	0.4	0.5
Other government	11.6	12.2	10.0	10.9	8.8	10.6	10.1
Domestic interest payments	0.2	0.7	0.5	0.6	0.5	0.5	0.5
Foreign interest payments	0.8	1.1	0.6	0.9	0.7	0.7	0.7
Total recurrent public spending	18.2	19.6	23.2	25.9	20.3	25.2	20.2

Source: World Bank staff simulations with the MAMS model.

Table 3.4: Impacts on government investment expenditures

	2005	*Base*	*MDG-Base*	*MDG - Mix*	*MDG - Gprd*	*MDG - Infcut*	*MDG - HDcut*
	mn US$	**Real annual growth 2006-2015 (%)**					
1st cycle primary education	18.6	4.0	24.1	24.7	24.3	25.6	12.4
2nd cycle primary education	13.6	4.0	24.4	24.4	24.4	24.4	24.4
Secondary education	26.6	4.0	21.1	21.1	21.1	21.1	21.1
Tertiary education	36.7	4.0	24.9	24.9	24.9	24.9	24.9
Low-tech health	16.3	4.0	28.0	29.5	28.0	30.4	14.9
Medium-tech health	23.9	4.0	22.6	23.8	22.6	24.6	11.3
High-tech health	45.3	4.0	29.6	31.1	29.5	32.1	15.9
Water and sanitation	15.4	4.0	40.4	41.1	40.5	41.1	38.6
Public infrastructure	378.4	4.0	24.6	24.6	24.6	18.9	24.6
Other government	444.3	4.0	4.0	4.0	4.0	4.0	4.0
	percent	**Percent of GDP in 2015**					
1st cycle primary education	0.2	0.2	0.9	1.2	0.9	1.1	0.4
2nd cycle primary education	0.2	0.2	0.7	0.9	0.6	0.7	0.7
Secondary education	0.3	0.3	1.0	1.3	1.0	1.1	1.1
Tertiary education	0.4	0.5	1.9	2.4	1.8	2.1	2.0
Low-tech health	0.2	0.2	1.1	1.5	1.0	1.4	0.4
Medium-tech health	0.3	0.3	1.0	1.4	1.0	1.3	0.4
High-tech health	0.5	0.6	3.4	4.8	3.2	4.4	1.2
Water and sanitation	0.2	0.2	2.6	3.4	2.5	2.9	2.4
Public infrastructure	4.4	4.7	19.2	24.0	18.2	13.0	20.3
Other government	5.2	5.5	3.7	4.6	3.5	4.0	3.9
Total public capital spending	12.0	12.6	35.5	45.5	33.6	32.0	32.7

Source: World Bank staff simulations with the MAMS model.

Table 3.5: Impacts on government revenues (as share of GDP)

	2005	*Base*	*MDG-Base*	*MDG – Mix*	*MDG - Gprd*	*MDG - Infcut*	*MDG - HDcut*
	percent	**Percent of GDP in 2015**					
Direct taxes	6.3	6.0	5.8	24.8	5.8	7.9	3.6
Import taxes	6.4	6.2	7.0	6.3	6.8	6.9	6.9
Other indirect taxes	3.3	6.2	5.9	6.0	6.1	5.9	6.0
Central bank borrowing	1.2	1.4	1.1	1.2	1.1	1.1	1.1
Other domestic borrowing	2.0	2.5	1.9	2.2	2.0	2.0	2.0
Foreign borrowing	5.8	4.2	2.4	3.4	2.8	2.7	2.7
Foreign grants	5.1	5.7	34.6	27.4	29.2	30.7	30.7
Net other capital inflows and errors	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**30.1**	**32.2**	**58.7**	**71.4**	**53.8**	**57.2**	**53.0**
Memorandum items:							
Total public expenditures	30.1	32.2	58.7	71.4	53.8	57.2	53.0
Foreign aid per capita (US$)[1]	16.2	18.5	80.8	51.4	61.9	67.5	67.5

Note: 1. Foreign aid per capita includes allowance for aid outside the government budget. In per-capita terms, aid in the government budget was around US$11 in 2005.

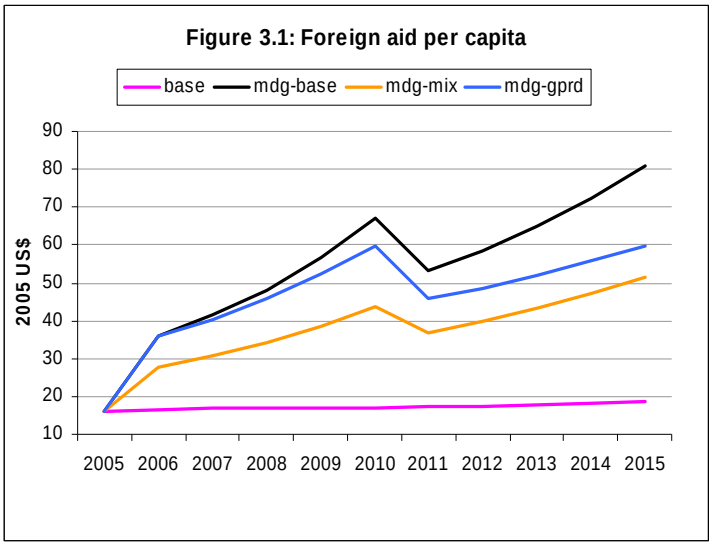
Source: World Bank staff simulations with the MAMS model.

