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IMPACTS OF GLOBAL AGRICULTURAL TRADE REFORMS AND WORLD MARKET CONDITIONS ON WELFARE AND FOOD SECURITY IN MALI: A CGE ASSESSMENT

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IMPACTS OF GLOBAL AGRICULTURAL TRADE REFORMS AND WORLD MARKET CONDITIONS ON WELFARE AND FOOD SECURITY IN MALI: A CGE ASSESSMENT

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ABSTRACT

IMPACTS OF GLOBAL AGRICULTURAL TRADE REFORMS AND WORLD MARKET CONDITIONS ON WELFARE AND FOOD SECURITY IN MALI: A CGE ASSESSMENT

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The Malian agricultural sector faces a series of trade reforms originating from within West Africa and from the rest of the world. These reforms are expected to change income and food consumption levels in Mali, but the direction and the magnitude of these changes are unknown. This dissertation contributes to the understanding of how, and the degree to which, these reforms would affect welfare and food security in Mali. The analysis is based on computable general equilibrium simulations using a 1997 social accounting matrix that has been specifically built for the purpose.

The dissertation is organized in seven chapters. Chapter I reviews the theoretical and empirical evidence supporting the need to investigate the impacts of trade reforms in the specific context of the Malian economy. Chapter II discusses the use of the Hicksian equivalent variation to measure welfare impacts, as well as the use of changes in household food consumption as a proxy measure of food security. Chapter III presents nine trade reforms scenarios, organized in four groups: (i) the FAPRI and OECD price change scenarios of partial reforms of world commodity markets; (ii) the IFPRI-1 status quo and the IFPRI-2 full liberalization price change scenarios; (iii) the EEP effective erosion of existing preferences and the DFA complete duty-free access preferential trade scenarios; and (iv) government policy scenarios on applying a common external tariff regime, banning cereals exports, and increasing investments in key sectors.

Chapter IV presents the analytical method, which is a single-country computable general equilibrium (CGE) model in the neoclassical structuralist tradition. The Malian model is based on a standard CGE model from the International Food Policy Research Institute, which is itself based on the Dervis, de Melo and Robinson (1982) seminal work. The CGE framework uses data from a disaggregated social accounting matrix (Chapter V), and the simulation results represent counterfactuals the nine trade reform scenarios.

The results, presented in Chapter VI, reveal that Mali has as much to gain from increased agricultural reforms in world markets, as it has to gain from deepened commercial integration in West Africa. The gains would amount to an average of three percent of initial income levels. Most of the gains would go to urban consumers who would benefit from reduced prices, appreciated real exchange rate, and increased factor incomes. In general, and in absence of productivity gains, rural producers would lose reductions in world commodity prices. The negative effects are mitigated, and could even be reversed, if Mali benefits from gains in productivity. The results also indicate that expanding existing trade preferences would raise incomes and food consumption in Mali, whereas reducing or eliminating these preferences would reduce incomes and weaken food security in Malian households.

The last chapter of the dissertation discusses several implications and limitations of these results. Mali would gain by allowing global market forces to work in the economy, expanding regional trade, increasing investments in key sectors, and improving agricultural productivity. While the first two options come at the cost of increased urban inequality, the last two have the potential to deliver Pareto-compatible results. Overall, the analysis may be refined by improving the underlying social accounting matrix.

To my family

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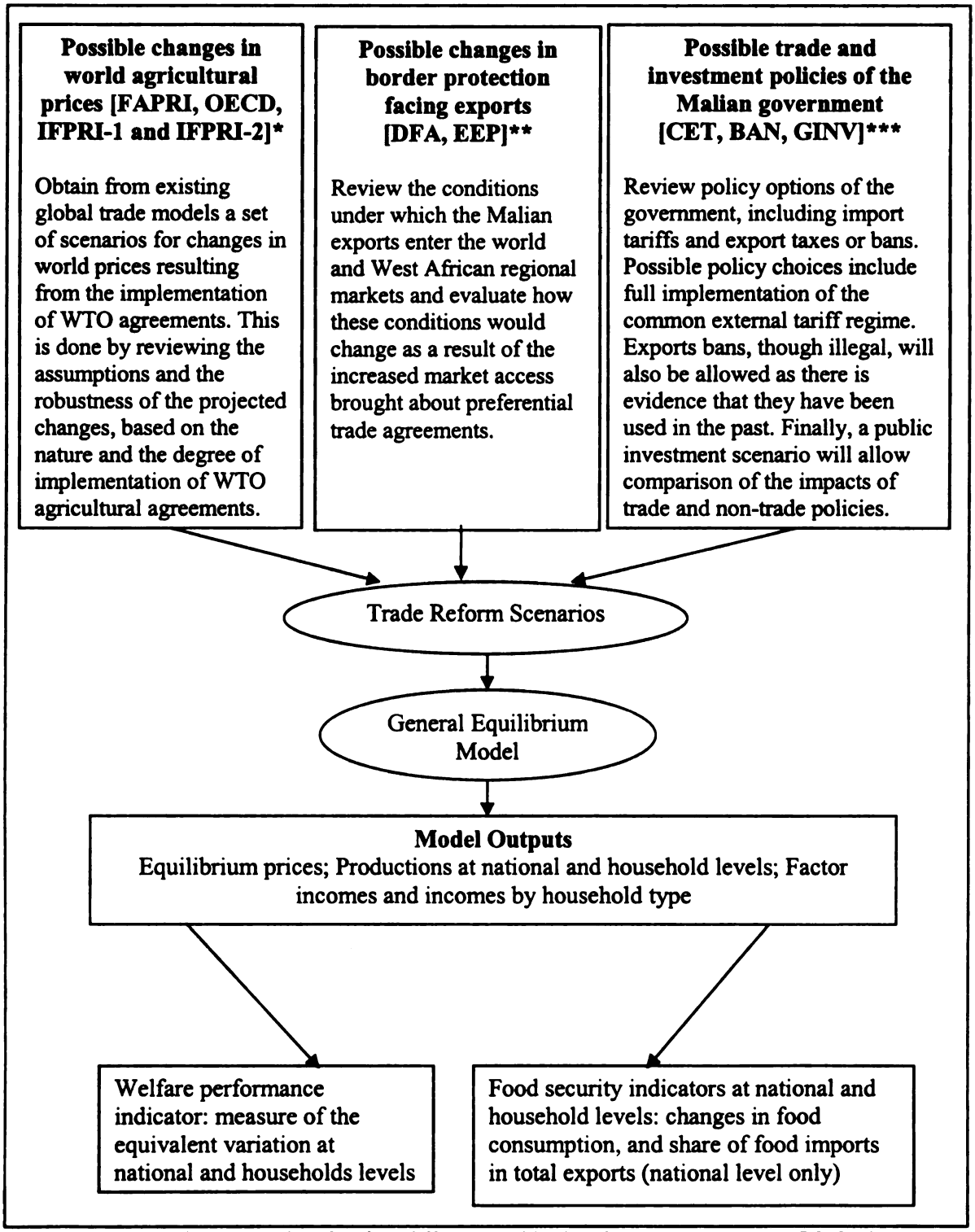
CHAPTER I: INTRODUCTION

