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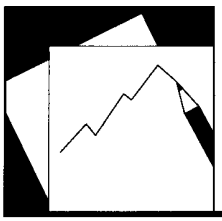

IMF Working Paper

Analyzing Fiscal Space Using MAMS: An Application to Burkina Faso

Jan Gottschalk, Vu Manh Le, Hans Lofgren and Kofi Nouve

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Analyzing Fiscal Space Using the MAMS Model: An Application to Burkina Faso

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Authorized for distribution by Doris C. Ross

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Abstract

This paper analyses economic implications and the transmission mechanisms of different options for creating and using fiscal space. For creating fiscal space, we consider prioritizing expenditures, raising revenue, and scaled-up aid. Fiscal space is used for increasing health and education spending, infrastructure spending, or both. The analysis takes place within the World Bank's MAMS model, which is a multisectoral real computable general equilibrium model that incorporates the Millennium Development Goals. The model has been calibrated for Burkina Faso, which serves as an illustrative country example. Some of the key results are that absorbing a more educated labor force requires fundamental structural change in the economy; increasing health and education spending can face sizeable capacity constraints; and infrastructure spending has a positive effect on growth as well as education and health outcomes.

JEL Classification Numbers: E13, E17, E62,

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I. INTRODUCTION[2]

This paper takes a detailed look at the economic impact of different options for creating and using fiscal space. The former refers to mobilizing resources and the latter to their possible uses. Regarding the creation of fiscal space, we consider

- Reducing spending in low-priority areas
- Increasing aid inflows (grants)
- Increasing domestic revenue

For the use of fiscal space, we simulate scenarios for

- Increasing health and education expenditures
- Increasing infrastructure expenditures
- A combination of the previous two options

The objective of the paper is to assess what the different options imply for the ultimate objectives of fiscal policy—e.g., promoting economic growth, reducing poverty, achieving the education and health-related Millennium Development Goals (MDG)—while also analyzing the economic transmission mechanisms involved. The analysis takes place at the macro and meso (sectoral) economic levels. To assess the impact on fiscal policy objectives, the paper considers the effect of fiscal space options on growth, the balance of payments, income distribution, and MDG variables. For analyzing economic transmission mechanisms, we consider the evolution of wage rates, prices, reallocation of factors between sectors, and sector outputs. While this analysis has policy implications, they are not at the center of this paper and are addressed only in the concluding section.

We are using the MAMS (Maquette for MDG Simulation) model for the economic analysis; the model has been calibrated for Burkina Faso, which serves as an illustrative example. MAMS is a multisectoral real CGE (computable general equilibrium) model that has been expanded to incorporate MDGs by modeling the health, education, and water-sanitation sectors and their linkages with the rest of the economy. A key feature of models of this type and related databases is that they strive to integrate consistently data on behavior and structure in different sectors of the economy. Of course, given data weaknesses, our tool should be seen as a rough approximation of Burkina's economy, not a replica.

Besides its ability to model key MDG indicators (which is critical for linking fiscal space options to the objectives of fiscal policy), the use of MAMS has additional advantages:

[2] This paper expands on a chapter on fiscal space for long-term growth in a Country Economic Memorandum (2009) for Burkina Faso prepared by the World Bank.

- MAMS has micro-foundations, i.e., it embeds profit maximization for producers and utility maximization, and price changes tend to clear markets. This means our results are consistent with standard neoclassical analysis.
- An exception to the general rule that prices clear markets is the labor market, where MAMS allows for reservation wages, and hence unemployment. This is useful for analyzing the effects of increased education spending on the labor market and its ability to absorb a new supply of educated labor.
- Unlike standard macroeconomic models, MAMS has a much richer set of sectors, households, and labor types. For example, while scaled-up aid would lead in a standard macroeconomic model to a reallocation of factors from the nontradable to the tradable sector, in MAMS we can identify in much more detail the sectors involved in the reallocation. Similarly, we can track a much larger set of prices and wages to capture the underlying transmission mechanism.

We will proceed as follows: After defining fiscal space (Section II) we present the key features of MAMS and the baseline calibration for Burkina Faso (Section III). One of the issues that emerges from the baseline calibration is the effect of the expansion of education that is embedded in the baseline on the economic structure. We then turn to the analysis of options for creating fiscal space (Section IV). Among other issues, we take a detailed look in this section at the effects of scaled-up aid on the trade balance, the sectoral allocation of factors, and the underlying transmission mechanism through a real exchange rate appreciation. Next, we consider different uses of fiscal space (Section V). One of the central results of these simulations is that increasing human development spending in real terms is likely to require considerable time because of bottlenecks in the expansion of health and education services. Finally, we draw policy lessons (Section VI).

In our simulations, whenever fiscal space is created it is used, and vice versa. To streamline the presentation, in our discussion of alternative scenarios for creating fiscal space (Section IV), we consider only one use of the space; conversely, in our analysis of alternative uses of fiscal space (Section V), we consider only one way of creating the space.[3]

II. Defining Fiscal Space

Heller (2005a) defines fiscal space as "the availability of budgetary room that allows a government to provide resources for a desired purpose without any prejudice to the sustainability of a government's financial position." In short, the essence of fiscal space is

[3] Simulations combining different methods for creating and using fiscal space are available upon request from the authors.

sustainable budgetary room.[4] This leads to two questions: how is fiscal space created and what is it used for?

To create fiscal space, countries can, in general, (i) mobilize domestic revenue; (ii) borrow from domestic and external sources; (iii) secure external grants; (iv) prioritize expenditures differently; and (v) make spending more efficient. For Burkina Faso, three sources of fiscal space are particularly relevant:

- Prioritizing expenditures is an option because poverty-reducing expenditures are relatively small compared to the size of the central government.[5]
- Scaled-up aid is an option because Burkina Faso receives substantial aid but per-capita aid is far below the Gleneagles' target.[6]
- Increasing revenue is an option because Burkina Faso's current revenue effort is low—approximately 13.5 percent of GDP in 2005—and the authorities have committed to increase this to 17 percent, which would create substantial fiscal space.

Because government covers a wide range of activities, from national security to promotion of sports, there are many potential uses of fiscal space. Here, we explicitly model current and capital expenditures, which are both split into health, education, public infrastructure, and "other" government activities. Collectively, the first two are referred to as human development. The use of additional fiscal space will focus on increasing expenditures for human development and for infrastructure spending.

III. The MAMS Model and Burkina Faso Calibration

A. Features of MAMS

MAMS is a recursive-dynamic CGE model designed for medium- to long-run development strategy analysis.[7] Like other CGE models, it provides a comprehensive account of the

[4] For a discussion of the experience with fiscal space in Africa, see also IMF (2007), chapter II.

[5] Poverty-reducing expenditures accounted for about 5.5 percent of GDP in 2007 whereas total government expenditures and net lending reached almost 26 percent of GDP. The average share of poverty-reducing expenditures in other countries benefiting from the Heavily Indebted Poor Countries (HIPC) Initiative in 2007 was about 8.8 percent of GDP (IMF (2008a). However, the definition of poverty-reducing expenditure can vary widely, which limits cross-country comparability. The share of total expenditures in Burkina Faso is comparable to that of other HIPCs.

[6] Aid inflows in Burkina Faso totaled about 9.5 percent of GDP in 2007. This is equivalent to about US$ 45 per capita; in Gleneagles, the donor community committed itself to scale up aid to approximately US$85 per capita.

[7] The starting point for MAMS is the static standard CGE model developed at the International Food Policy Research Institute (IFPRI) (Lofgren et al., 2002). MAMS is significantly extended in two key respects: the

(continued)

circular flow of income encompassing factors of production, production activities, institutions (households, the government, and the rest of the world), as well as different types of demands (intermediate and final, the latter split into consumption, investment, and exports) and supplies (from domestic producers and imports). In each time period, producers maximize profits and households make utility-maximizing consumption decisions. Both producers and households take market prices as given. Unlike other CGE models, it covers the generation of MDG and education outcomes, including the roles of different government functions in these processes (see Appendix I).

For the Burkina Faso specification, the model and the related database have the following disaggregation:

- **Households.** We model six different household types: (i) formal-sector wage-earners; (ii) informal–sector wage earners; (iii) cotton producers; (iv) food crop producers; (v) livestock keepers; and (vi) one "other" residual household, representing pensioners, independent businesses, and others not part of the preceding types. It needs to be emphasized that the households are not distinguished by their ownership of certain sectors—e.g., the cotton producer households do not own the production factors in the cotton sectors because sector-specific ownership of production factors is not modeled in MAMS; rather, households own a share of production factors that are employed economy-wide. Households are instead distinguished by the specific composition of their earnings and expenditures. For example, the defining characteristic of wage-earning households is that they receive a large share of income from educated labor. The difference between formal and informal sector households is that the former pay direct taxes and the latter do not. The agricultural households are relatively similar in their income sources, but differ in their expenditures: cotton producer households are the only agricultural households that are in the tax net, and livestock farmers are characterized by payments to other households for land use and relatively high investment spending. The 2004 household survey shows that the wage-earning households are the least poor, with an average (unweighted) poverty rate of about 10 percent, and the agricultural households are the most poor with a national (weighted average) poverty rate of about 55 percent.
- **Goods and services, collectively referred to as "commodities.** Outside the government and health and education sectors, which we discuss below, we have included 14 different types of commodities, covering agricultural products (including cereals and cotton); processed goods (for example, cotton fiber for export and manufactured goods for

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inclusion of (recursive) dynamics (that is, a time dimension) and the addition of an MDG module that endogenizes MDG and education outcomes. Other extensions include the endogenization of factor productivity (which depends, in the basic specification, on economic openness and government capital stocks) and the tracking of assets (or liabilities) of the different institutions (factor endowments, domestic government debts, and foreign debts). For a description of a standard CGE model, see also Sherman (1989). For details on the MAMS model, see Lofgren and Diaz-Bonilla (2007).

domestic use); utilities (including water and sanitation); petroleum (imported); and services (including construction).

- **Production factors.** Labor is differentiated by four education levels: (i) uneducated labor with completed primary education or less; (ii) educated labor with completed secondary I education; and highly-educated labor with (iii) secondary II education; and (iv) tertiary education. We also include private capital and land as production factors. This is complemented by public infrastructure, which enhances total factor productivity (TFP).

As mentioned, MAMS has micro foundations. Producers maximize profits in a perfectly competitive setting, i.e., they take prices, for both outputs and inputs, as given. By adjusting their factor inputs, producers can change both output and the relative factor intensity of production, subject to the constraints of a CES production function.[8] Profit maximization yields a first-order condition where for each production factor the marginal cost of employing this factor has to equal the marginal revenue it generates in production.

On the demand side, domestically produced commodities can either be exported or sold to the domestic market. Output is imperfectly transformable between exports and domestic sales, allowing producers to supply both markets if their prices differ. The relative price of commodities for exports and domestic sales determines the share for each destination. A similar mechanism determines the share of domestic demand that is met by imports. Changes in the exchange rate affect both exports and imports by changing their prices relative to the domestic supplier and demander prices of domestic output; the exchange rate adjusts to keep the current account in balance. Household demand is determined via a linear expenditure system[9]; the demand for a given commodity depends positively on household income (net of direct taxes and savings) via a fixed marginal income share; negatively on its own price; and on minimum demand determined through subsistence needs.

Household do not maximize utility on an intertemporal basis. In labor markets, this implies that overall labor supply depends only on exogenous population growth and not on wages; and that savings (and by extension investment) is not a function of interest rates (and return on investment) but is defined as a largely fixed share of post-tax household income. Households, though, make a decision on their education, which in turn determines the supply of different labor educations in the market. The education decision depends on the wage premium for education; education quality (determined by government spending on

[8] Production technology is defined by a nested two-level structure. At the bottom level, a CES production function aggregates the primary production factors discussed above into value-added output. In addition, a Leontief production function aggregates the intermediate inputs. At the top level, value-added and the intermediate inputs are aggregated into final output via a Leontief production function. For details, see Lofgren and Diaz-Bonilla (2007).

[9] This system is derived from utility maximization.

education); student health; infrastructure; and per capita household consumption. Two alternative regimes are possible in each of the four labor markets: (i) full employment (the unemployment rate is at its exogenous minimum), with a market-clearing wage; (ii) unemployment (the unemployment rate is above its exogenous minimum), with the producers employing as much labor as they desire at a reservation wage that is negatively related to the unemployment rate. For nonlabor factors (land and private capital), we assume a market-clearing wage or rent (the first of the two regimes). While factor wages or rents are set economy-wide, MAMS allows for exogenous sector-specific wage differentials; in the Burkina Faso calibration, agricultural labor wage rates have been set below those in other sectors to reflect lower observed wages and productivity in this sector. The wage differentials can be thought of as structural impediments that prevent agricultural labor from moving to higher–paying, and more productive, jobs in other sectors.

The government collects different types of revenue—direct income taxes, indirect sales taxes (the largest revenue source), and import duties—and spends it on the expenditure categories listed above. Both revenue sources and expenditure categories are calibrated to match Burkina Faso's budget composition. The required capital stock to support current government activities—the capital stock needed for education, health, and "other" government activities—is endogenous, depending on current government activities. Capital investment in public infrastructure, in contrast, is exogenous, but current government spending to maintain and operate the public infrastructure is endogenized, depending on the level of the infrastructure capital stock.

In international commodity markets, we assume that Burkina Faso is price-taker, facing infinitely elastic export demands and import supplies at exogenous prices. Domestic commodity markets, in contrast, clear through price changes. For example, if demand for a given commodity increases—this could result from increased government spending on an activity that needs this commodity as input—the relative price of the commodity will increase; on the demand side, this reduces household demand for the commodity, and on the supply side, production of the commodity becomes more profitable and increases. The latter leads to a rise in factor demand in this sector and to higher wage rates of factors that are intensively used in this sector. Higher wage rates, in turn, reduce factor demand and production in other sectors where the relative output price has declined.

Unlike a macroeconomic model of the dynamic stochastic general equilibrium (DSGE) type, MAMS does not model nominal rigidities that lead to a gradual price adjustment; rather, prices adjust instantly in MAMS. Consequently, MAMS-simulation results should be seen as depicting not a short-term forecast but rather the medium-term outcome after all prices have adjusted. In this sense, MAMS is a medium-term growth model, not a short-term macroeconomic model. Consistent with this medium-term orientation, MAMS does not model monetary policy or inflation, because monetary policy has real effects only in the short term but is neutral in the longer term, the MAMS modeling horizon. MAMS keeps the consumer price index (CPI) fixed and uses it as a numéraire (i.e., as the basic standard by

which values are measured); that is, all prices in MAMS are "real" prices, deflated by the CPI index.

B. Baseline Calibration of MAMS

The heart of the MAMS calibration is a social accounting matrix (SAM) that maps all flows between production activities, production factors, institutions (e.g., households, government), and commodities (goods and services) in the model economy. For Burkina Faso, these flows have been calibrated using sector studies (in particular for education); data compiled by the national statistics office (including input/output data and national accounts); government budgets; the MDG costing database; and the 2003 household survey. At a macro level, the SAM for 2007 broadly matches Burkina Faso's national accounts for 2007. For the following years, the MAMS simulation keeps most macroeconomic variables stable in GDP terms (Figure 1).

Comparison with the IMF staff macroeconomic framework

Whereas for 2007 the IMF macroeconomic framework and MAMS are similar, the IMF projection for the following years differs in two important aspects: (i) it assumes a gradual increase in the revenue-to-GDP ratio until it reaches the WAEMU target of 17 percent in 2018 (Figure 1, Panel 1), and (ii) aid inflows decline in GDP terms over the medium term (Panel 2).[10] These two developments are linked: the IMF framework projects the replacement of one source of fiscal space (aid) with another (revenue). The decline in aid results from lower grant inflows as the current high level of donor support gradually subsides and external borrowing declines due to debt sustainability concerns.[11] The increase in the revenue effort aims to compensate for lower aid inflows and maintain expenditure levels. Even though government expenditures in GDP terms stay broadly stable, overall consumption declines (Panel 3) as the transfer of resources from the private to the public sector crowds out private consumption; investment in GDP terms is stable (Panel 4). The trade deficit in the IMF framework narrows (Panel 5) as lower private consumption reduces import demand (Panel 6).