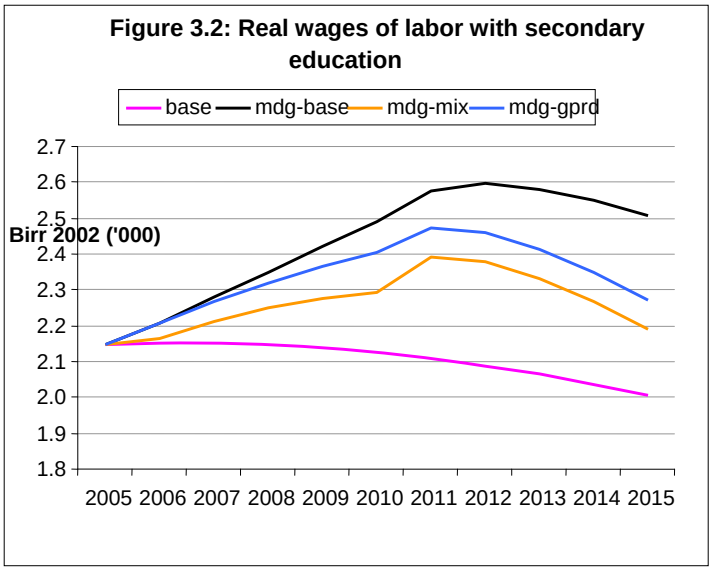
Table 3.6: Impacts on labor and capital

(Levels in 2005, average annual percent compound growth rate, 2006-2015)

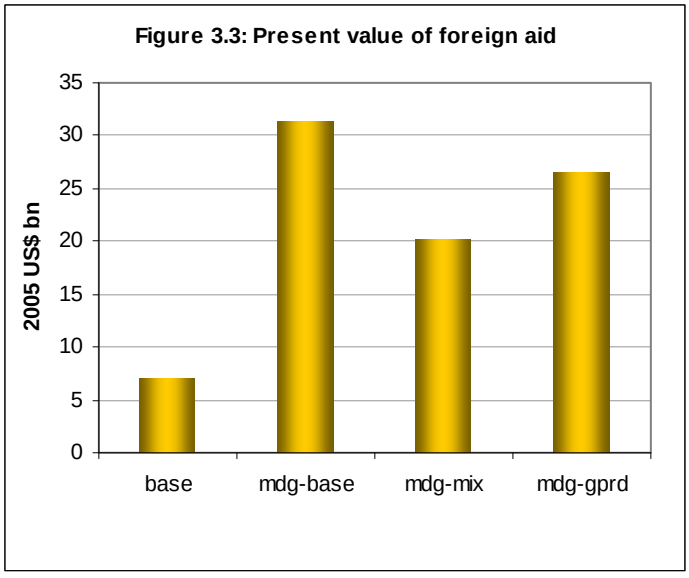
Wages and return to capital	2005 '000 birr/yr	*Base*	*MDG-Base*	*MDG - Mix*	*MDG – Gprd*	*MDG - Infcut*	*MDG - HDcut*
		Nominal annual growth 2006-2015 (%)					
Labor (< secondary education)	0.8	-0.4	3.9	2.4	3.4	3.2	3.4
Labor (secondary education)	2.1	-0.7	1.6	0.2	0.6	1.1	1.1
Labor (tertiary education)	9.6	2.2	3.4	2.2	1.8	3.3	2.7
Private capital	2.7	-0.4	0.4	1.1	0.4	0.1	0.6
Factor quantities	**million**	**Real annual growth 2006-2015 (%)**					
Labor (< secondary education)	29.8	3.5	1.9	1.9	1.9	1.9	2.2
Labor (secondary education)	2.3	3.9	5.0	4.9	5.0	4.9	4.8
Labor (tertiary education)	0.2	1.9	4.4	4.2	4.3	4.2	4.4
Private capital[a]	76.7	3.5	4.9	2.9	4.7	4.6	4.8
ICOR		3.7	6.8	7.6	6.7	6.5	6.2

Source: World Bank staff simulations with the MAMS model.
Note: a. Private capital units = billions of constant 2002 birr.

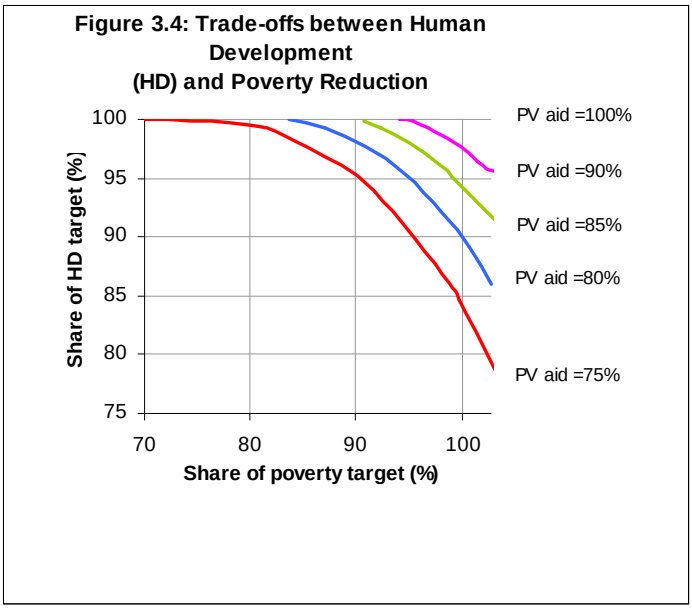




Source: World Bank staff's simulations with MAMS model.



Source: World Bank staff's simulations with MAMS model.



Note: The results for the base MDG simulation (100% aid) is that the HD target is achieved to 100%; poverty target is achieved to 102.8% -- upper right corner of graph. PV of aid 2006-2015 = US$31.4 bn
Source: World Bank staff simulations with MAMS model