1.1. Overview

This study investigates the impacts of global and West African agricultural trade reforms on welfare and food security in Mali. The research consists of designing various trade reform scenarios and simulating their impacts on welfare and food security in Mali using a static, single-country computable general equilibrium model. The reform scenarios are constructed from three sets of assumptions on (i) the direction and magnitude of change in world agricultural prices following the implementation of the World Trade Organization's (WTO) agreements on agriculture, (ii) the change in the level of border protection facing Malian exports, and (iii) the choice of fiscal and trade policies by the Malian government. These criteria are the most important elements determining the welfare and food security impacts of ongoing trade reforms in Mali. The study is expected to contribute to the empirical literature on linkages between agricultural trade reforms and food security in Sub-Saharan Africa.

In this study, trade reforms are modeled as scenarios which are jointly determined by the three sets of criteria mentioned above. A scenario is defined based on either (i) a magnitude of change in world agricultural prices, (ii) a specific level of tariffs and non-tariff barriers (in tariff equivalent) imposed on Malian exports, or (iii) a given set of fiscal and trade policy choices by the Malian government (Figure 1.1). Plausible changes in prices and border protection, as well as feasible fiscal and trade policies by the government, are identified through a critical review of the existing literature (see Chapter III).



Notes: *, **, ***: Chapter III identifies four different world price change scenarios (FAPRI, OECD, IFPRI-1 and IFPRI-2). The chapter also discusses two alternative market access regimes, based on whether the Malian exports will have a Duty-Free Access (DFA) to major markets, or whether there will be Erosion of Existing Preferences (EEP). Finally, government policy choices include a full implementation of the West African Common External Tariff (CET) regime, a ban on the Malian cereal exports (BAN), and increases in public investments (GINV).

Figure 1.1: A Framework for Analyzing the Impact of WTO and West African Trade Reforms on Welfare and Food security in Mali.

Once trade reform scenarios are designed, they are fed into a computable general equilibrium (CGE) model to generate a series of results. These include equilibrium prices and outputs as well as incomes to production factors and to various household groups. Results from the CGE models are then used to characterize the welfare and food security impacts of trade reforms at national level and household levels. While subsequent chapters of this dissertation elaborate on each of the steps outlined in Figure 1.1, the remaining part of this chapter presents the rationale and the objectives, as well as the organization of this dissertation.

1.2. Problem Statement

There is an ongoing debate about how agricultural trade reforms under the World Trade Organization (WTO) would affect welfare and food security in developing countries, including Mali. Current figures indicate that more than one-fifth of the Malian population is undernourished (FAO, 2003), while about 65% live under the poverty line (USAID-Mali, 2003). Reducing poverty and undernourishment are key policy objectives for the Malian government, and there is a general understanding among policymakers that ongoing trade reforms may have important effects on welfare and food security in Mali.

In this study, trade reforms refer to the WTO agreements on market access, domestic price supports and export subsidies. The general goal of these agreements is to encourage reduction of tariffs, eliminate non-tariff barriers, and reduce domestic price supports and export subsidies to agriculture. In Mali, trade reforms have an additional West African regional component whereby the country participates in region-wide trade

liberalization policies, characterized by a common external tariff and the implementation of a free-trade area within West Africa.

The ongoing debate is generated from a general uncertainty regarding the impacts of trade reforms on welfare and food security. This uncertainty has both theoretical and empirical components. Theoretically, it is well-known that trade reforms have ambiguous impacts on welfare. This ambiguity generally has two origins. First, the theory of second-best holds that trade reforms in an economy that is not perfectly competitive may generate net welfare gains or losses (Lipsey and Lancaster, 1956).[1] No economy in the world is perfectly competitive. Thus, all economies are prone to the uncertain second-best effects of trade reform (Suranovic, 1999). Second, this initial uncertainty may be exacerbated by the distributional impacts of trade reforms. It is also well-known from the Stolper-Samuelson theorem that trade reforms usually generate factor income gains in some production sectors and losses in other sectors (Dixit and Norman, 1980; Khan, 1998). Theoretical evidence on the impacts of trade reforms on food security can be inferred from the welfare impacts of these reforms. Welfare or income changes may be translated into changes in effective demand for food, which is an important indicator of national and household food security.

In addition to the theoretical uncertainty, empirical evidence also suggests that trade reforms have ambiguous effects on welfare. This is evidenced in existing studies in Sub-Saharan Africa (e.g., Mbabazi, 2003; Lofgren, 2001; 2002; Dorosh and Sahn, 2000) and elsewhere (Baustista and Thomas, 1997). In general, the empirical evidence depends on individual country characteristics. For example, Wobst (2002) shows in the context of

[1] Results from other trade theories, such as the new trade theory (based on imperfect competition and economies of scale) also suggest that trade reforms have an ambiguous impact on the direction of change in welfare (Krugman, 1981; Helpman and Krugman, 1985).

five Southern African economies that common policies measures may yield dramatically different welfare impacts. It follows that the structure of the Malian economy will be a major determinant of the way in which WTO and West African trade reforms are likely to affect welfare in the country.