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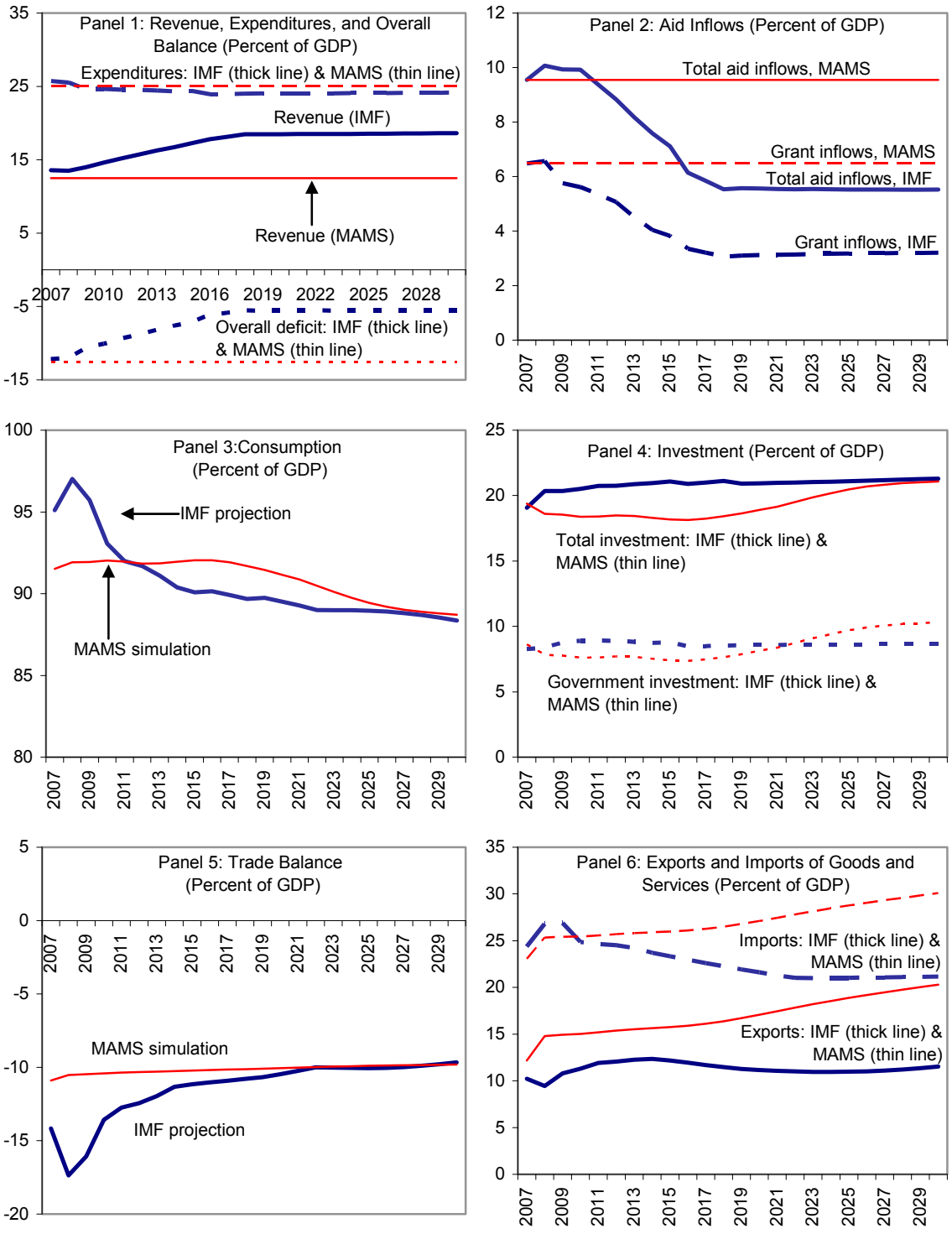
[10] The IMF projections shown in Figure 1 correspond to the macroeconomic framework underlying the second review of the PRGF-supported program. See IMF (2008b).

[11] According to World Development Indicator (WDI) statistics, Burkina Faso's average aid-to-GDP ratio for 2001–06 was about 13 percent, which is more than twice as high than the corresponding ratio for sub-Saharan Africa (5 percent) or low-income countries (about 6 percent). The IMF framework focuses on aid that goes through the central government budget, which is a narrower definition than official development assistance used in WDI. The fiscal aid-to-GDP ratio averaged about 10 percent for 2001–06 and is projected to decline to about 5.5 percent by 2020. Net loan disbursements would decline from a peak of almost 4.5 percent in 2010 to about 2.5 percent in 2020.

Figure 1. MAMS Baseline Calibration and IMF Forecasts



Source: Burkinabè authorities and staff calculations.

The MAMS baseline simulation does not include the increase in revenue, or the decline in aid inflows, because these are modeled as alternative scenarios in the section on creating fiscal space. Specifically, we will model a fiscal space scenario that raises the revenue-to-GDP ratio to the WAEMU target of 17 percent, in line with the baseline assumption of the IMF framework. We will also model an increase in aid inflows to the Gleneagles target of US$85 per capita; this differs from the IMF framework where aid inflows decline, but the results from the MAMS scaling-up simulation can easily apply to a scaling-down of aid by simply reversing the signs of the simulation results.[12]

Structural change in the MAMS simulation

Even though key macroeconomic ratios remain relatively stable in the MAMS simulation, the period 2008–30 is nevertheless marked in the simulation by substantial structural change brought on by the improving education of the workforce. The Burkinabè authorities have succeeded in recent years in boosting education—the net primary school enrollment rate, for example, increased from 36 percent in 2000 to 47 percent in 2007—and the MAMS baseline assumes a continuation of this path, with gross enrollment rates increasing for all school types throughout the simulation period (Figure 2, panel 1).[13] This has a sizable impact on the composition of the labor force: in 2007, the share of labor with some education level—i.e., labor with education beyond primary school—is only 5 percent, while by 2030 its share has risen to about 20 percent of the total labor force (panel 2). The supply of educated labor (i.e., with a lower secondary school degree) increases particularly rapidly, followed by highly educated labor which has completed full secondary or tertiary education (panel 3). This new supply of educated labor needs to be absorbed by the economy, and in MAMS this involves multiple adjustment channels:

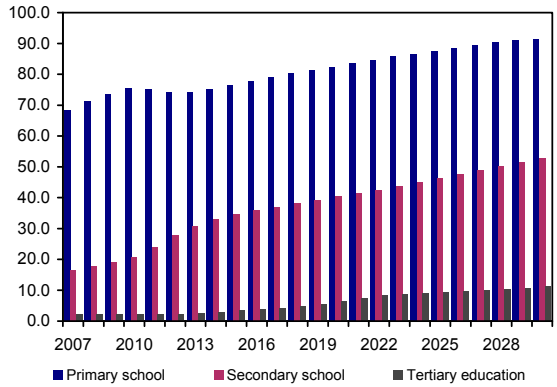
- Wage adjustment
- Factor substitution
- Unemployment
- Sector composition
- External adjustment

[12] In principle, it would have been desirable to validate the calibration through backtesting, i.e., to generate model simulations for preceding years and compare these to the actual performance of the economy. However, calibrating (and assessing) the model requires a substantial amount of data, often at the micro level, which is not available for prior years.

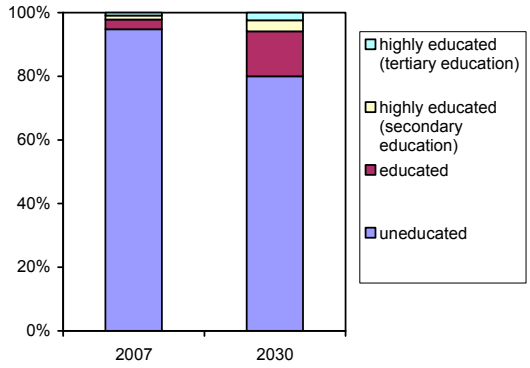
[13] For the net primary school enrollment rate, see IMF (2009), Table 9. Figure 2 (Panel 1) displays the gross primary school enrollment rate, which is considerably higher than the net enrollment rate because it includes students that are enrolled outside their own primary cohort, i.e., students that did not complete primary school when they were of primary school age but do so at a much older age. The data source for the MAMS calibration is the UNESCO Institute for Statistics (UNESCO, 2009).

Figure 2. Structural Change in the MAMS Baseline Simulation

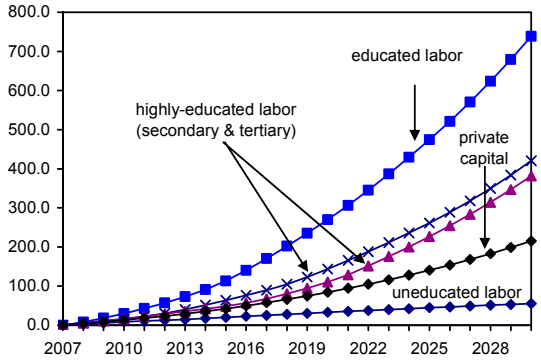
Panel 1:Gross Enrollment Rates by School Type, 2007–2030
(in percent)



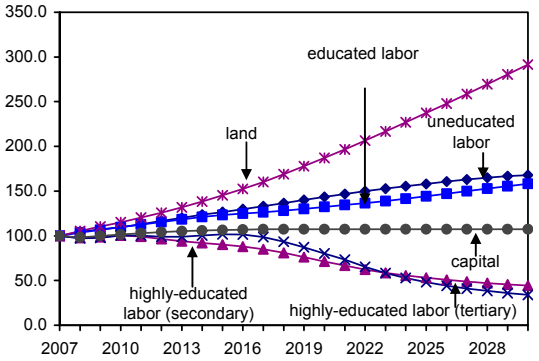
Panel 2: Labor Force Composition by Education Level (in percent)



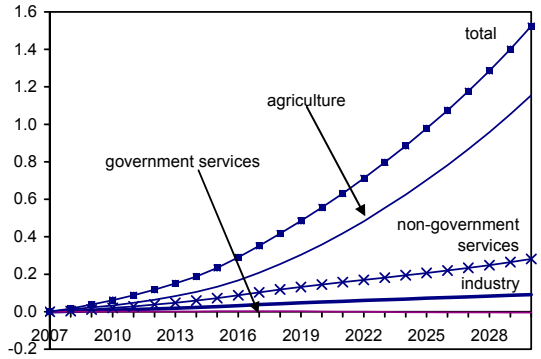
Panel 3:Labor and Capital Accumulation—Change in Percent Since 2007



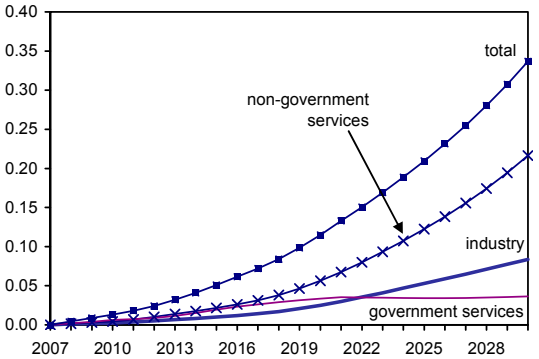
Panel 4: Wage Rates, 2007–2030
(Index 2007 = 100)



Panel 5: Change in Employment Relative to 2007—Educated Labor
2007–2030 (in millions)



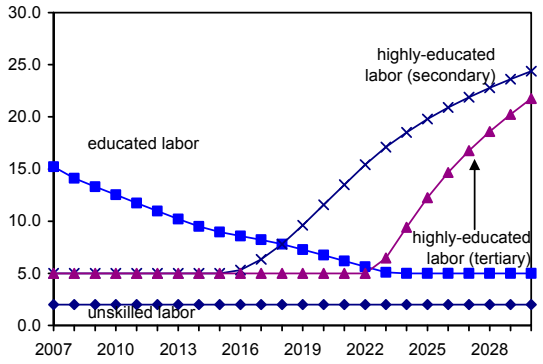
Panel 6: Change in Employment Relative to 2007—
Highly-educated labor (secondary education), 2007–2030 (in millions)



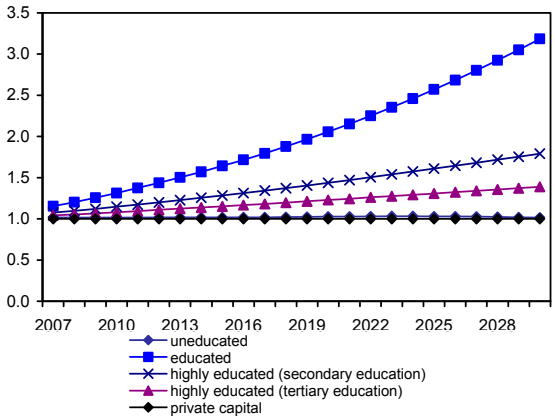
Source: Authors' calculations.

Figure 2. Structural Change in the MAMS Baseline Simulation (concluded)

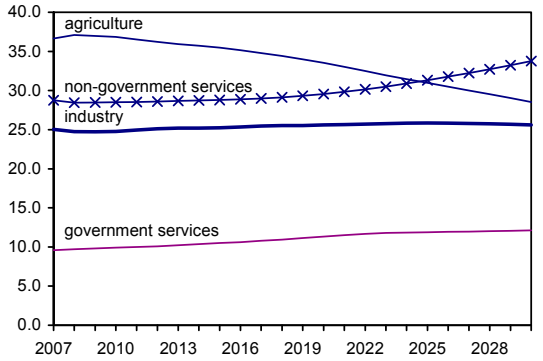
Panel 7: Unemployment Rates, 2007–2030
(in percent)



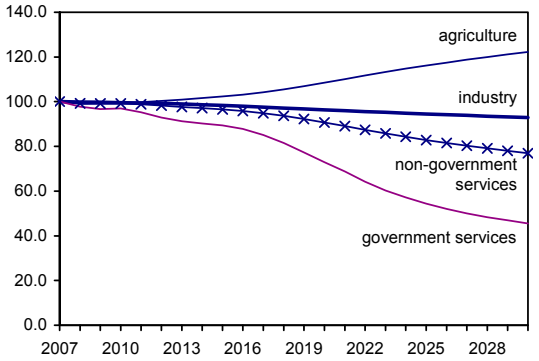
Panel 8: Factor-specific Productivity Trends, 2007–2030



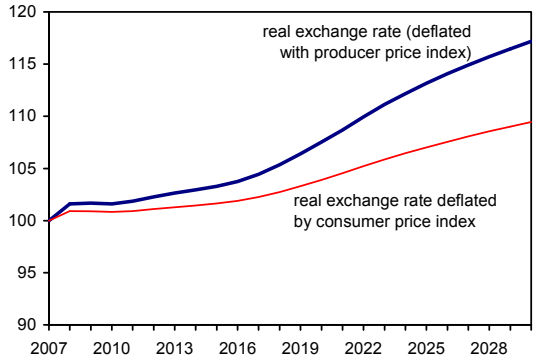
Panel 9: Sector Shares in Real GDP, 2007–30
(in percent)



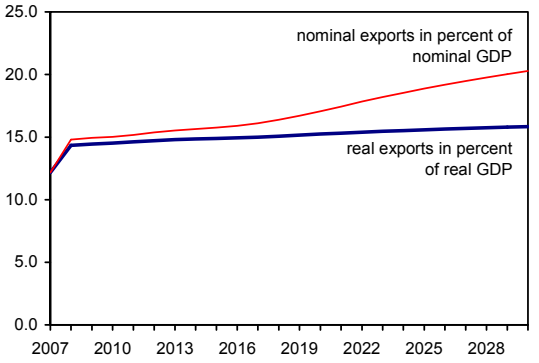
Panel 10: Producer Prices, 2007–2030
(Index 2007 = 100)



Panel 11: Exchange Rate Indices, 2007–2030
(2007=100; + Decpreciation)



Panel 12: Export-to-GDP Shares, 2007–2030
(in percent)



Source: Authors' calculations.

Considering the individual channels in some detail provides a good illustration of the economic transmission mechanism within MAMS. It also foreshadows several of the issues that arise if fiscal space is used to increase education spending and identifies some of the challenges Burkina Faso may face in making productive use of these new skills.

Wage adjustment

In MAMS markets are generally cleared through relative price changes, so wage rates for factors that are becoming more abundant (educated labor) tend to decrease, whereas those becoming more scarce (land, uneducated labor, private capital) increase. The wage rates depicted in Panel 4 conform to this pattern except for educated labor: even though the supply of educated labor increases noticeably, there is only minimal wage restraint relative to uneducated labor. The reason is twofold: first, productivity of educated labor is assumed to increase strongly throughout the simulation period, which promotes the absorption of labor into the labor market without wage restraint, and, second, unemployment of educated labor dampens the scope for downward wage adjustment because reservation wages form a wage floor. We will discuss both of these factors below.

Factor substitution

Table 1. Factor Intensity by Sector 1/

	Uneducated Labor	Educated Labor	Highly-educated Labor (second. edu.)	Highly-educated Labor (tert. edu.)	Private Capital
2007					
Agriculture	54.4	0.7	…	…	763
Industry	2.4	0.5	0.2	0.0	1,577
Nongovernment services	5.0	1.0	0.3	0.1	1,654
Government services	0.1	0.5	1.6	1.9	…
All sectors	*22.0*	*0.7*	*0.3*	*0.2*	*1,149*
2030					
Agriculture	36.4	3.9	…	…	894
Industry	0.9	0.4	0.3	0.1	1,183
Nongovernment services	0.6	1.0	0.6	0.2	1,116
Government services	0.0	0.1	0.6	1.5	…
All sectors	*8.8*	*1.6*	*0.4*	*0.3*	*934*
Change in percent					
Agriculture	-33.1	418.8	…	…	17.2
Industry	-63.4	-8.8	119.2	79.4	-25.0
Nongovernment services	-88.5	0.8	110.6	119.1	-32.5
Government services	-93.7	-86.5	-62.7	-18.9	…
All sectors	*-60.0*	*116.3*	*34.1*	*24.2*	*-18.7*

1/ Factor employment per 1000 value-added units.

The relative wage change leads to a factor substitution process, with production becoming more intensive in factors that have become relatively cheaper. With the general decline in wage rates for educated labor, production becomes more education-intensive. For instance, the agricultural sector is very intensive in uneducated labor at the start of the simulation in 2007 (Table 1). Over time, that intensity declines because educated labor adjusted for productivity becomes substantially cheaper, which leads to a substitution of educated for uneducated labor. As a result, the agricultural sector absorbs most of the new supply of educated labor (Panel 5). The adjustment process for highly educated labor is similar, but here the industrial and nongovernment service sectors increase their education intensity while lowering their capital intensity (i.e., they are substituting highly educated labor for capital). Consequently, most new entrants to this part of the labor force are absorbed by these two sectors (Panel 6).

Unemployment

Wage adjustments will not always be sufficient to clear labor markets because the Burkina Faso calibration allows for unemployment by specifying reservation wages that essentially form a wage floor. This can prevent wages from falling enough to clear the labor market. For 2007, elevated levels of unemployment are evident only for educated labor (Panel 7); the unemployment rates for other labor types are at their exogenous minimum levels (i.e., reflecting search unemployment).[14] That is, in 2007 the reservation wage floor is binding only for educated labor. However, as the expanded education system begins to produce a larger supply of highly-educated labor—increasing numbers of graduates with secondary education begin to enter the labor market around 2015 and with tertiary education around 2020—reservation wages for highly-educated labor become binding as well, and unemployment begins to rise. In the long run it is likely that unemployment would revert to its exogenous minimum for educated labor because, first, the reservation wage itself would adjust downward (in MAMS, it is modeled as a negative function of unemployment), and, second, the decline in wages would reduce the number of students seeking high levels of education. However, these adjustment processes require a long period to take effect.

Another aspect is the ability of the economy to create suitable jobs for new educated labor market entrants. In MAMS the ability to switch employment in a given sector from uneducated to educated labor, for example, is governed by the producer's first order condition (i.e., the marginal cost of employing a factor has to equal its marginal revenue product). The switch in employment then depends mostly on the factors' wage rates (which affect the marginal cost) and their productivity (which affect the revenue product).[15] Given

[14] However, given the scarcity of labor market data, these estimates should be treated with caution.

[15] If the factor substitution leads to adjustments in goods markets, changes in the sector's output and price levels also affect the first-order condition.

the assumption of a CES production technology in MAMS, productivity is a function of employment levels, the elasticity of substitution, and a factor-specific productivity term. The last, depicted in Panel 8, shows an assumption of strong productivity growth for educated labor, in particular educated labor.[16] This assumption is critical for the relatively smooth process of absorbing additional educated labor that is embedded in the MAMS baseline for Burkina Faso. Without productivity growth, the baseline would depict strongly increasing unemployment rates and falling wage rates for educated labor. That is, the newly educated labor force would end up in part unemployed. In the real world, the type of productivity growth underlying the MAMS baseline simulation could take two forms:

- **Moving up the value chain in agriculture**: The increase in the educated labor force has to be absorbed mostly by the agricultural sector. To realize the productivity gains implied in the MAMS simulations, it is not enough to simply replace an uneducated worker with an educated one—this would yield only marginal productivity gains—but requires moving more-educated labor into high-value areas like fruit production or agroprocessing where these skills are indispensable. That is, the assumption of high productivity growth for educated labor is shorthand for a fundamental transformation of agriculture. Increasing the education level of the labor force in agriculture will be part of the process, but it will also require entrepreneurship, a supporting environment (e.g., an effective financial sector), and identifying and exploiting business opportunities for higher-value agricultural products.
- **Expanding the industrial and nongovernment services sectors:** The industrial and service sectors will have to provide job opportunities for the highly educated labor force entering the labor market in the medium term, because agriculture is unlikely to require that much highly educated labor. In the MAMS simulations, highly educated labor is absorbed by an expansion of the service sector, as will be discussed below. However, while in MAMS this is a relatively mechanistic process based mainly on the decline in wage rates for this type of labor, in the real world it will be less automatic. Rather, as with agriculture, individual businesses will have to find opportunities to establish new lines of business or expand existing ones. This type of discovery process is inherently uncertain.

A final aspect of the evolution of unemployment is the fragmentation of the labor market in Burkina Faso: for a similar type of labor, agriculture typically pays significantly lower wages

[16] The productivity growth for highly educated labor benefits in particular government, because government health and education services are intensive users of this type of labor. The productivity gains increase the efficiency of government services, i.e., government requires less factor input for a given output, which explains why the government sector becomes less intensive in all factors over time (Table 1). Simultaneously, the relative share of highly-educated labor in government increases. In the real world, productivity growth could result from productivity-enhancing reforms like reforms of the civil service or public financial management that become more feasible with a more highly-educated workforce.

than industry or services. Besides a sectoral dichotomy, this likely reflects also a rural/urban divide. The significance of this is twofold:

1. It implies that the present factor allocation is inefficient, i.e., if labor were able to migrate from low wage/low productivity jobs in the agricultural sector to high wage/high productivity jobs in the industrial or service sectors, the overall productivity (and income) of the economy would improve. Also, the abundance of uneducated labor provides Burkina Faso with a comparative advantage that could give rise to the development of light manufacturing employing uneducated labor (e.g., assembly or textile production)—but with a large part of this labor "locked up" in agriculture, the country does not effectively use this advantage.

2. The barriers that prevent the equalization of wages and productivity over sectors—examples could include unions that raise wages in formal sectors above market-clearing levels or cultural barriers that prevent migration from rural to urban areas—could interfere with the structural change that is necessary to absorb an influx of educated labor. If sectors that could generate skilled employment are segmented from the rest of the economy--if wages in these sectors are kept high and employment limited through barriers like high unionization—increasing the supply of educated labor may mostly yield higher unemployment because wage rigidity would prevent employment generation. For individual workers it might still be worthwhile to invest in education and face the prospect of unemployment if this opens up a chance to eventually land a high-paying job in the segmented sectors, but education then serves primarily as an opportunity for securing a share of the rents in these sectors, so it becomes a means of rent seeking. Labor market segmentation is captured in the Burkina Faso calibration through exogenous wage distortion parameters, but these cannot fully capture the structural impediments that give rise to these distortions or their impact on structural change.

Sector composition

The changes in relative wages also change sector composition: the share of the agricultural sector in real GDP declines while that of the two service sectors expands (Panel 9).[17] Agriculture is relatively intensive in uneducated labor and land, the two factor categories showing the strongest wage rate increase (Panel 4). The sector passes part of the higher factor costs through to consumers (Panel 10), which lowers demand and production.[18] As a result, the share of agricultural production in real terms declines. For the two service sectors, the process works in reverse: they are relatively intensive in highly educated labor; the decline in

[17] Both sector output and GDP are measured at constant prices.

[18] Another part of higher factor costs is absorbed through factor substitution, i.e., by replacing uneducated labor with relatively cheaper (after adjusting for productivity differences) educated labor.

wage rates allows them to lower their producer prices, which increases demand and production.

External adjustment

The change in sector composition also implies a shift of resources from the tradable (agriculture) to the nontradable (services) sector. This tends to create an external imbalance, which in turn triggers a real exchange rate depreciation that keeps the balance of payments in equilibrium (Panel 11). Because of Burkina Faso's membership in the West African Economic and Monetary Union (WAEMU), real exchange rate depreciation is brought about by lower inflation than in other countries rather than through a nominal depreciation. The real exchange rate deflated by producer prices—which better captures producer competitiveness—depreciates by even more. This enhances the competitiveness of the economy at large and also raises the profitability of the export sector compared to other sectors, because producer prices in the export sector are exogenously given and do not decline, which raises relative producer prices in this sector.

The real depreciation keeps the share of exports and imports in terms of real GDP relatively constant (Panel 12). In nominal terms, however, the export and import shares increase because the depreciation increases their nominal value (Figure 1, Panel 6).

IV. CREATING FISCAL SPACE

In this section, we will consider three different sources of fiscal space—prioritizing expenditures, increasing aid inflows, and raising domestic revenue—and compare their impact on macroeconomic variables, MDG indicators, and income distribution. The fiscal space will be used in all scenarios in the same way, i.e., for increasing both human development and public infrastructure spending.

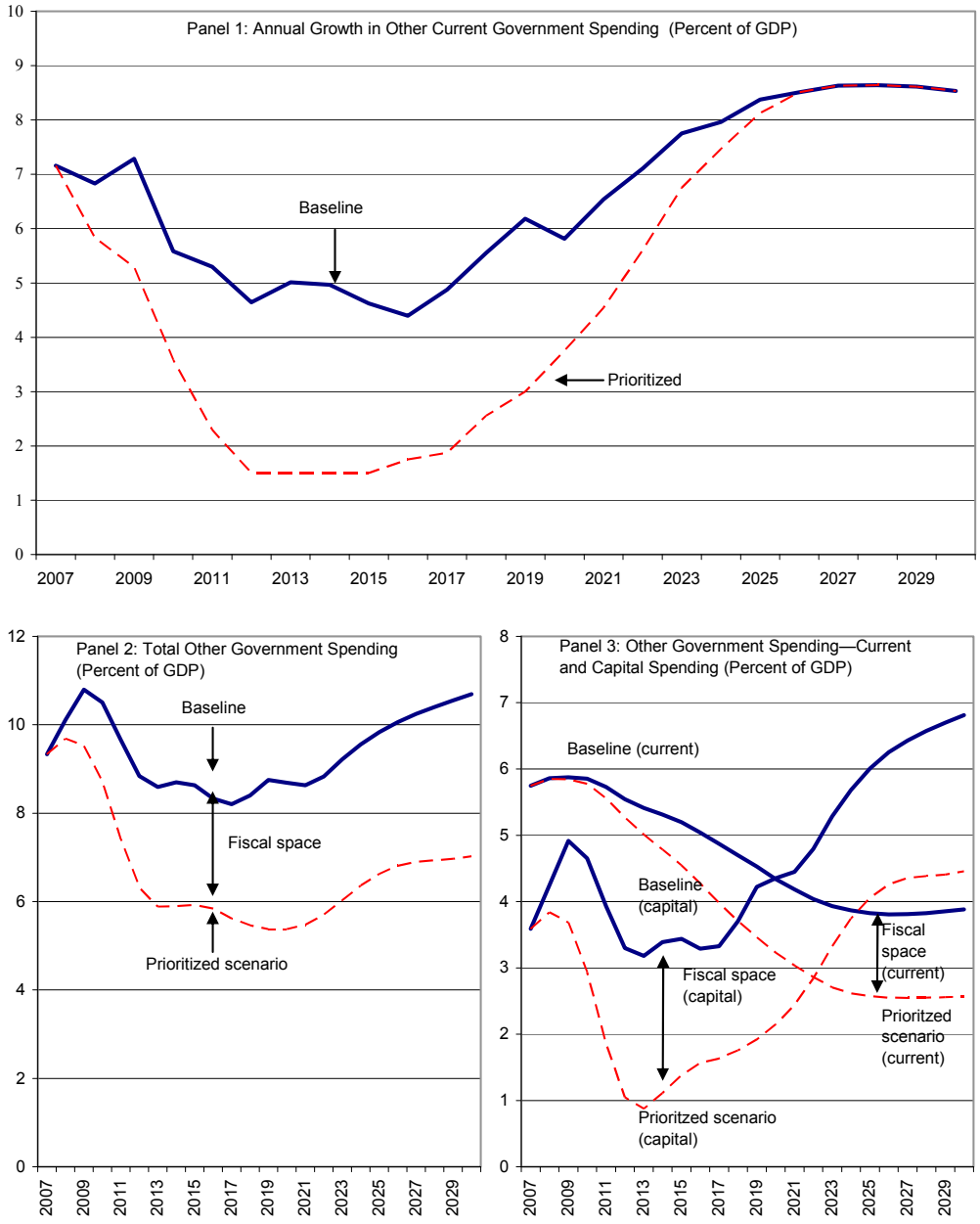
A. Prioritizing Expenditures

This scenario creates fiscal space by shifting resources from government activities other than human development or infrastructure spending (referred to as "other" government activities hereafter) to the aforementioned categories. This expenditure shift helps to promote growth and the MDGs, thereby prioritizing expenditures. In the baseline, current spending on other government activities grows at an annual rate of 6 percent; in the prioritized scenario, the growth rate is gradually reduced until it reaches 1.5 percent for 2012–15, with the growth path returning gradually to the baseline afterward (Figure 3, Panel 1).[19] As a result, total other government spending (with current and capital components) declines gradually relative to GDP, with a total reduction of about 2.5 percent of GDP by 2015 (Panel 2).

[19] All growth rates are in real terms.

The gain in fiscal space has two sources: on the one hand, current other government spending declines in the prioritized scenario, which creates fiscal space gradually; on the other hand, capital investment for other government activities is cut back immediately because the reduction in current spending for this activity reduces the required capital stock (Panel 3). The latter frees up considerable fiscal space in the short term. The overall gain in fiscal space is relatively persistent because the temporary spending restraint in this scenario has permanently reduced the expenditure base for other government activities.

Figure 3. Fiscal Space in the Prioritized Scenario



Source: Authors' calculations.

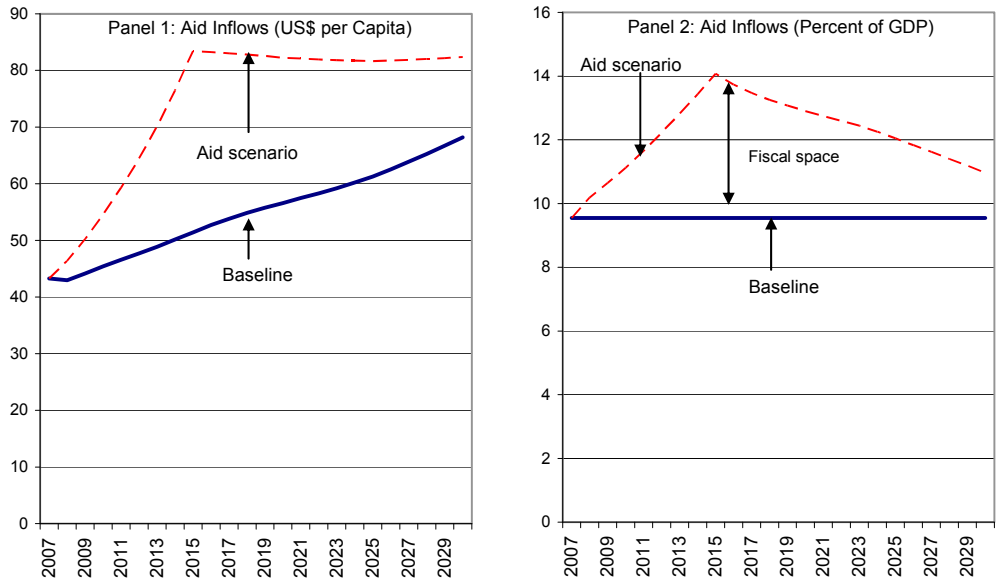
Prioritization is a difficult option for creating fiscal space because it involves deciding which expenditures will get lower priority. In Burkina Faso's 2007 budget (which is broadly mirrored in the MAMS composition of government expenditures) other government expenditures (those not dedicated to health, education, or public infrastructure) account for approximately 50 percent of both current and capital expenditures (see Appendix II). It includes items like support for agriculture (including irrigation), internal security and justice, and decentralization. Many of these expenditures are highly desirable and potentially economically productive, which makes it hard to work out which are not a priority.

In the calibration for Burkina Faso, MAMS does not link other government expenditures directly to factor productivity in any economic activity—unlike infrastructure, education, or health expenditures, where the link is modeled. The reduction in the growth rate for other government activities in the prioritized scenario therefore has no negative impact on productivity. This implies that expenditure growth in the prioritized scenario is reduced only in the subsectors of other government that have no or a negative impact on productivity. These could be administrative expenditures; defense spending; or expenditures on culture or sport that are not economically productive. Cost savings through efficiency gains (e.g., reduction in wasteful spending or overlapping government functions) would also fall into this category.

B. Increasing Aid Inflows

In this scenario aid inflows are increased from about US$45 per capita in 2007 to about US$ 85 per capita in 2015, in line with the Gleneagles commitment of developed countries to increase aid (Figure 4, Panel 1). This corresponds to an increase in aid inflows from 9.5 percent of GDP in 2007 to about 14 percent in 2015 (Panel 2). The increase in GDP terms is much smaller in percent than in per capita terms because Burkina Faso's real GDP per capita expands strongly in this period, reducing the aid-to-GDP share for a given US dollar aid amount. After 2015 we hold aid inflows at US$85 per capita, which implies a gradual decline in the aid-to-GDP share as real GDP per capita increases.

Figure 4. Fiscal Space in the Aid Scenario

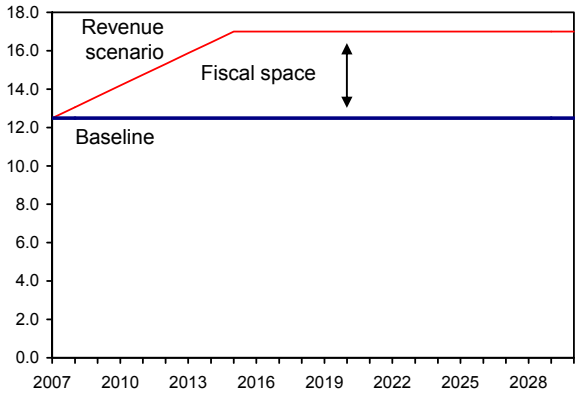


Source: Authors' calculations.

C. Raising Domestic Revenue

In this scenario, the revenue (tax collection) effort is raised to the WAEMU target of 17 percent of GDP in 2015, starting from about 12.5 percent in 2007 (Figure 5). We maintain this revenue ratio over the long term, thereby making the gain in fiscal space permanent. In practice, achieving this type of revenue increase would require reforms of both revenue administration and tax policy.

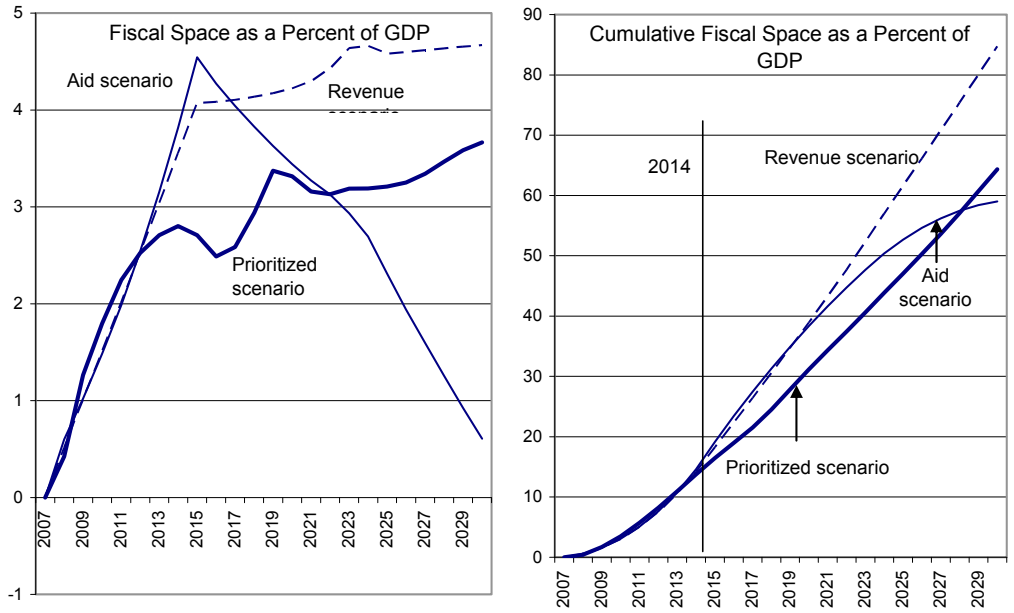
Figure 5. Fiscal Space in the Revenue Scenario, 2007–2030
(Revenue as a percent of GDP)



Source: Author's calculations.