In terms of food security, there are few systematic analyses of the impacts of ongoing WTO trade reforms on food security in Sub-Saharan Africa, and particularly in West Africa. However, there are countless case studies, usually found in online reports by non-governmental organizations, which generally come to the conclusion that agricultural trade reforms are harmful to food security in poor small-scale farm communities. Examples of such studies include Posner (2001), Charles, Longrigg and Tugend (2001) and Madeley (2000). The Charles, Longrigg and Tugend study is a Consumers International's assessment of the reforms in 13 developing countries. The study concludes that, in many poor countries, increased exposure to agricultural trade reforms weakens food security through increased dependence on food imports and reduced employment opportunities. Madeley (2000) reviews the experience of trade reforms in 27 developing and least-developed countries and reaches a similar conclusion. The main limitation of these case studies is that they rely heavily on isolated situations of a specific community in a given country. These isolated situations rarely reflect the economy-wide impacts of trade reforms. Thus, they constitute a poor proxy of what could be the overall effects of trade reforms. Economy-wide effects must be captured within a economy-wide analytical framework, which is the approach taken in this study.

Given the theoretical and empirical uncertainties outlined above, it is impossible to establish a priori the direction of change in welfare and food security in Mali following

the implementation of global and West African regional trade reforms. This is primarily an empirical question, and thus requires further investigation. The need for this assessment also arises because improving welfare and food security is one of the most important concerns for poor countries, when it comes to global trade reforms (Diaz-Bonilla et al., 2000).[2]

1.3. Objectives of the Study

The main objective of this study is to assess empirically the welfare and food security impacts of the WTO-led agricultural trade reforms on the Malian economy while accounting for regional integration dynamics in West Africa. This main objective is broken into the following four specific objectives:

(i) To design trade reform scenarios based on expected changes in agricultural prices, border protection facing Malian exports and government trade and fiscal policy choices;

(ii) To build a social accounting matrix for the Malian economy, differentiating between the West African and rest-of-the-world imports and exports;

(iii) To simulate the impact of trade reform scenarios in a general equilibrium setting, maintaining the regional differentiation of trade; and

(iv) To translate the CGE results into welfare and food security indicators at country and household levels.

The proposed study is expected to contribute to the empirical literature on the linkages between agricultural trade reforms and food security primarily in Mali, but with

[2] Improving welfare and food security has also been recognized as an explicit objective of the WTO agreements. This is acknowledged not only in the preamble of Marrakesh Decision that established WTO in 1994, but also in the WTO Decision regarding the possible negative impacts of the reform agenda on the least-developed and Net-Food Importing Developing Countries (NFIDC). The Doha Development Agenda also stressed on the need to use the trade engine to support development (including improved welfare and food security) in poor countries.

possible implications for other Sub-Saharan African countries. The contribution will be in the form of conditional statements on the impacts of specified trade reforms on welfare and food security in Mali, given a series of reform outcomes depending on changes in world agricultural prices, border protection in the Malian export markets, and the government trade and fiscal policy choices.

1.4. Organization of the Dissertation

The dissertation is organized in seven chapters, including the present introductory chapter. The next chapter offers a summary discussion of the concepts of welfare and food security, in the context of global and West African agricultural trade reforms. Welfare is measured by equivalent variation at both national and household levels, and food security is captured by changes in the level of national and household food consumption (see Figure 1.1). Trade reform scenarios are discussed and presented in Chapter III, and Chapter IV lays out the analytical model, which is a computable general equilibrium model in the neoclassical structuralist tradition. Chapter V documents the construction of a disaggregated, agriculture-oriented, social accounting matrix (SAM) for the Malian economy. The SAM is the main database used in simulating the welfare and food security impacts of trade reforms in Mali. Chapter VI deals with the implementation of the SAM-based CGE model and discusses the simulation results in terms of the welfare and food security indicators. The last chapter concludes the dissertation.

CHAPTER II: INDICATORS OF WELFARE AND FOOD SECURITY

2.1. Introduction

There are several indicators of welfare and food security in the literature. This chapter does not attempt to make an exhaustive survey of welfare and food security literatures. It simply aims at presenting a limited number of indicators that may be used to characterize the impacts of various scenarios of agricultural trade reforms on welfare and food security in Mali. In particular, the chapter discusses briefly the equivalent variation (EV) concept, which is one of the most common indicators used to measure changes in welfare. Most of the chapter elaborates on the concept of food security at the national level, and its linkages with regional and global trade. The chapter also discusses how changes in food consumption may be used to measure changes in the state of food security under various trade reform scenarios. Both the welfare and food security measures may be computed under each scenario of trade reforms, allowing a comparison of impacts between scenarios and with respect to the base scenario.

2.2. Welfare

As mentioned earlier, this section does not conduct an exhaustive review of welfare indicators. Instead, the aim is to identify an appropriate indicator able to capture welfare changes under different trade reform scenarios. The equivalent variation (EV) is considered to be such an indicator.

While there is still an ongoing debate on the appropriate measurement of welfare, many CGE-based studies rely on the EV measure. For example, Decaluwé, Dissou and Patry (1998) used EV to measure changes in welfare in seven West African countries.

Anderson and Martin (1996) review several measures of change in welfare and conclude that EV dominates other measures. EV is particularly attractive for the purpose of this study because, as explained in Varian (1978; p. 162), this will keep the baseline scenario as fixed and compare all the other scenarios with respect to this status quo. In addition, EV may be computed not only for the country as a whole, but also for various household groups within the country, allowing welfare impact assessment across households.

In order to compute EV, the Malian economy in the base period (1997) may be viewed as supported by an initial commodity price vector, say p^0. Each trade reform scenario s corresponds to new price vector p^s. A consumer (or household group) with income m enjoys an initial utility u^0 at price p^0 and a new utility u^s at price p^s. Define an expenditure function $e(p, u)$ to be the amount of money that a consumer spends in order to achieve utility level u given the price vector p. EV is defined as follows[3]:

$$EV = e(p^0, u^s) - e(p^0, u^0) \tag{2.1}$$

EV represents the net change in welfare that causes the consumer to get the utility level u^s at price p^0. A consumer would be better off if EV is positive, and worse off if it is negative.

In addition to EV, further insight into welfare change may be gained through direct examination of changes in national and household incomes and in the functional distribution of income to factors of production. This study will make use of this insight to complement conclusions drawn for the EV measure.

This choice of EV as a measure is not without problems. In the strict sense, EV measures changes in individual welfare. Thus, the use of EV to evaluate welfare changes

[3] Varian (1992, p. 167) defines EV as $e(p^0, u^s) - e(p^s, u^s)$, which is slightly different from the definition in Mas-Colell, Whinston and Green (1995, p. 82), shown in Equation (2.1). The two expressions are identical, however, because $e(p^0, u^0) = e(p^s, u^s) = m$, since m is the wealth needed at any given price and utility level.

in a country or household group raises the traditional aggregation problem. Central to the aggregation problem is the representative agent assumption. It is clear that for any household group, individuals are likely to be heterogeneous within that group. Yet, the representative agent assumption considers individuals to be homogenous within the representative group, so that any decision made by the representative group is deemed equivalent to the aggregate choice of individuals acting independently. Kirma (1992) offers a detailed critique of the representative agent concept, but falls short of proposing any meaningful alternative other than calling for "a paradigm in which individuals operate in diverse subsets of the economy, [and] are diverse both in their characteristics and the activities that they pursue" (p.134). This is precisely what modern applied general equilibrium models emphasize in grouping individuals in household groups, so as to achieve some reasonable level of within-group homogeneity. But even with such a fix, the fundamental aggregation problem remains regarding the use of EV as a measure of welfare change. For most CGE-based analyses, however, household grouping is indispensable if one is to keep a model tractable and relevant for policy applications.[4] This study opts for the latter approach, acknowledging that EV may not be a perfect measure of welfare changes in household groups or for the country at a whole. It is, nevertheless, a reasonable measure of such changes and is maintained for the analysis in this study.

[4] There is an emerging CGE literature that emphasizes the use of "real households", instead of the standard use of "representative households" (e.g., Bourguignon, Robilliard and Robinson, 2003). The application of the real household approach has delivered results that are encouraging, but the linkage between the macro model and real household is not yet satisfactory. Furthermore, the new approach requires individual household data from national household surveys. Such data were not available for this study, hence the use of the standard representative household approach.

2.3. Food Security

2.3.1. The Concept

"Food security" is a very broad and complex concept, which makes it very susceptible to misuses. In order to avoid misunderstandings, this study adopts the widely used definition put forward by the 1996 World Food Summit. It will be considered that "food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary need and food preferences for an active and healthy life" (FAO, 1996). Thus, food security implies three key conditions. First it requires adequate *availability* of food, i.e., a sufficient, sustainable and stable food supply, as argued by Maxwell (1996). Second implies a sustained *access* to food by each individual. And finally, it requires effective *utilization* of the available food (for details, see Staatz, 1990; Tweeten, 1999; Barrett, 2002; PCHA, 2002.)

It is clear that insufficient food supply at any level of aggregation implies undernourishment, hence food insecurity. It is also true that sufficient food availability in a given geographic area does not assure adequate food access to all individuals living in that area. This has been the essence of the entitlement literature pioneered by Sen (1981). It is finally clear that while food availability and access are preconditions for adequate utilization, they "do not determine unequivocally the more substantive issue of malnutrition and nutrition security at the individual level" (Diaz-Bonilla et al., 2000; pp. 4-5). The *utilization* dimension of food security, which depends on intra-household food allocation and use, goes beyond the scope of this study and is therefore not addressed here. Instead the study focuses on the first two dimensions of food security. Physical food sufficiency is measured through nationwide food supply indicators, whereas economic

access is captured by both households' effective demand for food and the country's capacity to finance its current food imports through trade.

2.3.2. Food Security and Trade

The idea that trade is an instrument for achieving food security is best understood with the concept of "self-reliance". For a country or a region, a self-reliance strategy consists of securing a sufficient, safe, and nutritionally adequate food for its population, using a combination of domestic production and imports. The self-reliance concept is widely discussed in the literature and appears in trade and food security-related works, such as Martin (1988), Sumner (2002) and Beghin, Bureau and Park (2003). Self-reliance is also the building block of food security strategies in Mali and other West African countries.[5]

Trade has a direct link with national food security, allowing direct food purchases in the world market with incomes that are generated from exports. Global and regional trade allows a country to buy or sell food in the world market, adjust its production to terms of trade shocks, generate government revenues, and achieve overall economic growth, all of which have direct or indirect impacts on the nutritional status of people in the country. Figure 2.1 depicts the various components of a food security system at various levels of aggregation.[6]

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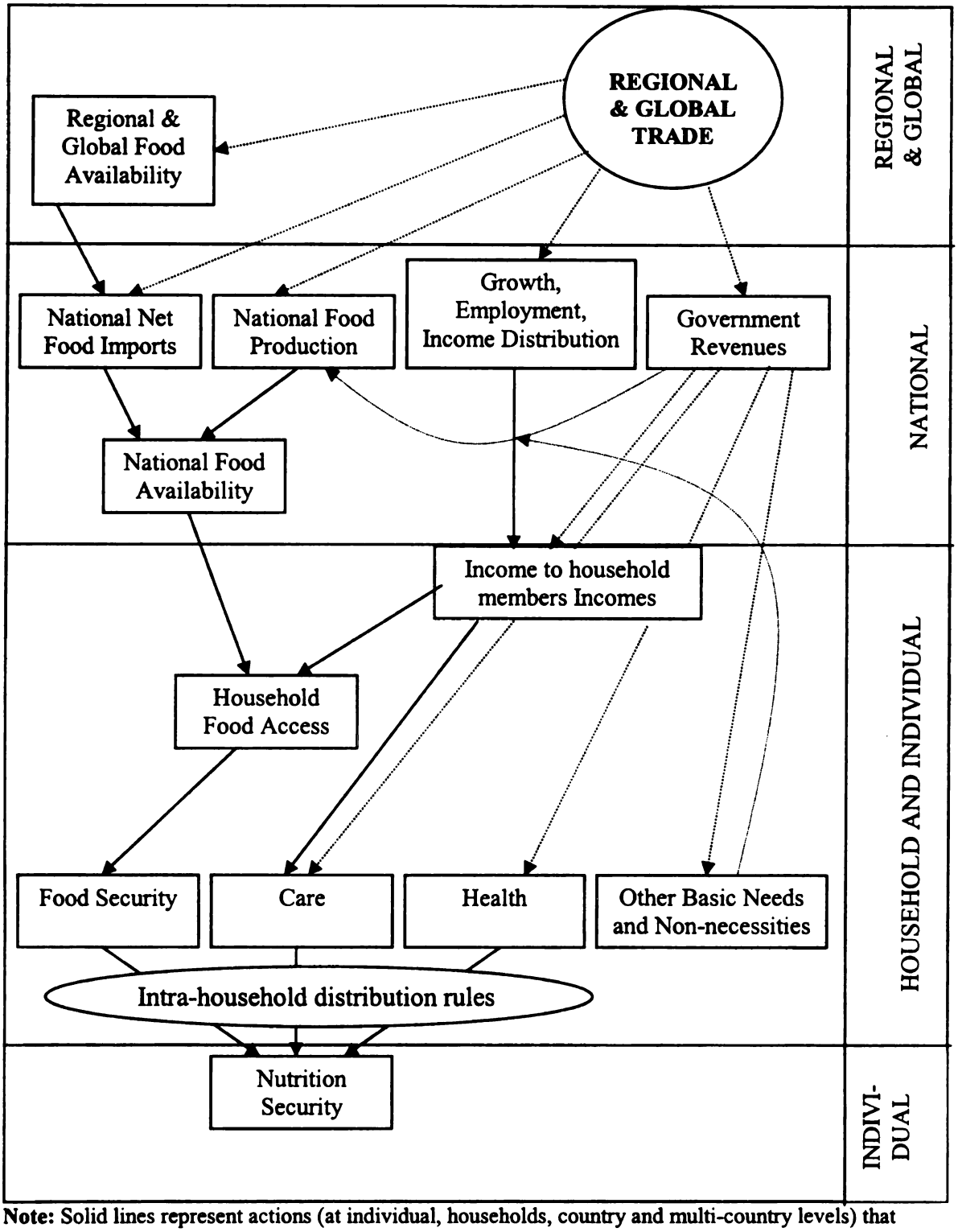
[5] Nouve and Staatz (2003) review food security dynamics in West Africa and highlight the key linkages between global and regional trade among West African countries.