D. Comparing Gains in Fiscal Space

Figure 6. Comparing Fiscal Space in Priority, Aid, and Revenue Scenarios



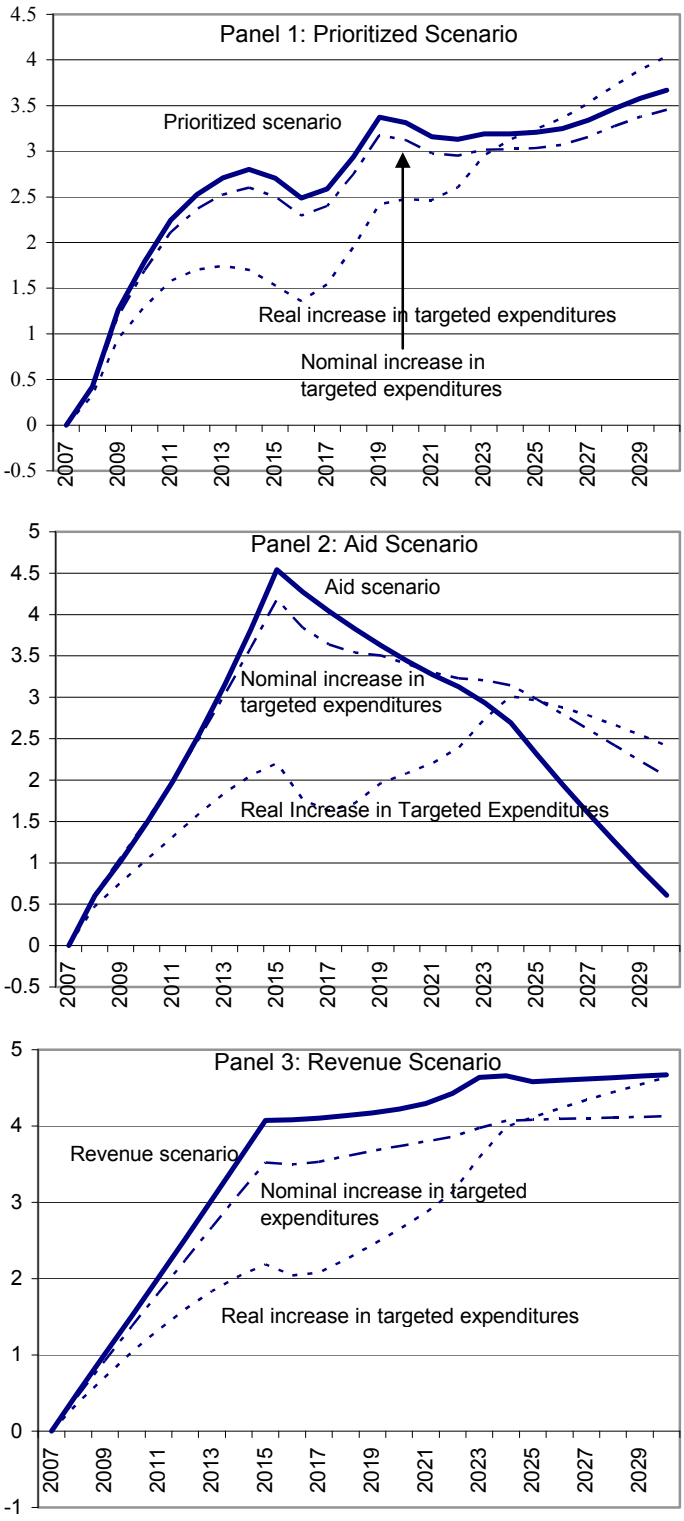
Source: Authors' calculations.

The two domestic scenarios—prioritizing expenditures and raising revenue—are programmed to create fiscal space permanently (Figure 6, Panel 1), whereas the increase in aid is temporary in GDP terms. The rationale behind the permanent nature of the domestic scenarios is that once created, fiscal space can be maintained over time without additional policy measures. In contrast, Burkina Faso will eventually graduate from its low-income and aid-recipient status, which makes any scaled-up aid inherently temporary. Considering the

cumulative effect of these options for creating fiscal space, the impact is relatively similar until 2014 (Panel 2), when the scenarios begin to diverge. The following discussion on the macroeconomic effects of these options will consequently focus on the period up to 2014, but the charts will display the full projection period to show the longer- term effects of these options.

Comparing the gains in fiscal space (Figure 7, thick line) with the increase in targeted expenditures (thin lines), i.e., human development and infrastructure spending, shows leakages. One type of leakage is the difference between the created fiscal space and the increase in nominal targeted expenditures (thin dashed line) for human development and infrastructure. This leakage is relatively small for the prioritized and the aid scenario (Panels 1 and 2) but somewhat larger for the revenue scenario (Panel 3). The reasons for the leakage differs according to the sources of fiscal space:

Figure 7. Fiscal Space and Targeted Spending Increases
(Percent of GDP)



Source: Authors' calculations.

- **Prioritized scenario:** This scenario induces a positive GDP growth response (discussed below). Aid inflows stay at their baseline value in US dollar terms; as a result, the aid-to-GDP ratio declines, which slightly offsets the gains in fiscal space in GDP terms.
- **Aid scenario:** The hallmark of this scenario is a major increase in the prices of factors needed for production of government services. This affects the cost of producing other government activities: whereas real expenditures on other government activities remain the same as in the baseline scenario, nominal expenditures increase because of the increase in service factor prices, which reduces the fiscal space for the targeted expenditures. In the longer term, this is reversed as factor costs in the aid scenario fall below those in the baseline.
- **Revenue scenario:** In the MAMS model this scenario tends to have a negative effect on real GDP; other government activities (nontargeted expenditures), are programmed to grow at their baseline rate, which is now higher than the GDP growth rate in the revenue scenario. Consequently the GDP share of other government activities increases, leaving less room for increasing targeted expenditures.

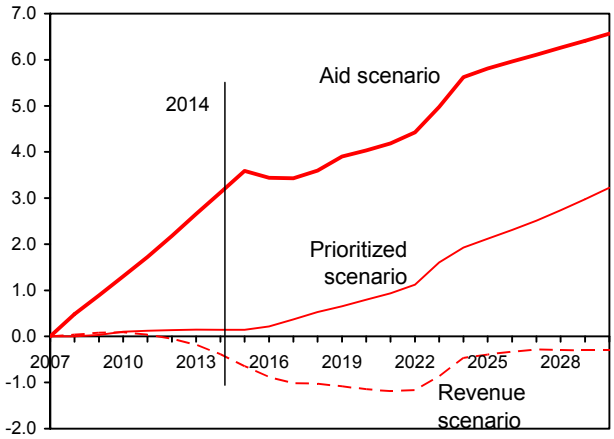
A much larger, source of leakage is the difference between nominal and real increases in targeted expenditures (thin dotted line). This results from a large increase in factor prices across all scenarios in which education and health expenditures are ramped up, creating a wedge between nominal and real expenditure increases. This will be explored in detail in the section on the use of fiscal space.

E. Macroeconomic Impact

Growth impact

In all scenarios, the increase in human development and public infrastructure spending increases TFP and thereby real GDP. In the period up to 2014, when the cumulative fiscal space created in the three scenarios is comparable, the GDP impact is positive and large for the aid scenario, slightly positive for the prioritization scenario, and slightly negative for the tax scenario (Figure 8). The negative GDP impact in the revenue scenario is the result of higher taxation crowding out the private sector because it reduces private investment and private capital accumulation. This effect

Figure 8: Cumulative Change in Real GDP, 2007–2030
(Percent difference from baseline)

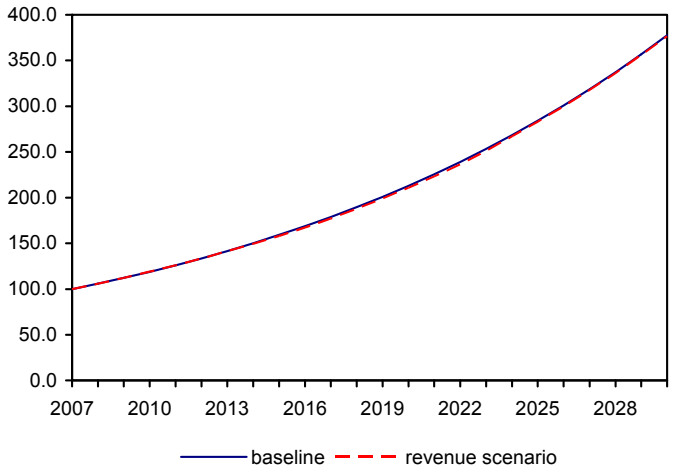


dominates the positive growth effect of higher public infrastructure spending.

At the other end of the spectrum, the large positive GDP impact in the aid scenarios results from the availability of external financing that allows a reduction in export production (mostly cotton) and a shift of production factors out of cotton to sectors in high demand, i.e., construction and health and education services, on which the government is spending more. Given that labor productivity is low in the cotton sector and high in the construction and service sectors (MAMS captures these differences in the form of the exogenous wage distortion parameters already discussed), this factor reallocation leads to a general improvement in labor productivity.

For the prioritized scenario, the last effect is much smaller, because prioritization frees up factors in sectors related to spending on other government activities, which generally have much higher productivity than in the cotton sector. The shift in factors from other government activities to construction and health and education services consequently does not raise overall labor productivity significantly.

Figure 9: Real GDP, 2007–2030
(2007=100)



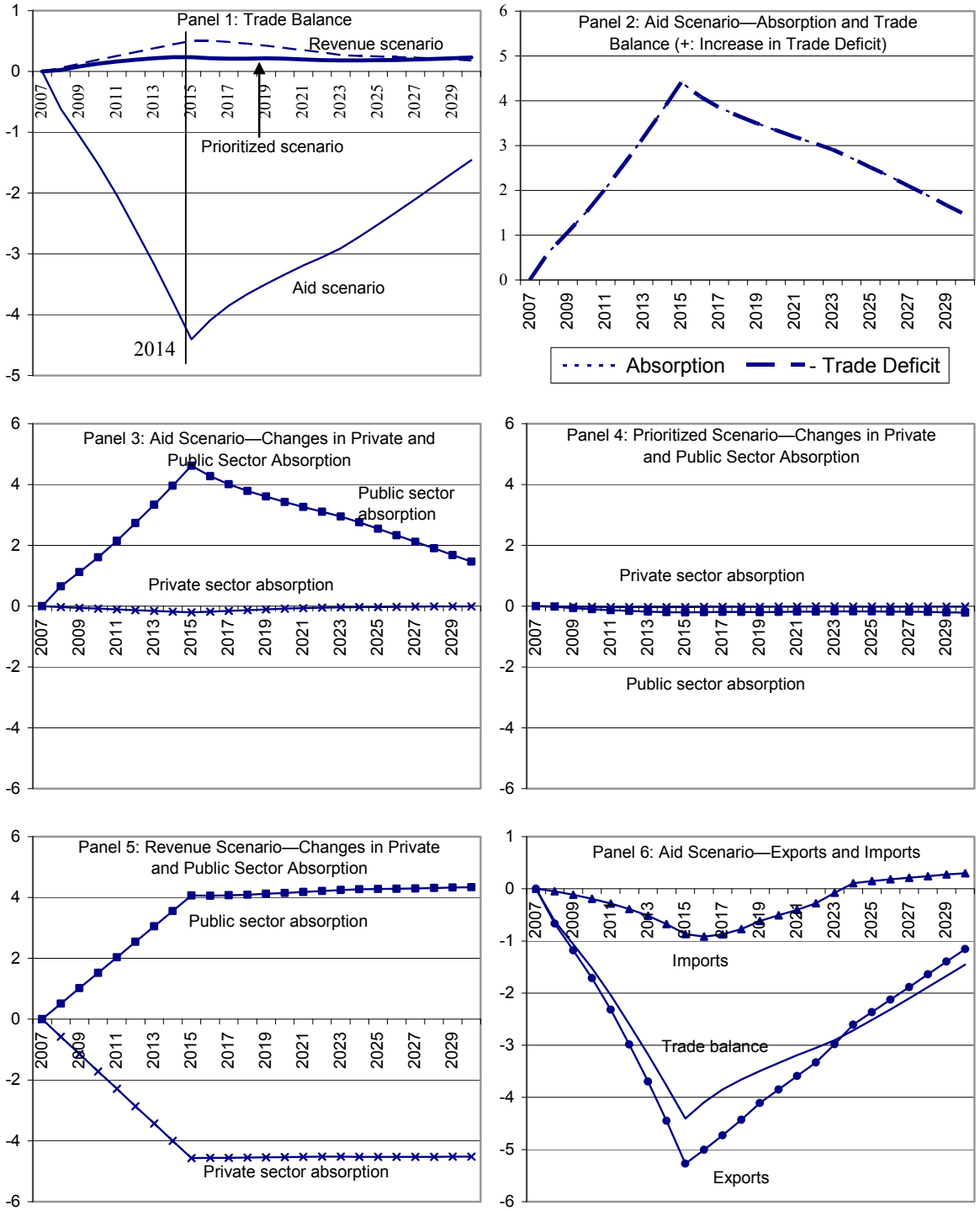
Source: Author's calculations.

Regarding the negative real GDP impact of the revenue scenario in the MAMS model, a number of additional factors need to be taken into account:

- The growth effects will depend on the design of tax reforms. A tax reform that makes the tax system more efficient by broadening the tax base and simplifying the system may be expected to promote growth. However, MAMS does not capture such potential efficiency gains. Burkina Faso could substantially raise the efficiency of its tax system by (i) lowering administrative costs for both taxpayers and revenue administration and (ii) reducing the disincentive effects of the tax system. The former could be realized by simplifying and reducing the number of Burkina Faso's taxes and fees, which currently number over 200. The latter requires broadening the tax base by eliminating exemptions to allow a reduction in tax rates without major revenue losses. MAMS does not capture the benefits of these reforms because it models neither administrative costs nor labor supply decisions that would be affected by tax rates.

Balance of payments impact

Figure 10. Trade Balance and Absorption
(Difference from Baseline as a Percent of GDP)



Source: Authors' calculations.

Given an underlying annual real GDP growth rate of 6 percent in the model, the negative impact on real GDP in the revenue scenario is small compared to the increase in real GDP over the simulation period (Figure 9).

The aid scenario would substantially widen the trade deficit, whereas changes in the trade deficit for the two domestic scenarios are comparatively small (Figure 10, Panel 1). The mirror image to the widening of the trade deficit in the aid scenario is the increase in domestic absorption (Panel 2), i.e., domestic consumption and investment. The defining characteristic of the aid scenario is that external resources are available to finance the increase in government expenditures, thereby allowing an increase in government absorption without crowding out the private sector (Panel 3) by widening the trade deficit instead. In contrast, for the domestic scenarios the increase in government spending needs to be financed by reducing other domestic activities, thereby leaving overall domestic absorption (and the trade deficit) unchanged. In the prioritized scenario, increased government absorption of education, health, and infrastructure activities comes at the expense of other government activities, which leaves overall government and private absorption practically unchanged (Panel 4). In the revenue scenario, the government absorbs more by crowding out private absorption (Panel 5).

The increase in overall absorption in the aid scenario requires appropriate fiscal and monetary policies (spend-and-absorb) and is accompanied by an adjustment process covering exports and imports, reallocation of factors between sectors, and changes in the exchange rate, prices, and wages. The following sections look at these issues in detail.

Spend-and-absorb approach in the aid scenario

Comparing the aid and revenue scenarios shows that making effective use of aid resources requires fully spending and absorbing the additional aid: a scenario where aid resources are spent (increase in government absorption) but domestic absorption does not increase (no widening in the trade deficit) is akin to a domestically financed increase in government spending where the increase in government absorption comes at the expense of private sector absorption. The policy implication is that scaled-up aid requires consistent fiscal and monetary policies: fiscal policy needs to spend the additional resources, and monetary policy needs to allow the real appreciation needed to bring about the increased absorption through a widening in the trade deficit.[20]

[20] For detailed discussion of the spend-and-absorb" approach, see Berg et al. (2005) and Gupta, Powell, and Yang (2006). For empirical evidence, see Aiyar and Ummul (2008).