[6] This figure appears in various forms in several publications. Diaz-Bonilla et al. (2000) adapts it from Smith (1998), who adapted from UNICEF (1990) and Frankenberger et al. (1995). Also, FAO (2002) exposes a similar framework.



Note: Solid lines represent actions (at individual, households, country and multi-country levels) that *directly* affect national food availability, household food access, and individual food and nutritional security. Dotted lines represent actions beyond the control of households or individuals that *indirectly* influence household and individual food and nutritional security.

Figure 2.1: Conceptual Framework for Food Security (Based on Diaz-Bonilla et al., 2000).

Government expenditures and investments in productivity-enhancing infrastructures have both direct and indirect effects on national food production. This feedback is shown in Figure 2.1, with arrows from "Government Revenues" to "National Food Production" either directly or via the government financing of "Other Basic Need and Non-Necessities". These linkages are important, and are modeled as shocks to government investments in the Malian computable general equilibrium model.

2.3.3. Measuring the Level of Food Security

There are several indicators of food security in the literature. This section first discusses a selected number of these indicators, and identifies the indicators to be used to evaluate the food security impacts of global agricultural trade reforms. Commonly used indicators include: (i) per capita food production (in cereal equivalent or per food category), (ii) per capita caloric availability, (iii) per capita protein availability, and (iv) ratio of food imports in total exports. The first three indicators measure food security at both national and household (group) levels, and the larger are the values of these indicators the higher is the level of food security. The last indicator is exclusively a national food security measure. Diaz-Bonilla et al. (2000) and FAO (2001), among others, discuss in detail the appropriateness of these indicators as measures of national and/or household food security.

(i) Per Capita Food Production

Per capita food production measures the level of food production in the economy. It is the total national or household production divided by the relevant population. National food production is usually calculated by food category and as an aggregate index for all food products. The aggregate Food Production Index (*FPI*) is computed

following the FAO production index. For any given trade reform scenario *s*, this index can be defined as the ratio of value of food production in scenario *s* to the base food production value. Algebraically, the ratio is expressed as follows:

$$\text{(2.2)} \qquad \textit{Food Production Index } (FPI) = \frac{\sum_{c=1}^{C} P_c^s Q_c^s}{\sum_{c=1}^{C} P_c^0 Q_c^0} * 100$$

where the subscript *c* indicates commodities and the superscript *s* and 0 represent prices (*P*) and quantities (*Q*) in the base period and under scenario *s*, respectively. *C* is the total number of food products, and all P_c^0 and P_c^s are expressed in real terms.

A *FPI* that is greater than 100 would indicate an average increase in the value food production under *s*, relative to the base situation. An index value less than 100 would indicate an average reduction in the value of food production as a result of the implementation of a trade reform scenario *s*. A potential major limitation of this index is that it can change in response to changes in relative prices (brought about by the trade reforms), even if physical quantities of production remain unchanged or change in the opposite direction. An index based on physical quantities would therefore be more useful in describing changes in food production under various trade reform scenarios.

One of the criticisms of the WTO is that it shifts the mix of agricultural production away from domestically consumed staple food towards production of export crops, thus lowering domestic food availability. Also important to domestic food availability are food imports, so that a more useful food security indicator would consider changes to overall food availability that accounts for both domestic production and imports. This is what is done in this study by focusing on changes in physical quantities

of national and household food consumption. Changes in consumer food demand depend on changes in domestic food production and in food imports, and these two sources of changes are accounted for in the Malian CGE model.

(ii) Per Capita Caloric Availability

This indicator characterizes the average consumption levels in a given country. The indicator can be calculated for the country as a whole, and for individual household groups. As a national (or household) average, caloric availability or dietary energy supply (DES) may be viewed as an imperfect indicator of the state of individual food security. But empirical evidence, such as Smith and Haddad (2000), suggest that there is a strong correlation between this national (household) average and more individual-based indicators of food security (e.g., anthropometric indicators of children's nutritional status). In particular, Smith and Haddad (2000) show that national caloric availability was responsible for more than a quarter of reductions in child malnutrition in developing countries over the period 1970-95.[7]

DES has been widely used in the literature as one of the main determinants of national food availability (Smith and Haddad, 2000). It has also been widely used in connection with health and nutrition-related studies, such as Anand and Ravallion (1993), Subbarao and Raney (1995), Prichnett and Summers (1996), Frongillo, de Onis, and Hanson (1997) and Osmani (1997). The DES level is often calculated from food composition tables and a highly disaggregated food consumption basket. While a food composition table is available for Mali, products in the Malian social accounting matrix

[7] Women's education and status accounted for nearly 55% of these reductions, whereas the health environment of the household explained the remaining 19%. However, most of these effects were found to be concave in time, with diminishing marginal contribution to reduction in child malnutrition over time.

are not sufficiently disaggregated to produce a reliable DES measure for the country. Thus, the DES indicator will not be used in this study.

(iii) Per Capita Protein Availability

Similar to the caloric availability (DES), per capita protein consumption indicates the average levels of national or household protein consumption. According to Diaz-Bonilla et al. (2000), this indicator is useful in addressing traditional criticisms (e.g., by von Braun et al.(1992), Smith (1998), and Bouis (2000)) that food consumption measures tend to ignore protein and micronutrient consumption. Data on national micronutrient consumption are generally said to be scarce (Smith and Haddad, 2000), but Mali could be an exception. The Malian food composition table could allow a computation of changes in the levels of micronutrient consumption under various trade reform scenarios. The problem is once again the insufficient level of commodity disaggregation, making it impossible to obtain accurate estimates of micronutrient levels, both in the base year and under the trade reform scenarios.

This study will emphasize changes in physical quantities of protein-rich food products consumed at both national and household levels. Evidence from Bouis (2000), and reported in Diaz-Bonilla et al. (2000), suggest that availability of animal proteins is more directly correlated with measures of nutritional security than is availability of total proteins. While themselves using the total per capita protein availability, Diaz-Bonilla et al. (2000) implicitly recommend the use of per capita availability of animal protein. Thus, this study will approximate the changes in nutritional security using the average national and household consumption of livestock and fish products.

(iv) Ratio of Total Exports to Food Imports

This indicator is often thought to be a measure of the capacity of a country to finance its food imports using revenues from exports of goods and services. This measure has been used, among others, by Diaz-Bonilla et al. (2000). Also widely used is the inverse of this ratio, that is, the percentage of food imports in total exports (e.g, FAO, 2001). Diaz-Bonilla et al. (2000) argue that their measure, which they traced back to earlier works such as Valdés and Konandreas (1981), is easier to interpret because it is directly related to food security. However, the interpretation of the inverse ratio is equally straightforward, the target being to achieve a ratio (food imports/total exports) that is as small as possible.[8] So the inverse ratio will be used in this study.

Whether food imports or total exports are put in the denominator of the ratio, it is misleading to treat this ratio as a measure of a country's capacity to import food, let alone as a measure of food security. The ratio will decline when food imports fall faster than total exports, which may result in reduction in the level of overall food consumption. This point is clearly made in FAO (2003). What is measured by the ratio is the capacity of the country to pay for *current* food imports, and this has little or no relationship with changes in overall food consumption. Therefore, the ratio needs to be interpreted in light of observed changes in food consumption. This is what is done in this study.

It is clear that the food imports/total exports ratio is an imperfect food security indicator. There is, however, a concern among developing nations and activist movements that WTO agricultural trade reforms would increase food import dependency

[8] Even Diaz-Bonilla et al. (2000) proceed with their discussion of this indicator, using the (inverse) ratio of food import divided by total exports. For instance, they compared "A country...for which the total food bill takes a larger percentage of total exports) with "a country...whose food bill takes only a small percentage of its total exports" (p. 6).

in these countries, which is often equated to a situation of worsened food security. Thus, computing the ratio and comparing it with expected changes in food consumption will shed light on the tradeoffs between reducing food import dependency and increasing food consumption in Mali.

(v) Measuring Changes in Food Consumption Levels

The change in food security is proxied by changes in the level of food consumption between the base and the counterfactual scenarios (Equation 2):

$$(2.2) \qquad \%\Delta x_i = 100^*[x_i(\mathbf{p}^s,y^s) - x_i(\mathbf{p}^0,y^0)]/x_i(\mathbf{p}^0,y^0)$$

where $\%\Delta x_i$ is the percentage change in the consumption of food item *i* between the initial and new scenarios; $x_i(\mathbf{p},y)$ represents the demand of food product *i*; y^0 and y^s represent the initial and new household incomes, respectively; and $\mathbf{p}^0$ and $\mathbf{p}^s$ are, as defined earlier, the initial and new price vectors, respectively. One of the general equilibrium relationships that is key in agrarian economies is the well-known endogenous income effect. Because households are endowed with consumption goods **x** that they produce, their income y^s under each scenario depends on the equilibrium price vector $\mathbf{p}^s$. Thus, as domestic prices change under each trade reform scenario, the net consumer demand for goods **x** changes in response to direct price changes and indirect income effects. It is argued later in the paper that while the direct price effects are important in terms of welfare, they are less so in terms of food consumption. A substantial part of households' food demand comes from home consumption, which is very price-inelastic in rural Mali.

2.4. Conclusion

This chapter discusses the concepts of welfare and food security and proposes indicators to be used to measure welfare and food security impacts of global agricultural trade reforms in Mali. Welfare is measured by equivalent variation at national and households' levels. Food security is characterized by physical quantities of food consumed at the national and household levels, as well as by the ratio of food imports to total exports. The comparison of the two food security indicators will elucidate tradeoffs involved in increasing food consumption and increasing the level of food self-sufficiency.

CHAPTER III: DESIGN OF AGRICULTURAL TRADE REFORM SCENARIOS

3.1. Introduction

This chapter discusses the design of various scenarios of global agricultural trade reforms that are relevant for Mali and other agriculture-dependent Sub-Saharan African countries. The scenarios are designed based on expected changes in (i) the level of border protection applied to Malian exports, (ii) world agricultural prices, and (iii) domestic trade and fiscal policies in Mali. The first three sections of this chapter elaborate on each of these sources of changes, and the last section summarizes and concludes the chapter.

3.2. Border Protection in the Malian Export Markets

The Malian export markets can be differentiated into West Africa and the rest of the world (ROW). This section discusses how border protection is treated in these two differentiated markets.

3.2.1. Border Protection in ROW

Commodity exports from Mali to the rest of the world (ROW) in the base year (1997) were limited to three products, including two agricultural products (groundnuts and cotton) and one mining product (gold). Thus, this study will assume that counterfactual changes in border protection facing the Malian exports to ROW are restricted to these three commodities. A further restriction will apply to gold, and this is discussed in the next section. Since 1997, gold and cotton have contributed more than 80% of export receipts in Mali. Therefore, focusing on the three commodities will capture most of the export activities in the country.