Reallocation of factors between sectors in the aid scenario

In general, spending aid resources effectively on human development and infrastructure requires that there be a supply response in the economy that makes it possible to ramp up production in sectors that provide these services (e.g., health and education as well as construction). This requires increasing the amount of production factors available in these sectors, which in turn implies that other sectors will have to shrink to release production factors.[21] The only exception to a factor reallocation is a case where aid resources are spent exclusively on imports, in which case the government can increase service delivery without any changes in domestic production. An example would be using aid entirely for imported medicines to improve health services. However, most types of government spending are likely to have a sizable nontradable component that cannot be met through government imports. In this case, the aid scenario has two adjustment channels for freeing up production factors:

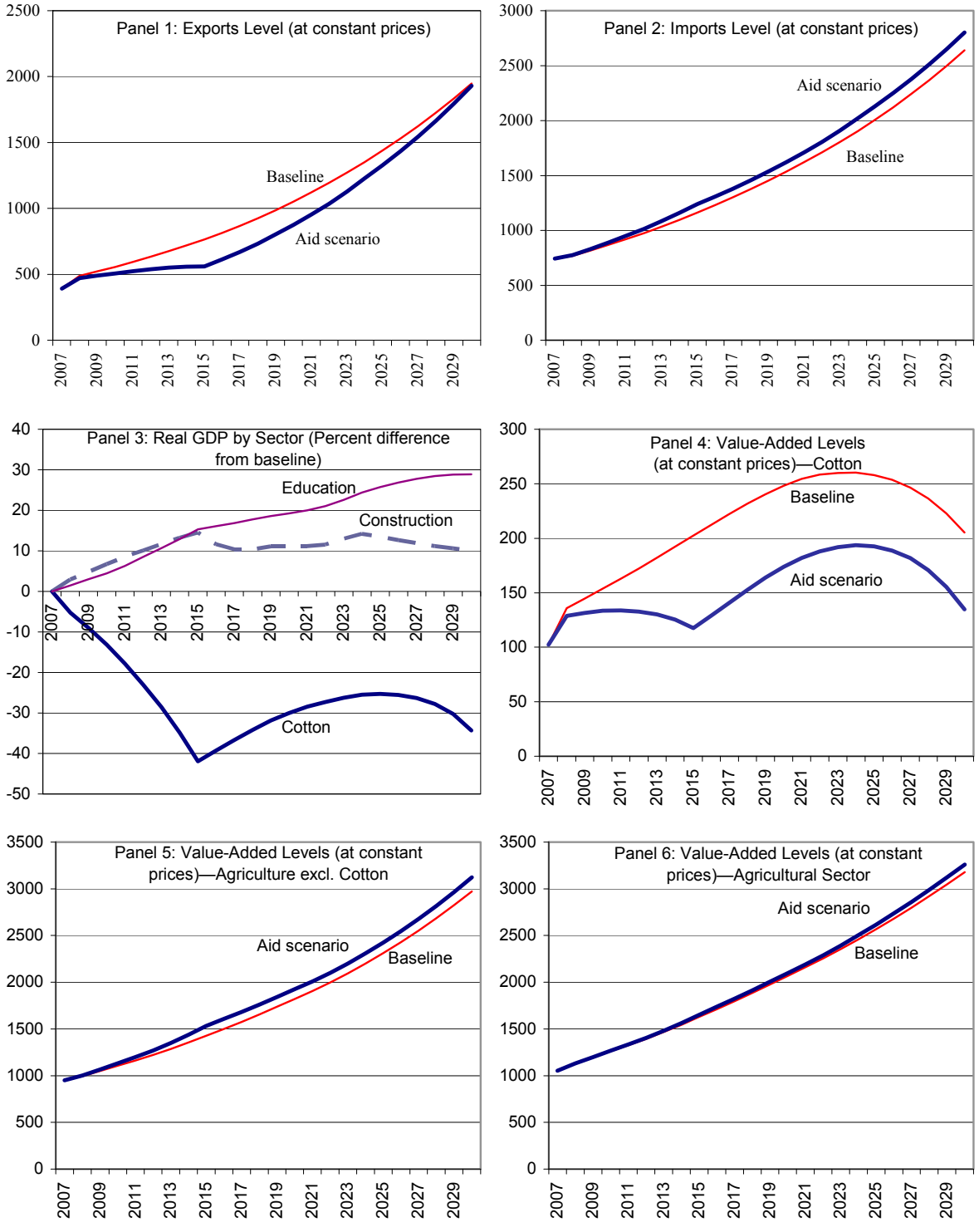
1. Exports can decrease, which releases production factors from export sectors; or

2. Private-sector imports can increase, which would free up factors from domestic import-competing and nontradable sectors as a result of expenditure-switching effects (see below).

In the Burkina Faso simulation it is apparent that the trade deficit widens mostly as a result of a reduction in exports relative to the baseline (Figure 10, Panel 6). In absolute terms, export levels stay flat for a number of years and ultimately converge back to baseline levels, but imports slightly exceed baseline levels (Figure 11, Panels 1 & 2). In essence, aid inflows replace the foreign exchange earned by cotton, which is Burkina Faso's main export sector. This allows for reallocating factors from cotton to construction, health, and education, which are in high demand because of public investment and human development spending (Panel 3). A real exchange rate appreciation is a central part of this transmission mechanism (see below).

[21] If there is a large amount of surplus labor currently not participating in the production process, drawing this labor into sectors that expand (or filling voids in sectors adversely affected by the reallocation of factors), could avoid the shrinkage of sectors that do not benefit from human development and infrastructure spending. In principle, MAMS takes the existence of such surplus labor into account by allowing for labor unemployment; for the Burkina Faso simulation, there is evidence for unemployment of educated labor that is integrated into the economy as aid-financed spending is scaled up. Nevertheless, some sectors (especially cotton) still shrink because unemployment is not high enough to prevent this. Of course, if the model calibration underestimates unemployment, the projected shrinkage of sectors like cotton would be smaller. But even in this case it still would be likely that education levels of unemployed labor do not match the demand generated by scaled up aid spending and that there would be a shortage of capital. That is, factor reallocation would still be taking place, with some sectors shrinking and others expanding.

Figure 11. Reallocation of Factors Across Sectors in the Aid Scenario



Source: Authors' calculations.

While the cotton sector in the Burkina Faso simulation bears the burden of the adjustment process, it would not necessarily shrink drastically in absolute terms: rather, like exports, cotton production would remain flat for a number of years instead of growing as in the baseline (Figure 11, Panel 4). Uneducated labor from the cotton sector that is not in demand in construction or human development services would migrate to other agricultural sectors and increase production there beyond baseline levels (Panel 5). That is, farmers for whom cotton production has become unprofitable might, for example, plant cereals. Although the cotton sector wold shrink relative to the baseline, agriculture as a whole would expand with the increase in noncotton agriculture and the overall GDP expansion resulting from the scaling up (Panel 6).

The increase in imports in the Burkina Faso simulation is relatively mild because, first, the direct import share of government expenditures is small, and, second, private demand does not easily switch to imports in the Burkinabè specification. The government share is small because health and education services require mostly highly educated labor, and public infrastructure spending affects mostly the construction sector, which also has a relatively small import share.[22] Increasing private sector imports involves two channels, both of which rely on a real exchange rate appreciation:

1. A real appreciation makes the production of tradable goods less competitive with imports, which reduces the size of import-competing industries, thereby freeing up resources in the tradable sector.

2. A real appreciation could also lead to expenditure-switching effects, where consumers switch their demand from nontradable to tradable goods, with imports meeting the increased demand for tradables; this tends to free up production factors in the nontradable sector.

In the previous simulations, neither of these two channels is very strong because in the Burkinabè specification of the MAMS model, the substitution elasticity between domestically produced tradable and imported goods is small—these are not close substitutes. The very limited substitutability between domestically produced and imported goods reflects the fact that manufacturing is not well developed in Burkina Faso; consequently, imports for a large range of products like cars or machinery have little domestic competition. Nor does , domestic manufacturing like processing of local food have much import competition. As a result, it is easier to shift resources from the export sector (cotton and fiber production) to other sectors that are in demand than it is to shift demand from domestically produced goods to imports.

[22] In other countries, the share tends to be larger, but available data for Burkina Faso point to a small import component of construction.

Adjustment of the real exchange rate, prices, wages in the aid scenario

A real appreciation of the currency is a central part of the transmission mechanism in the aid scenario to shift factors from the export sector to those that are in high demand due to government spending (Figure 12, Panel 1).[23] This transmission mechanism involves not only the exchange rate but also other prices (e.g., wages, producer prices) and factor intensity in sectors. Panel 1 summarizes these factors by deflating the exchange rate with the producer price index.

Taking a more detailed look at this transmission mechanism, the key is the first-order condition for producers, which demands that in each sector all producers have to equalize the marginal cost of each factor with the marginal revenue product of employing this factor in production:

- In countries with a flexible exchange rate, the first step would be a nominal appreciation of the exchange rate, which by reducing the producer price for export production in domestic currency lowers the marginal revenue product. For Burkina Faso the nominal exchange rate is fixed, which rules out a nominal appreciation. Instead, aid spending would raise consumer prices, leading to an appreciation of the real exchange rate deflated by the CPI (Panel 2).[24] The effect of a general increase in consumer prices is similar to that of a nominal appreciation: higher consumer prices lead to higher producer prices, except for exporters because their prices are fixed in international markets, resulting in a relative decline in producer prices for exporters (see Panel 3).

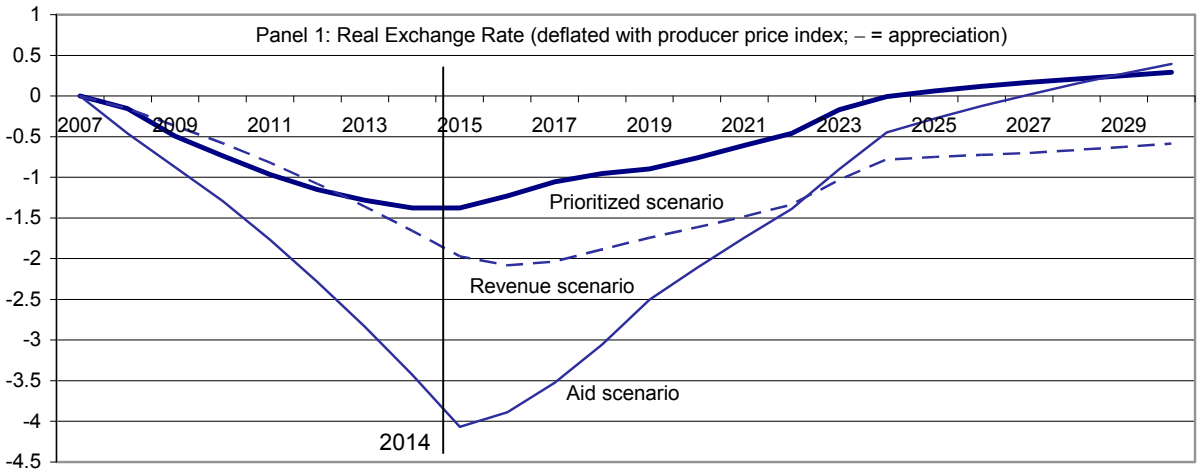
- The second step is a release of production factors from the export sector. Lower producer prices from the first step imply, for given wage rates, that the marginal revenue product has fallen below marginal factor costs, i.e., the first-order condition for producers is violated at this stage. Put another way, the export sector is not sufficiently profitable. As part of the process of adjusting toward a new equilibirum, the export sector scales down production and releases the factors it employed.

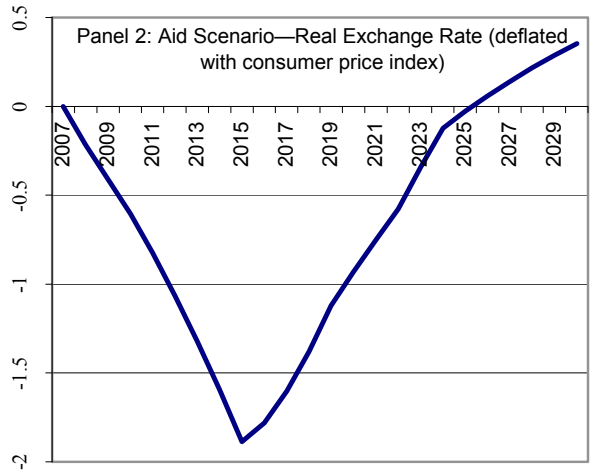
- The third step is the absorption of factors in sectors that are in high demand. Government spending has raised the profitability of construction, health, and education services, as evidenced by the strong increase of producer prices for these sectors (Panel 3). That is, in these sectors the situation is the reverse of the export

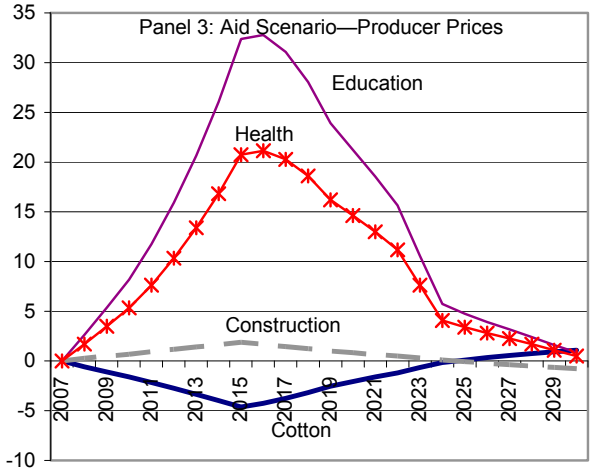
[23] There is also a sizable appreciation in the revenue scenario. The crowding-out of the private sector reduces import demand—i.e., private sector demand is more import-intensive than government demand—which would lead to a trade surplus. The appreciation rebalances the trade balance.

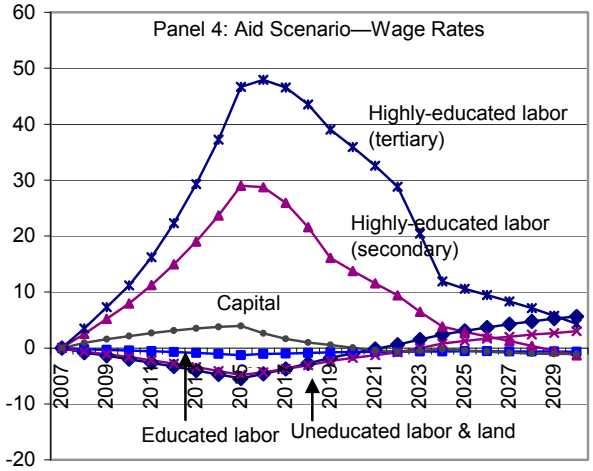
[24] MAMS measures the exchange rate while keeping the CPI constant, i.e., an appreciation of the exchange rate can be brought about by either a nominal appreciation or by a rise in consumer prices relative to other countries.

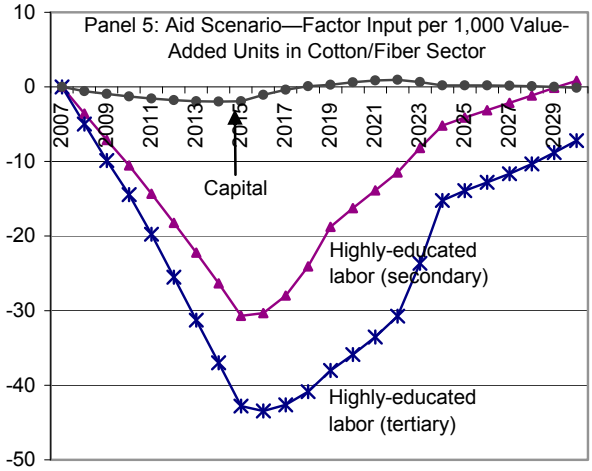
Figure 12. Real Exchange Rate Adjustment
(Percent Difference from Baseline)











Source: Authors' calculations.

sector, with the marginal revenue product exceeding the marginal factor costs. These sectors expand production and employment.

- In the fourth step, wage rates are adjusted. Some of the factors released from the export sector—in particular highly educated labor and private capital—can easily be re-deployed to construction, health, and education. In fact, the demand for these factors is so high that their wage rates increase (Panel 4). Uneducated and educated labor, in contrast, are now in surplus, and their wage rates have to decline in order to be absorbed into other sectors, usually elsewhere in agriculture.

- In equilibrium the effect of the appreciation on the revenue product in the export sector has to be offset by a new set of factor prices and factor allocation within the sector until for each factor marginal costs and revenue products are equal again. For uneducated and educated labor, equilibrium will be reestablished mostly through a decline in wage rates (as depicted in Panel 4) to match lower revenue in the export sector due to the appreciation with lower factor costs. For highly educated labor and private capital, equilibrium will be re-established by moving these factors out of the export sector. As these factors become relatively more scarce in the export production process (i.e., their factor intensity declines), their marginal productivity increases, which raises their marginal revenue product. This process continues until marginal productivity has increased by enough to offset the negative effect of the appreciation on the revenue product plus the increase in factor costs through higher wage rates. Panel 5 shows that the factor intensity for highly educated labor in the cotton/fiber sector declines substantially relative to the baseline, and the intensity for capital declines moderately.

The extent of the appreciation depends on how easy it is to bring about the necessary factor reallocation. If all sectors had a very similar factor composition, reallocation is relatively easy, and even a small appreciation would reduce exports significantly. Specifically, the appreciation would lower profitability in the export sector, trigger a large outflow of factors, and require practically no changes in relative factor prices or factor intensity for the factors to be absorbed in sectors where demand is high. In an extreme case where factors released from the export sector can be absorbed in the rest of the economy without any changes in relative factor prices and intensity in production, it would become impossible for the export sector to offset the reduction in the revenue product through either changes in marginal factor costs (because wage rates do not change) or marginal productivity (because factor intensity does not change). Thus, it cannot restore the first-order condition. Consequently, production factors would continue to flow out, and in this extreme scenario a small appreciation could eventually shut down the export sector.

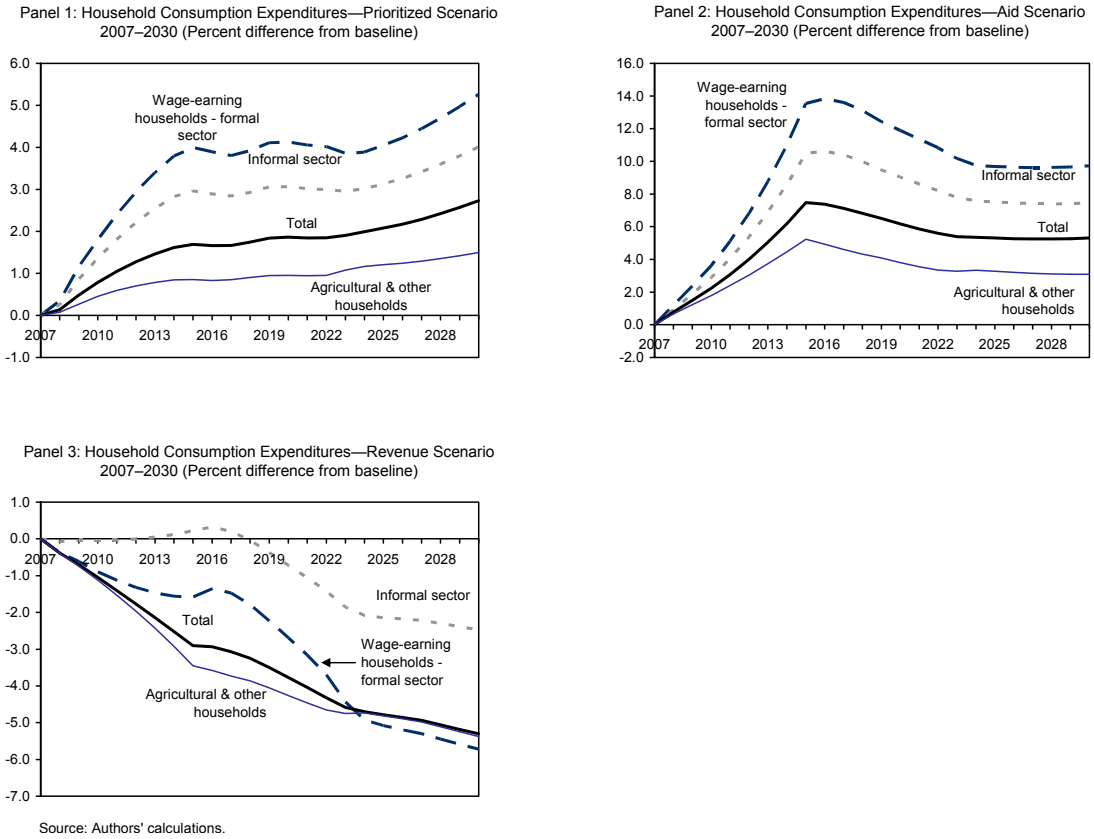
For Burkina Faso, the factor composition of sectors is quite different, which means it is not easy to reallocate factors from one sector to the other; rather, this will lead to sizable changes in relative factor prices and factor. Under these conditions, factor reallocation will happen

only if there is a large appreciation. The difference in factor composition could be considered as a form of real rigidity that can be overcome only by a large change in the real exchange rate.

The combination of a real appreciation with a decline in export sector production is often associated with concerns about Dutch disease, which permanently damages the economy by shrinking the tradable sector. This can be the case if the tradable sector is a source of special productivity growth. In MAM, we allow for this channel by linking productivity growth to export and import volumes.[25] Despite this link, the overall GDP effect is still positive: the productivity gains from a more educated and healthier workforce and better infrastructure outweigh the productivity loss from the shrinkage in exports. Nevertheless, outside the model, a reduction in the size of the cotton sector can be cause for concern because cotton is an important source of income for a large part of the population and has some special attributes, such as an effective vertical integration that provides farmers with inputs.

F. Impact on Income Distribution

Figure 13. Impact on Income Distribution by Household Type



Source: Authors' calculations.

[25] This could result, for example, from learning-by-doing effects in the tradable sector due to the role of foreign investors and associated knowledge transfer in export production and import-competing industries.

We assess the impact on household income distribution by measuring the change in household consumption (Figure 13). The six different representative household groups modeled in MAMS are, again, two wage-earning households, three agricultural households, and one residual household (for pensioners, independent businesses, and other groups). Mostly the distribution impact depends on the use of fiscal space, with spending on education and health services benefiting in particular the wage-earning household groups (for details, see below, the section on use of fiscal space). This is visible in the solid improvement in the relative income position of wage-earning household groups, especially those in the formal sector, in the prioritized and aid scenarios (Panels 1 and 2).

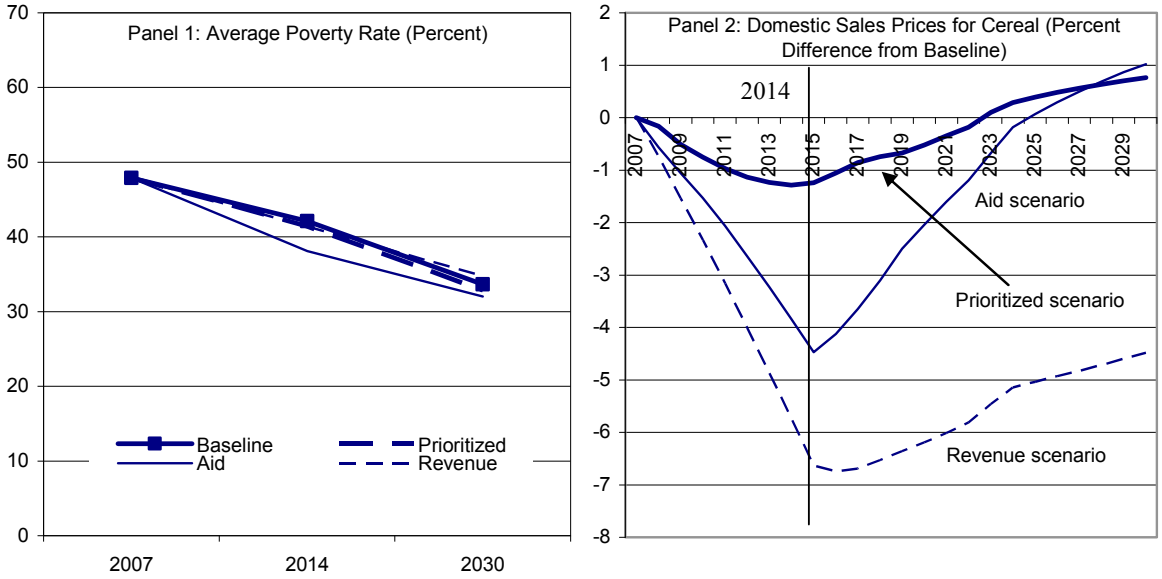
However, the revenue scenario shows that tax policy can have a powerful impact on income distribution: the formal sector wage-earning household groups are among the main beneficiaries of higher education and health spending, but they are also the largest payers of direct income taxes; increasing their tax burden tends to equalize the distributional impact (Panel 3). Wage earners in the informal sector, on the other hand, escape from higher taxation, leaving their benefits from higher education and health spending intact. Cotton agricultural household groups, in contrast, become part of the tax net because this sector is relatively well organized, making it part of the formal economy, and higher income taxation leaves cotton households overall worse off because they reap only few benefits from higher education and health spending.

G. Impact on MDGs

The poverty impact depends essentially on two factors: the increase in per capita consumption, and the distribution of the consumption increase. Here, we simulate poverty rates per household group. The starting point is the 2004 household survey, which provides information on income and household classification for about 8,500 individuals. We extrapolate the path for per capita consumption expenditures by using expenditure growth rates by household group generated by MAMS. To compute the poverty rate, we compare per capita consumption expenditures to the poverty line obtained by extrapolating the 2004 poverty line with price changes for the consumption bundle of the poorest household, which approximates the consumption basket at the poverty line. These calculations are done for 2014 (when all three scenarios are comparable) and 2030.

The household survey establishes a national poverty rate of about 45 percent in 2004. In the MAMS simulations this increases slightly, to about 48 percent, by 2007, because adverse terms of trade shocks (higher oil prices and lower cotton prices) dampened growth. In the baseline, poverty decreases gradually over the simulation period, reflecting the strong annual real GDP growth rate of 6 percent (Figure 14, Panel 1). By 2030 it has declined to about 34 percent.

Figure 14. National Poverty Rate and Food Prices



Source: Authors' calculations.

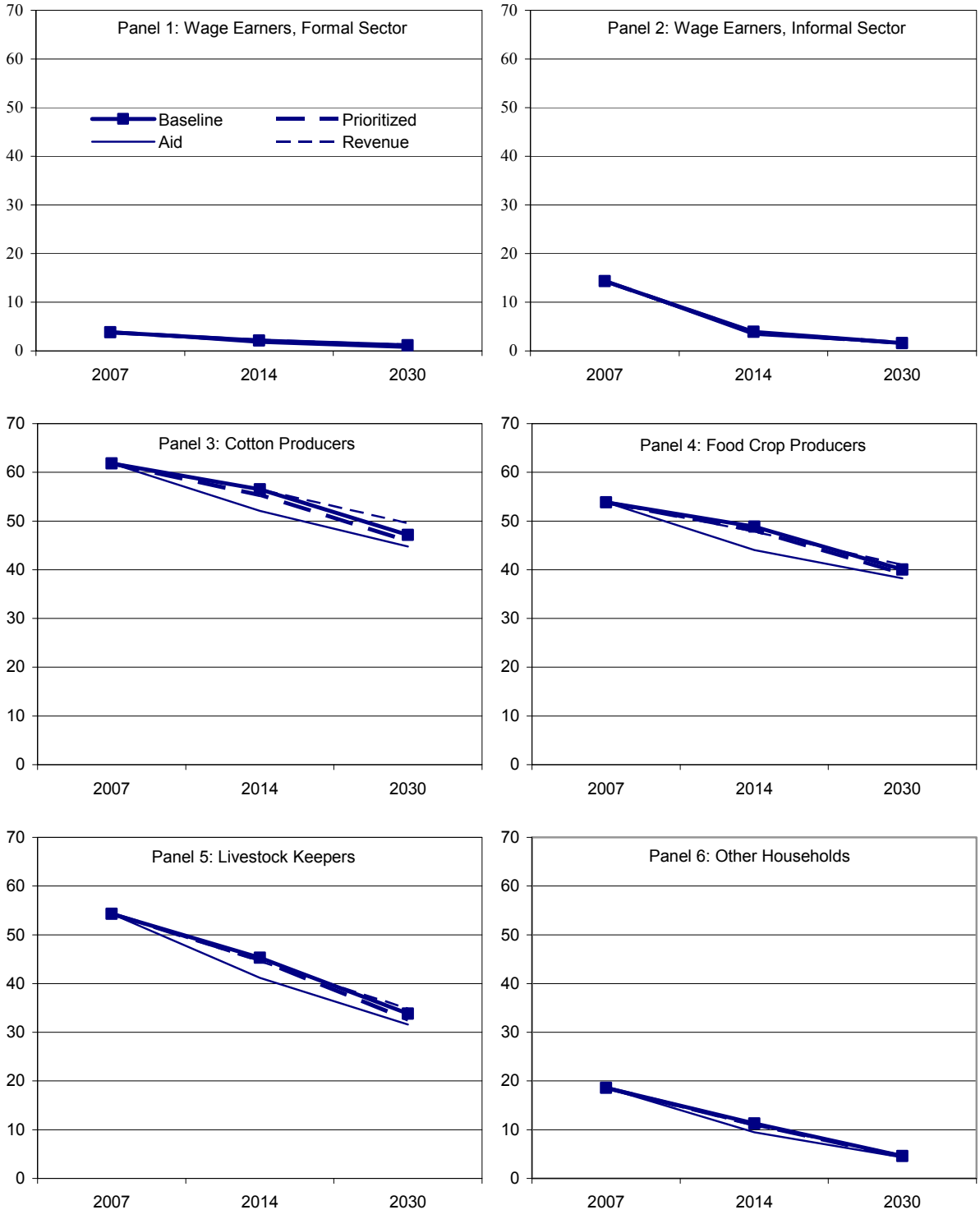
There are marked differences between households (Figure 15):

- The poverty reduction is small for wage earners in the formal sector (Panel 1), because almost all its members are above the poverty line to begin with, which implies that increasing their income has only a limited poverty effect.

- Wage earners in the informal sector experience the largest decline in the poverty rate among all household groups up to 2014 (Panel 2): a reduction of about 10.5 percentage points, compared to an average of about 6 percentage points for all households. They benefit strongly from the expansion of education given that most graduates from secondary or tertiary education are members of the wage-earning household groups in the formal and informal sectors; with these two household groups becoming more educated, average wage income rises, which is key to their income growth. For 2014–30 the poverty rate of wage-earners in the informal sector does not decline much further because by 2014 it has already declined to levels comparable to formal sector wage-earners.

- Poverty rates are much higher for the agricultural household groups than for other households (Panels 3–5). The reduction in poverty accelerates from about 5 percentage points in the first period to 10 percentage points in the second. One reason for the more sluggish performance in the first period is that income growth for these household groups lags behind that of other households (average annual per capita income growth rate for agricultural households for 2007–4 is 1.2 percent, compared to about 4 percent for the wage-earning households), because the effects of

Figure 15. Poverty Rates by Household Group (Percent)



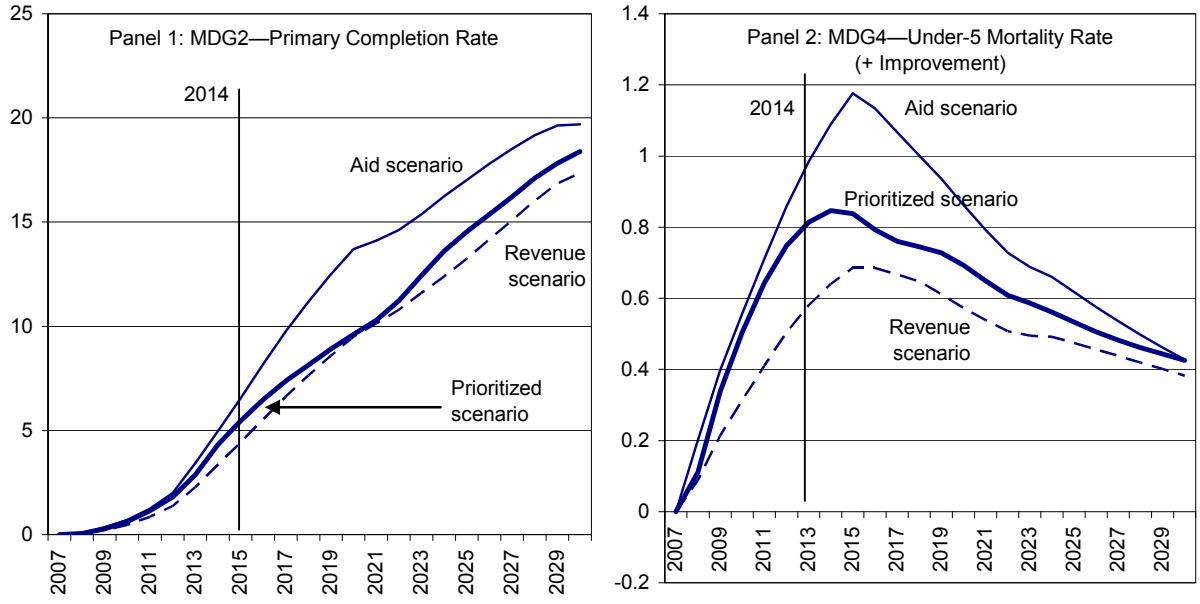
Source: Authors' calculations.

education policy benefit wage-earning households relatively more. Another factor is that wage-earning households have significantly higher savings rate, and the return on these savings (i.e., private capital investment) also bolsters their income growth. In the second period, per capita income growth accelerates for agricultural groups—reducing poverty more quickly—as rising wage rates for land and uneducated labor in the baseline benefits them (Figure 2, Panel 4).

- The other household group is relatively well off, with a poverty rate just slightly higher than that of informal wage-earning groups (Panel 6). The poverty rate declines steadily for this group throughout the simulation period.

Until 2014 the aid scenario has the most effect on reducing poverty (Figure 14, Panel 1), owing to the large increase in per capita consumption. The poverty effect in the priority and revenue scenarios are similar (though small compared to the baseline), even though the increase in per capita consumption is larger in the former. Lower per capita consumption in the revenue scenario is offset by declining food prices (Panel 2), which is a major component in the consumption basket of the poorest household; as a result, the poverty line declines, which offsets the effect of falling per capita consumption. By 2030 poverty rates in the aid and prioritization scenarios approach that of the baseline, reflecting mostly a decline in consumption expenditure growth rates relative to the earlier period as aid inflows recede in GDP terms and expenditure prioritization has run its course.

Figure 16. Education and Health MDG Indicators
(Percent Difference from Baseline)



Source: Authors' calculations.

All three scenarios are effective in improving the education and health MDG indicators, which are primarily a function of education and health spending and per capita income (Figure 16). Note that improvements display a stronger trend in the school indicator than in the health indicator. In the Burkinabè specification, the health indicator depends more on current real services per capita—a function of current spending—than the school indicator, where gains are more easily locked in (i.e., they tend to depend on cumulative spending). An example for the role of current spending in the health sector is the distribution of malaria bed nets, which are effective in improving health but require repetitive spending each year; if spending stops and the distribution of bed nets ceases, malaria rates will go up again. In contrast, if health spending were able to eradicate a disease, spending could be reduced, and the health indicator would depend more on cumulative than on current spending. For the Burkinabé specification, however, we have assumed that health interventions usually require continued efforts like malaria bed net distribution.

V. USING FISCAL SPACE

As we said, in the Burkina Faso MAMS model fiscal space can be used to promote (i) human development through higher education and health spending; (ii) GDP growth through higher infrastructure spending; and (iii) both, via an expansion in both types of spending. In the previous section, we compared different sources of fiscal space while considering only one use of fiscal space, the combination of human development and growth spending. In this section, we compare human development to infrastructure spending while considering only one source of fiscal space, increased aid inflows.

A. Human Development Spending Versus Infrastructure Spending

The two spending scenarios have a number of differences:

- **Size of fiscal space:** The spending increase relative to the baseline is somewhat larger for infrastructure scenario (Figure 17, Panels 1 & 2) because this scenario has a bigger output effect (see below), which creates additional fiscal space. Moreover, in the human development scenario the spending increase is not limited to targeted expenditures (health and education) but spending increases also on other government expenditures that do not contribute to human development goals. That is, the fiscal space for targeted expenditures in the human development spending scenario is smaller than the overall expenditure increase. This is caused by a large increase in wage rates (see below) that raises the cost of delivering other government services, somewhat crowding out human development spending.[26]

[26] The real growth rate of other government services is fixed in this scenario at baseline values, but the nominal cost of producing these services is a function of prices and wage rates.