Agricultural and mining exports originating in Mali have benefited from preferential access to developed countries' markets. These benefits include the General System of Preferences (GSP) in the Quad markets (European Union, the United States, Canada and Japan). In addition, Mali has preferential access to the European Union's markets under the Lomé Convention (and the subsequent Cotonou Agreements) between EU and the African, Caribbean and Pacific (ACP) countries. The EU, together with other Quad countries, absorbs most of the Malian exports of primary products. But Mali is increasingly directing its exports (particularly cotton) to other countries, such as China.

As a preference beneficiary country, Mali is concerned with potential erosions of trade preferences following the implementation of the WTO agricultural trade reforms. In terms of the magnitude of the preference margins, Hoekman, Michalopoulos and Winters (2003) draw on existing studies and evaluate that these reforms would cut average tariffs of preference commodities from 4.3 to 2.5 percentage points, which is equivalent to more than a 41% erosion. Comparable estimates suggest that the preference margins extended to the least-developed countries vary with countries and average 50% of the Most Favored Nation (MFN) rates (IMF and World Bank, 2001; 2002).[9] Thus, a removal of these preferences under the ongoing WTO reforms would amount to 50% erosion. This magnitude of erosion is accounted for as one scenario of erosion of existing preferences (EEP) on the Malian groundnuts and cotton exports. Being a traditional monetary unit, gold enters most countries duty-free, and this is maintained in the study.

[9] EU's preferential margins tend to be the highest for Sub-Saharan African countries, although their relevance is often mitigated by a combination of low MFN rates and restrictive rules of origins (IMF and World Bank, 2001; 2002). This is evidenced by much lower preference margins for sensitive products on which high tariffs (tariff peaks) are imposed.

In addition to the traditional GSP and ACP-EU preferences, new preference initiatives have emerged with the new millennium. These include the US African Growth and Opportunity Act (AGOA) and the EU's Everything But Arms (EBA). Preliminary investigations of these initiatives suggest that they are unlikely to improve the already liberalized access the least-developed countries (such as Mali) have to markets in the Quad. For example, Brenton (2003) argues that for many poor countries, the current EU trade preferences are of no real value because more than 99% of LDC exports are concentrated in products for which the EU's MFN external tariff is zero. The EU tariff database[10] indicates that the Malian exports of cotton and groundnuts were qualified for a duty-free access to the Union in 1997, which is the base year used for simulations in this study. In addition, existing simulation-based studies show that the impact of the EBA initiative is likely to be concentrated on a narrow set of sectors, in particular, sugar and rice (Ianchovichina et al., 2001, UNCTAD 2001, Trueblood and Somwaru 2002). Mali imports both sugar and rice, and is therefore unlikely to be affected by improved access to export markets of these commodities. Similarly, AGOA does not offer any additional market access opportunity for products Mali exports to ROW, such are cotton and groundnuts. AGOA benefits seem to be concentrated in textile apparels (Hoekman, Michalopoulos and Winters, 2003). Textiles do not constitute major exports from Mali to ROW. Also, Nouve and Staatz (2003b) find no evidence of change in agricultural exports from Sub-Saharan Africa to US in the post-AGOA period.

In light of the preceding, this study acknowledges the possibility that the Malian groundnut and cotton (in addition to gold) exports would have effective duty-free access

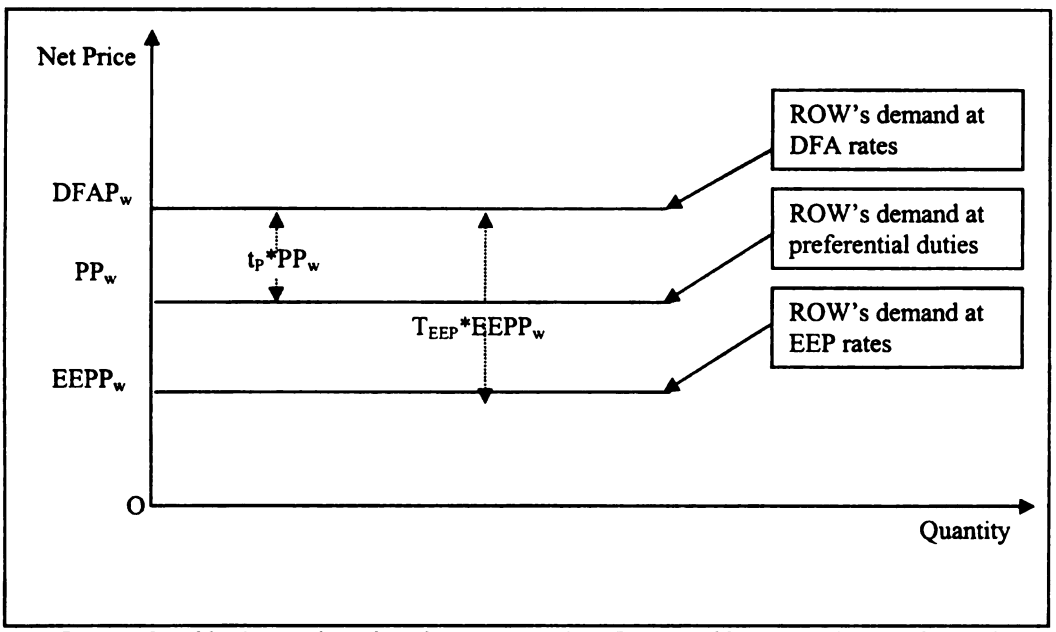
[10] It is the TARIC database, available online at http://europa.eu.int/comm/taxation_customs/dds/en/tarhome.htm, viewed April 16, 2004.

to major export markets. Such an access would be equivalent to zero effective duties on these commodities. The effective duty-free entry of Mali's exports to ROW's markets, called duty free access (DFA), is also accounted for as a scenario in this study.

The implementation of both the 50% preferential access and the duty-free access to export markets is based on Figure 3.1. The figure is drawn from the perspective of a small country that faces an infinitely elastic world demand at the prevailing world prices. Three border protection regimes are depicted in the figure. They correspond to the access of Malian export to ROW under duty-free, preferential, and EEP regimes. For the exporter, the infinitely elastic world demand at the prevailing world price represents a schedule of net marginal benefit accruing from each additional unit of exports. This net benefit is the highest when the exporting country has duty-free access to importers' markets. From Figure 3.1, Malian exporters would receive the net price $DFAP_w$ for each unit of exports, and the corresponding marginal benefit is represented by the vertical distance O-$DFAP_w$. When exports are subject to the EEP rate, t_{EEP}, the net marginal benefit drops to its lowest level (O-EEPPw), as the net price received by exporters falls to $EEPP_w$. Under preferential border protection regime, the net price paid to exporters (PP_w) and the corresponding net marginal benefit (O-PP_w) will lie between the two extremes.