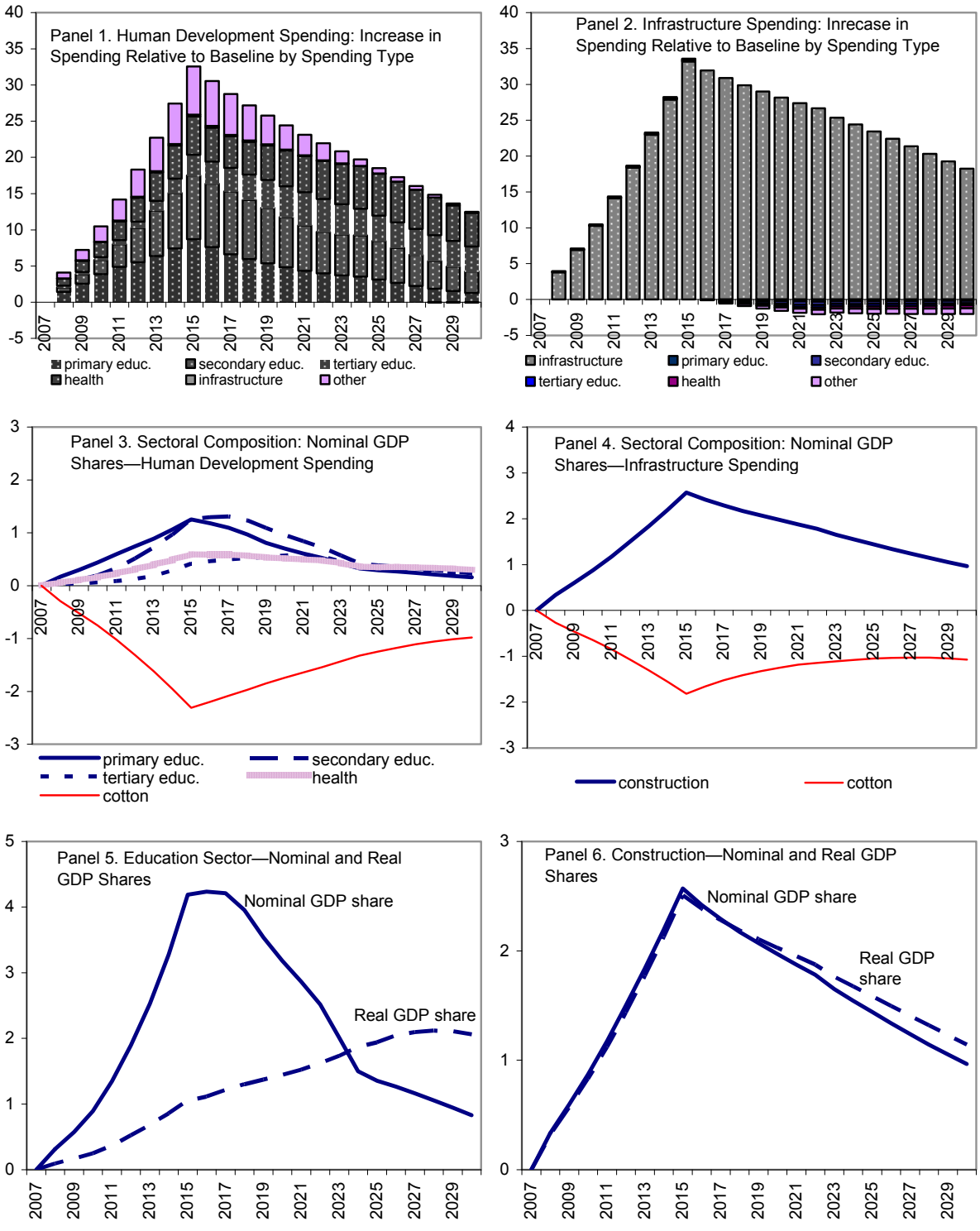
- **Sector response:** The economy has a different supply response to each type of spending. Higher human development spending increases the nominal GDP share of providers of health and education services, which are mostly government sectors (Panel 3). In contrast, public infrastructure requires a large private sector input, in particular from the construction sector (Panel 4). The counterpart to the increase in these sectors is a decline in the cotton sector relative to the baseline; the mechanism for reallocating factors between these sectors follows the processes outlined above for creating fiscal space through higher aid inflows.

- **Real spending increase:** In real terms the expansion in the education sector lags for many years behind the nominal expansion (Panel 5; the result is similar result for health services), whereas there is practically no gap between the nominal and real expansion in the construction sector (Panel 6). Consequently, the real increase in human development spending over the medium term is much smaller than the nominal increase (Panel 7) whereas there is no such difference for infrastructure spending (Panel 8). In the long run, the real increase in spending exceeds the nominal spending increase in both scenarios, which reflects the supply response of the economy (see below).

- **Bottlenecks:** The delay in increasing health and education services in real terms reflects a bottleneck in the form of a shortage of highly educated labor, teachers and nurses, to deliver these services. The increase in spending on these services leads initially to higher wages (Panel 9) until a sufficient number of new teachers and nurses has been trained, a lengthy process (MAMS models explicitly the years required to complete different education cycles). During this period the spending increase leads mainly to an increase in wages for the current workforce and only a very limited increase in employment and services. No such bottlenecks hinder expansion of the construction sector—it requires mostly private capital, which is in more ample supply—and wage rate increases are much more modest (Panel 10).

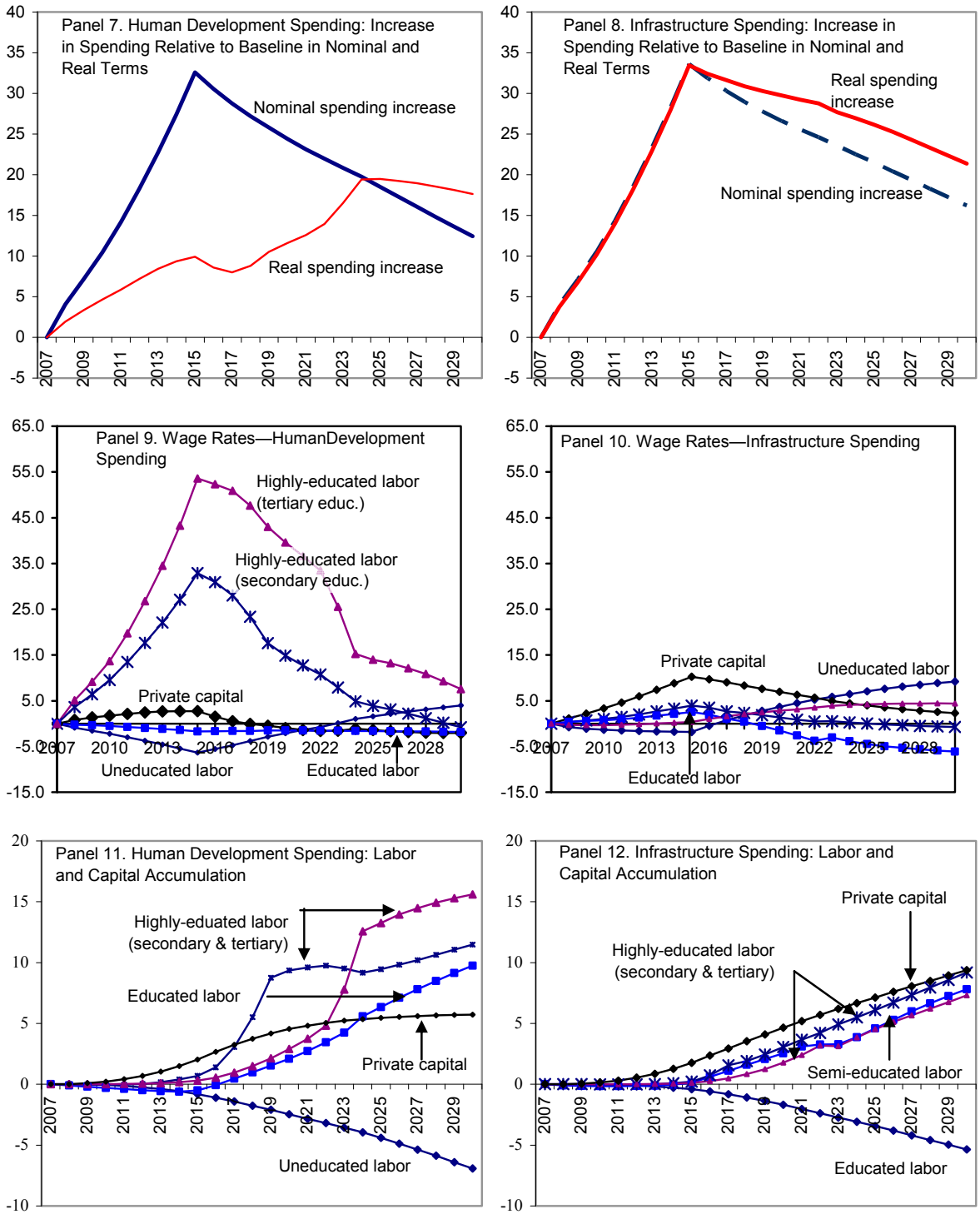
In the longer term, the combination of increased education spending and high wages for highly educated labor (which make it attractive for students to remain in school and obtain secondary and tertiary education degrees) lead to a major increase in the supply of highly educated labor (Panel 11). With this new supply, the delivery of health and education services expands in real terms, and wage rates for highly educated labor plunge. The educated labor supply increases also in the infrastructure scenario—the major increase in output and public infrastructure lead to a higher demand for education—but by less than in the human development spending scenario (Panel 12). The accumulation of capital increases substantially in the infrastructure scenario because higher GDP growth raises saving and thereby investment.

Figure 17. Human Development vs. Infrastructure Spending
(Percent Difference from Baseline)



Source: Authors' calculations

Figure 17. Human Development vs. Infrastructure Spending (concluded)
(Percent Difference from Baseline)



Source: Authors' calculations

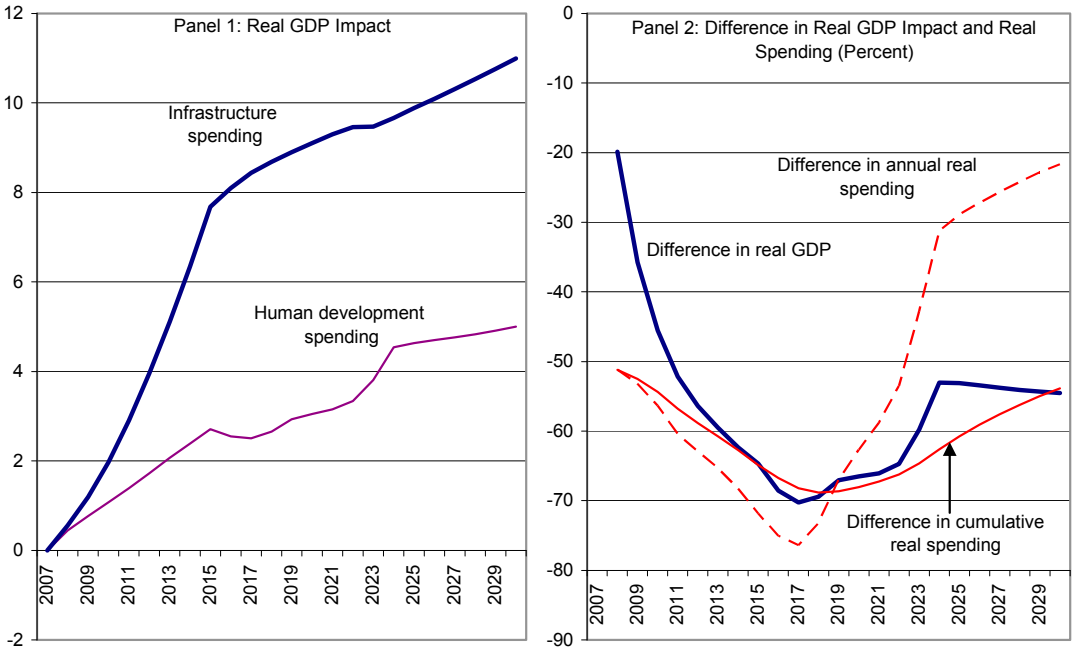
B. Macroeconomic Impact

Growth Impact

Human development and infrastructure spending both raise factor productivity in the MAMS model:

- Higher education spending lifts the educational attainments of workers, raising labor productivity and TFP.
- Similarly, higher health spending improves health indicators, which has a positive impact on labor productivity and TFP.
- An increase in the infrastructure capital stock raises TFP.

Figure 18. Real GDP Impact
(Percent Difference from Baseline)



Source: Authors' calculations.

Comparing the growth effect of human development and infrastructure spending, the latter has a much larger impact on real GDP (Figure 18, Panel 1). In general, the output effect of both infrastructure and human development spending depends to a large extent on the additional stock of infrastructure and human capital that these two types of spending create. Capital stock accumulation can be proxied by cumulative infrastructure and human development spending in real terms (Panel 2). The difference in cumulative spending accounts for a large part of the lower output effect of human development spending: the bottlenecks and delays in expanding health and education services imply that infrastructure

capital is built up much faster than the human capital stock; the cumulative difference in real spending narrows gradually as the gap between annual real spending on infrastructure and human development becomes smaller, but at the end of the projection period the cumulative gap still exceeds 50 percent. Another aspect is that even if education and health services can be expanded in real terms, building human capital still takes time because of the multiyear education effort required; this accounts for the large output difference in the short run.

Balance of payments impact

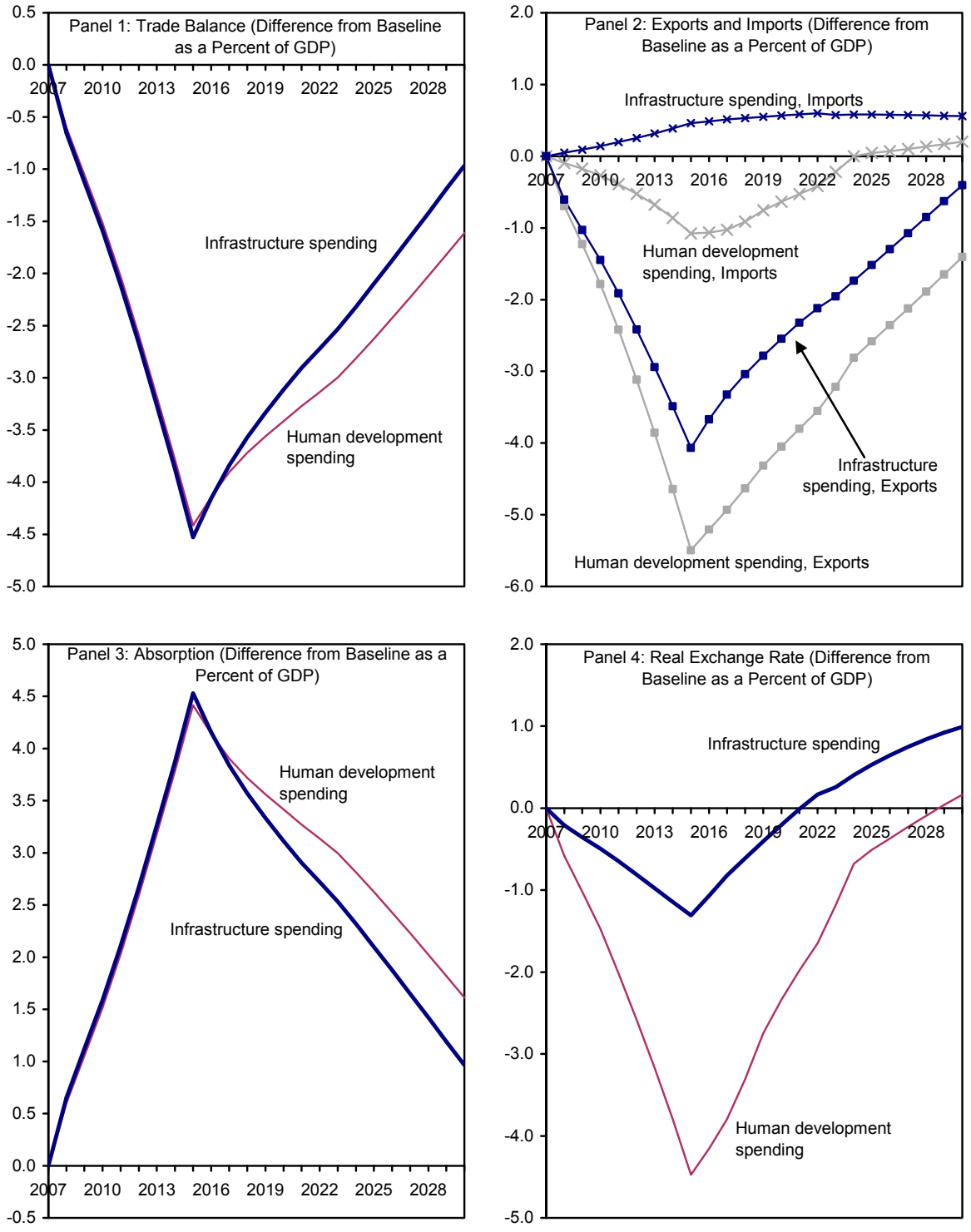
The impact on the trade balance and absorption in the human development and infrastructure scenarios is similar (Figure 19, Panels 1 and 3). There are sizable differences, though, in the impact on the composition of the trade balance and the real exchange rate. In the infrastructure-spending scenario the negative impact on exports is smaller—which leaves more room for an expansion in imports to achieve the same increase in the trade deficit—and so is the real exchange rate appreciation (Panels 2 and 4). In general, the main function of the real appreciation is to reallocate factors to those sectors that are in high demand to meet increased government expenditures. In essence, this is easier (and therefore requires a smaller real appreciation) for the infrastructure-spending scenario for two reasons:

- Infrastructure spending has a larger output effect, which raises the production level in the construction sector. This reduces the need to shift resources into this sector to meet the government demand for construction services.

- The construction sector can be expanded in a relative straightforward way by shifting private capital from cotton to construction. In contrast, increasing public education and health services requires shifting capital from export sectors to sectors that are relatively intensive in highly educated labor (e.g., other services), then replace highly educated labor in these sectors with capital, and finally shift highly educated labor to the public sector. The latter requires a larger transfer of private capital—and therefore a more pronounced shrinking of the export sector—to free up the required amount of highly educated labor. The result is larger price signals, including the higher rate of appreciation in the human development spending scenario.

After 2015 aid inflows in GDP terms become smaller, which leads to a reversal in appreciation in both scenarios and eventually the depreciation that is necessary to rebuild the export sectors.

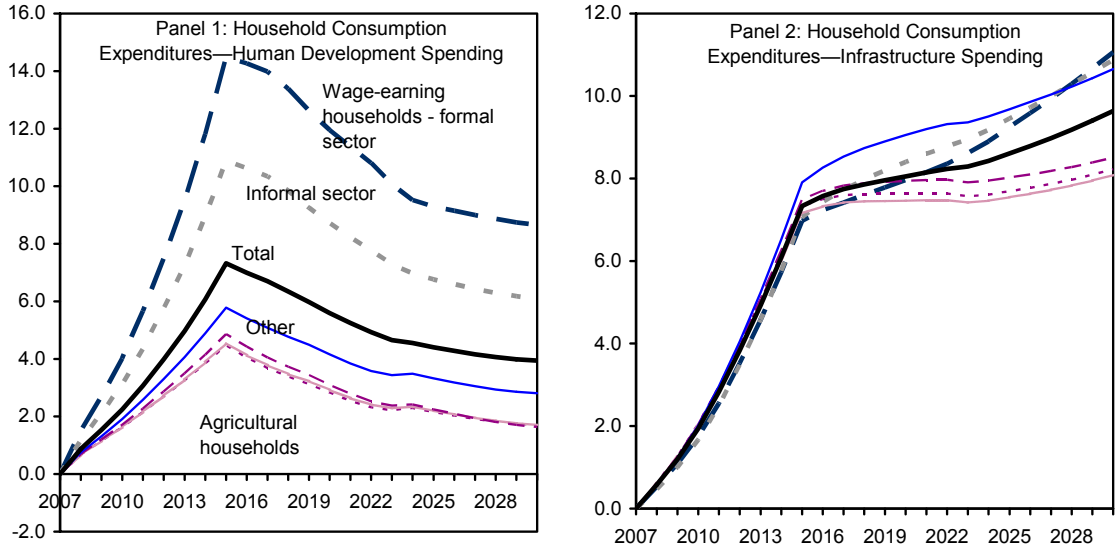
Figure 19. Balance of Payments Indicators



Source: Authors' calculations.

C. Impact on Income Distribution

Figure 20. Impact on Income Distribution by Household Type
(Percent Difference from Baseline)



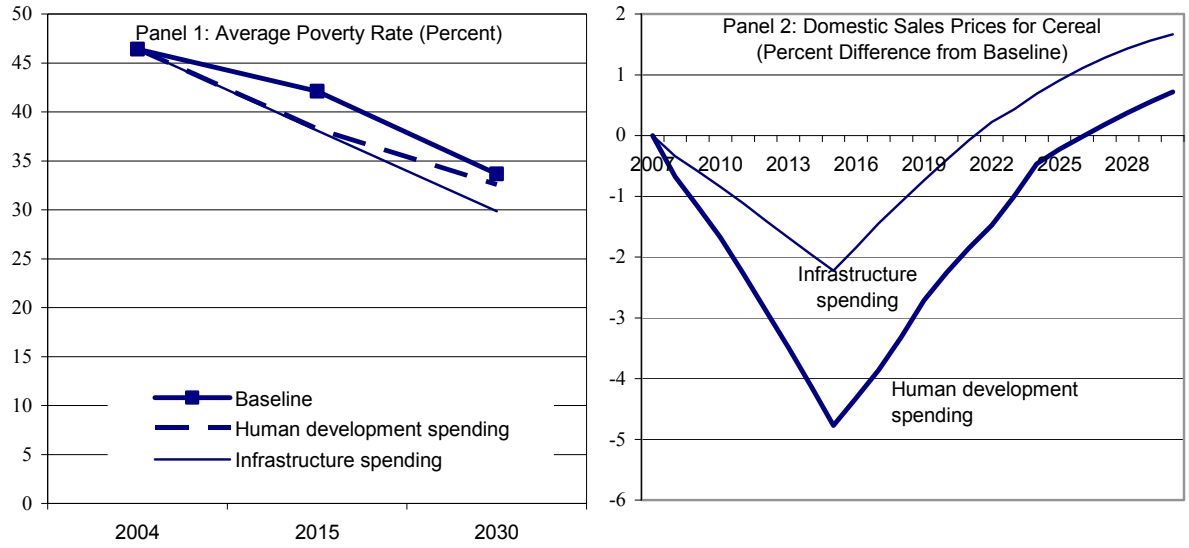
Source: Authors' calculations.

Human development spending strongly benefits the relative income position of wage-earning households as a result of the large increase in wages for educated labor (Figure 20). Since these households account for most of the educated labor, and educated-labor wages are an important source of their income, the increase in wage rates raises their income considerably. In the longer term this effect recedes somewhat as wage rates for educated labor decline.[27] By comparison, the income distribution remains relatively unchanged when infrastructure spending is increased.

[27] Another factor benefiting wage-earning households is the increase in the number of educated, and highly-paid, laborers.

D. Impact on MDGs

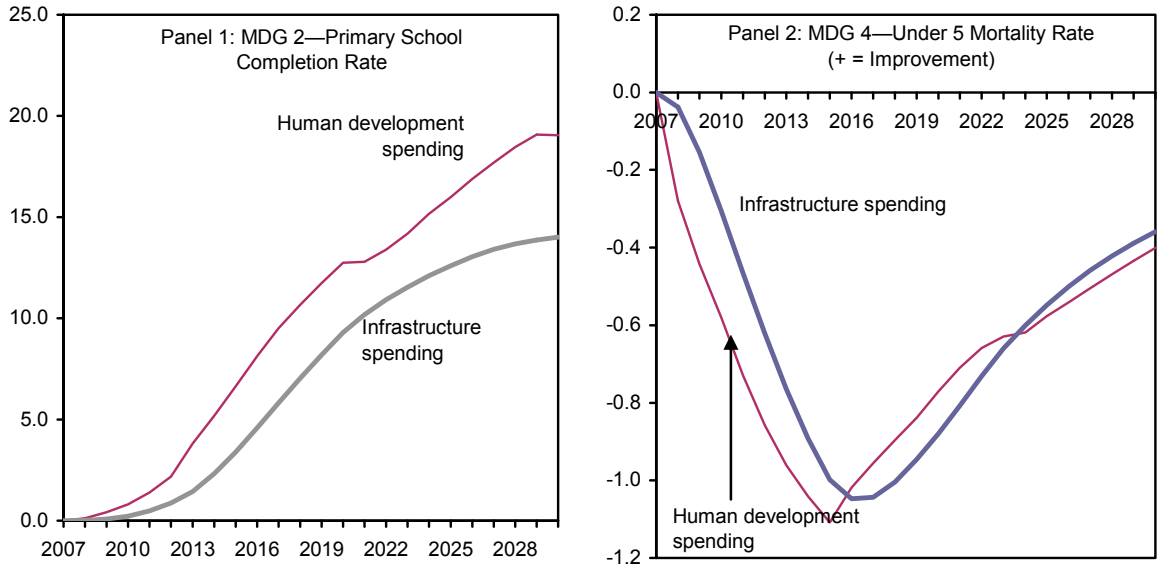
Figure 21. Poverty Impact



Source: Authors' calculations.

Human development and infrastructure spending are equally effective in reducing poverty up to 2015, but infrastructure spending is more effective thereafter (Figure 21, Panel 1). The income effect is larger throughout in the infrastructure spending scenario, but in the earlier period food prices decline more sharply in the human development spending scenario, which lowers the poverty line and offsets the lower income growth in this scenario. The larger decline in food prices is itself the result of a more pronounced decline in wages for uneducated labor in this scenario, reflecting fewer employment opportunities for uneducated labor released from the export sector compared to infrastructure spending, where overall economic growth is higher. In the longer term, the relative income gains in the infrastructure-spending scenario become larger and dominate the poverty effect. Regarding the poverty impact on different household groups, the human development spending scenario has a particular strong effect on the wage-earning households due to the large increase in wage rates for highly educated workers, at least in the earlier period.

Figure 22. Education and Health MDG Indicators
(Percent Difference from Baseline)



Source: Authors' calculations.

For the MDG education indicator, human development spending achieves better outcomes due to the large increase in education spending, but infrastructure spending also brings substantial improvement. The reason for the latter is that the decision to seek education is not only a function of education quality—and thus of education spending—but also depends inter alia on per capita household consumption (better-off households tend to demand more education and more successfully absorb the education received) and on the level of infrastructure (more lowers the cost of getting to schools for both teachers and students). Infrastructure spending affects the last two factors positively, which accounts for the substantial gain for the MDG education indicator in this scenario. In addition, the real increase in infrastructure spending is larger than that in education and health spending. A similar explanation applies to the MDG health indicator, where infrastructure spending also yields good results.

VI. Lessons

With regard to which fiscal space options are best for reaching the MDGs, none of the scenarios dominates the others, which makes it necessary to consider trade-offs. For example, poverty is likely to be reduced most by 2015 through an aid-financed increase in infrastructure spending. However, focusing the aid resources on human development spending would yield a better outcome for the education and health MDG indicators, so there is a trade-off between MDGs. There are also trade-offs regarding the sources of fiscal space. For example, mobilizing additional aid will allow an increase in domestic absorption and

avoids the political resistance that may emerge as domestic sources of fiscal space are generated—e.g., taxpayer lobbying against higher taxes or changes in the tax structure—but it is potentially less reliable (and permanent) than domestic sources of fiscal space, and it does make the government more dependent on donors. Ultimately, these trade-offs need to be resolved at the country level, taking into account country-specific preferences. The model-based analysis of fiscal space, though, can help to identify and quantify likely trade-offs.

Increasing education and health services in real terms takes time. Burkina Faso has in recent years already made substantial progress in these areas, and the baseline projects very large gains in education and health MDG indicators in coming years. But expanding these services substantially over baseline levels can prove challenging because doing so requires capacity, which takes time to build up. Consequently, expanding expenditure in these areas requires careful preparation to align the pace of expenditure increases with the ability of education and training programs to deliver suitably educated workers. There may also be a need to monitor wage pressures to avoid large increases in the wage bill that could crowd out other expenditures.

Infrastructure spending promotes not only growth but also other MDG objectives. In MAMS infrastructure has a direct positive impact on education and health MDG indicators because it facilitates the delivery of these services. There is also an indirect effect through higher growth—higher per capita income increases demand for these services. In the simulations infrastructure spending yields very substantial improvements in the education and health MDG indicators through these two channels. However, they take some years to effectively improve education and health indicators.

Appendix I. Modeling of MDG Sectors in MAMS[28]

MAMS (Maquette for MDG Simulations), the model used for this paper, 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 appendix presents 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.

The 'production' of the MDGs

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.

[28] This appendix is excerpted from Bourguignon, Diaz-Bonilla, and Lofgren (2008).

- 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 education 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 educated 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.

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.[29] 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

[29] 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.

defines MDG outcomes as a function of service delivery and other determinants.[30] 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:

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

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.

[30] This presentation is simplified, highlighting key mechanisms. For a detailed technical documentation of MAMS, see Lofgren and Diaz-Bonilla (2007).

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:

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

$$INT_m = \alpha_m \left(\frac{P}{P_m} \right)^{\sigma} INT \qquad (4)$$

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.

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

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:

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

Table A.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 I.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		

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.[31] 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.

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 A.1.);[32] (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 A.1.[33] 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

[31] 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.

[32] 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).

[33] 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 (2005), Deolalikar (1998), Case and Deaton (1998), and Baldacci et al. (2004). For more details, see Kamaly (2006).

(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.[34]

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[35]) 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.

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[34] 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 equation 6.

[35] 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).

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 A.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).

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 educated 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 educated 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 educated 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.[36] 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

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

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 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.

Appendix II. Budget Composition in Burkina Faso

Table II.1. Burkina Faso: 2007 Budget

Sections	Dotations	Montants Engagés
Présidence du Faso	3,878,766,000	10,416,436,771
Secr. Gén. Gouvernement	370,431,000	341,539,414
Premier Ministère	2,545,839,000	2,530,653,322
Parlement	7,207,498,000	7,207,498,000
Conseil économique et social	1,650,777,000	1,604,217,821
Min. chargé des relations avec Parlement	237,528,000	200,798,130
Min. Administration Territoriale / Sécur.	14,525,171,000	16,027,022,838
Ministère de la Justice	5,273,021,000	4,719,030,715
Ministère de la Défense	53,879,945,000	53,919,732,671
Ministère des Affaires Etrangères et Coop. Rég.	18,572,554,000	17,547,466,865
Ministère de la sécurité	16,122,549,000	17,056,840,859
Ministère des Finances et du Budget	14,830,245,000	20,667,798,167
Ministère de la Culture, Arts et Tourisme	2,662,434,000	2,717,213,350
Min. Travail, Emploi& Jeunesse	576,876,000	814,831,817
Min. Fonct Publ et Réforme de l'Etat	2,095,800,000	2,341,166,138
Min. de l'Information	3,439,123,000	3,517,279,934
Ministère de la Promotion de la Femme	647,592,000	627,059,744
Ministère des sports et des Loisirs	1,588,154,000	2,675,150,570
Ministère de la Santé	56,000,958,000	57,367,880,907
Min.de l'Action Sociale et de la Solidarité Nle	5,062,270,000	5,276,983,803
Min. Enseign.de Base & Alphabétisation	69,733,407,000	78,710,057,951
Min. Enseign.Sec. Sup.& Rech Scient	41,924,258,000	47,870,333,078
Min. du Commerce, Promotion Entr. Et Artisanat	2,590,981,000	1,772,952,093
Min. des Mines, Carrières et Energie	1,492,117,000	1,473,552,885
Min. Agri. Hydrauliq.et Ress. Halieutiq	21,929,880,000	20,415,969,992
Min.des Ressources Animales	4,248,647,000	3,647,745,837
Min. de l'Environnement et Cadre de Vie	3,332,940,000	3,851,414,450
Min. des Infrastruct., Transport et Habitat	34,729,577,000	29,926,046,272
Min. des postes et télécommunications	8,361,904,000	6,730,120,692
Min. des transports	2,688,050,000	2,045,253,408
Min. de l'Economie et du Developpement	4,682,307,000	3,607,331,075
Ministère de la Promotion des Droits Humains	291,346,000	284,031,163
Min. de la Jeunesse et de l'emploi	4,509,505,000	3,596,458,102
Min; de l'Habitat et de l'Hurbanisme	1,020,567,000	324,002,706
Grande Chancellerie	255,897,000	235,739,535
Conseil Supérieur de la Communication	838,173,000	835,464,922
Inspection Générale d'Etat	389,106,000	377,342,840
Conseil Constitutionnel	464,200,000	354,788,160
Conseil d'Etat	509,334,000	476,445,721
Cour des Comptes	397,039,000	374,459,162
Cour de Cassation	405,871,000	396,931,383
CENI	7,278,476,000	7,224,657,472
Dépenses Communes Interministérielles	132,214,769,000	121,622,396,738
Total	**555,455,882,000**	**563,730,097,473**
Of which education, health, and infrastructure:	250,562,519,471	260,016,802,524
Percent:	45%	46%
Of which other government:	304,893,362,529	303,713,294,949
Percent:	55%	54%

Table II.2. Burkina Faso: 2007 Capital Budget

Sections	Dotation	Montants Total Annuel Décais.
Présidence du Faso	11,948,053,000	7,735,489,820
Secr. Gén. Gouvernement	-	-
Premier Ministère	2,306,500,000	1,391,542,755
Parlement	317,000,000	317,000,000
Conseil économique et social	1,297,127,000	1,237,895,850
Min. chargé des relations avec Parlement	-	-
Min. Administration Territoriale / Sécur.	4,977,670,000	3,590,275,487
Ministère de la Justice	2,631,181,000	2,878,152,281
Ministère de la Défense	10,250,123,000	9,888,859,000
Ministère des Affaires Etrangères et Coop. Rég.	988,000,000	1,446,000,000
Ministère de la sécurité	3,798,006,000	3,742,033,266
Ministère des Finances et du Budget	5,423,424,000	25,746,284,209
Ministère de la Culture, Arts et Tourisme	905,836,000	628,178,812
Min. Travail, Emploi& Jeunesse	30,000,000	947,839,792
Min. Fonct Publ et Réforme de l'Etat	243,829,000	243,827,310
Min. de l'Information	985,752,000	952,335,455
Ministère de la Promotion de la Femme	301,756,000	280,500,793
Ministère des sports et des Loisirs	332,707,000	507,694,186
Ministère de la Santé	31,584,488,000	29,154,690,768
Min.de l'Action Sociale et de la Solidarité Nle	1,139,027,000	873,532,564
Min. Enseign.de Base & Alphabétisation	39,842,844,000	28,381,258,344
Min. Enseign.Sec. Sup.& Rech Scient	25,412,413,000	14,619,906,424
Min. du Commerce, Promotion Entr. Et Artisanat	10,011,120,000	2,592,188,457
Min. des Mines, Carrières et Energie	30,394,321,000	4,058,347,762
Min. Agri. Hydrauliq.et Ress. Halieutiq	104,915,093,000	69,928,228,949
Min.des Ressources Animales	11,014,359,000	2,945,588,674
Min. de l'Environnement et Cadre de Vie	6,214,940,000	2,732,942,902
Min. des Infrastruct., Transport et Habitat	118,733,521,000	86,188,705,480
Min. des postes et télécommunications	2,995,446,000	1,814,822,649
Min. des transports	3,429,750,000	1,797,173,369
Min. de l'Economie et du Developpement	9,838,176,000	7,235,953,885
Ministère de la Promotion des Droits Humains	-	-
Min. de la Jeunesse et de l'emploi	3,767,744,000	1,510,003,936
Min; de l'Habitat et de l'Hurbanisme	489,589,000	122,856,091
Grande Chancellerie	-	-
Conseil Supérieur de la Communication	303,963,000	303,962,500
Inspection Générale d'Etat	37,106,000	18,552,686
Conseil Constitutionnel	26,000,000	-
Conseil d'Etat	148,000,000	148,000,000
Cour des Comptes	-	-
Cour de Cassation	33,702,000	18,407,204
CENI	-	-
Dépenses Communes Interministérielles	27,824,311,000	22,150,310,814
Total	**474,892,877,000**	**338,129,342,474**
Of which education, health, and infrastructure:	228,203,856,786	168,717,459,199
Percent:	48%	50%
Of which other government:	246,689,020,214	169,411,883,275
Percent:	52%	50%

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