In general, the level of border protection in export markets is not treated explicitly in applied general equilibrium models, and this study does not make an exception to this tradition. Export market protection is often thought to be part of the world price of commodities sold in a hypothetical global market. Thus, the net price received by exporters is considered to have already taken into account the border protection level in importing countries. In implementing border protection scenarios, this study will assume

that the prevailing conditions in the base year (1997) corresponded to some level of preferential access that lied between the extreme DFA and EEP levels. This is because Mali was a legitimate beneficiary of trade preferences in 1997, which would make the average protection facing Malian exports less than the EEP protection. But because eligibility for preferences does not necessarily translate into utilization of these preferences, the effective access level would be different from a duty-free access, even in regions such as EU where zero-duties were recorded in 1997.[11] In terms of Figure 3.1, preferential export prices in the base year would correspond to PP_w. This price level will be obtained by calibrating the computable general model to the base year data.



Notes: $DFAP_w$: World prices under a duty-free export regime; PP_w: World prices under a preferential export regime; $EEPP_w$: World prices under an export regime of erosion of existing preferences; t_{EEP}: level of protection when existing preferences are effectively eroded; and t_p: average preference rate.

Figure 3.1: Three Border Protection Regimes with Infinitely Elastic World Demand

[11] This is because there may be other duties besides tariffs (e.g., custom regulatory duties) that are imposed on the exports. In addition, exports may face non-tariff barriers, which will usually have a tariff equivalent. There is also the possibility for the exporting country to incur costs associated with compliance with technical regulations, and these costs may conceptually be treated as tariffs. So even if the EU data show zero duty on Malian exports of groundnuts and cotton in 1997, it is still possible that there were hidden tariffs. Under the DFA regime, both the apparent and hidden tariffs are assumed to be eliminated.

The implementation of the two remaining scenarios of border protection in Malian export markets requires knowledge of average EEP tariffs applied to commodities of export relevance to Mali (t_{EEP} in Figure 3.1). The EEP tariffs are applied to all countries having the most-favored nations (MFN) status in the importing country. Given previously cited evidence, average preferential tariffs (t_p) will be set to half the EEP or MFN tariff level ($tp = 0.5t_{EEP}$). It follows from Figures 3.1 that $DFAP_w = (1 + t_p)*PP_w = (1 + 0.5t_{EEP})*PP_w$. Similarly, $DFAP_w = (1 + t_{EEP})*EEPP_w$, which implies that $EEPP_w = DFAP_w/(1 + t_{EEP}) = [(1 + 0.5t_{EEP})/(1 + t_{EEP})]* PP_w$. The price level $DFAP_w$ defines the duty-free access scenario, whereas $EEPP_w$ defines the EEP access scenario. Both scenarios depend on the calibrated level of preferential access price (PP_w) and on the MFN tariff rate, t_{EEP}.

The question that arises is how to determine t_{EEP}. The average effective tariffs faced by Malian cotton and groundnuts exports to ROW is not known, due to the lack of data documenting the tariffs effectively paid by Malian exporters in various export markets. A trade-weighted approximation could have been used, but country-specific information on the destinations of these exports was not available at the Malian national statistical office, the *Direction Nationale de la Statistique et de l'Informatique* (DNSI). Though these two commodities were in theory eligible for duty-free entry to markets in many developed countries (under the GSP and ACP-EU preferences), effective access to these markets may not be duty-free, due to technical restrictions and other regulations. Given the lack of data on effective rates applied to the Malian commodity exports markets, and due to the lack of information required to approximate these rates, this study relies on simple averages of MFN tariffs applied to imports of these commodities in

ajor markets. The database of the Global Trade Analysis Project (GTAP) at Purdue iiversity (McDougall and Elbehri, 1998) documents these rates for several regions in e world.

Table 3.1 presents the average MFN tariffs on groundnuts and cotton in the Quad anada, EU, Japan, and USA) and in the rest of the world (ROW) for the mid-nineties. ie table shows varying rates per country/region and commodities. Cotton appears to be bject to the highest MFN rates, due to high ad valorem rates in Japan (42%), EU 9.6)% and ROW (23.7%). MFN rates on groundnuts lies between the relatively high es on cotton and the close-to-zero rates on gold.

ible 3.1: Average Import Tariffs per Commodities and Importers

mmodity	Country and Region					Mean (Quad only)	Mean (All)
	Canada	EU	Japan	USA	ROW		
ar (for tariff data)	1996	n.a.	1996	1996	n.a.	Mid-nineties	
getables, fruits and nuts (groundnuts)	0.2	2.1	5.9	1.3	26.1	2.4	7.1
nt-based fibers (cotton)	3.2	39.6	42.0	0.1	23.7	21.2	21.7

tes: EU is European Union (excluding Germany and Northern European countries); ROW: rest of the rld in GTAP 4 database; n.a. not available.
urce: Based on GTAP 4 Database, Table 1 (McDougall and Elbehri, 1998).

The average MFN rates used in this study could be determined in two ways, own in the last two columns of Table 3.1. The first approach assumes that MFN rates e equivalent to a simple mean of the Quad rates. This yields average MFN tariffs of 4% on groundnuts and 21.2% on cotton. In the second approach, the MFN tariffs are easured as a simple average of the rates in the five countries/regions (Quad plus ROW). is results in MFN tariffs of 7.1% on groundnuts and 21.7% on cotton. As indicated rlier, Mali directed most of its commodity exports (except cotton) to Quad countries, so e Quad mean MFN rates will be used in the simulations to determine how the MFN and

duty-free scenarios would deviate from the (calibrated) preferential scenario.[12] The average MFN tariff rate on cotton is nearly identical under the two approaches, so choosing the Quad mean tariffs will not discount the fact that Mali increasingly exports its cotton to Asia, including China.

3.2.2. Border Protection in West Africa

In addition to changes in border protection facing the Malian exports to ROW, there are also changes in the protection level facing the Malian exports to the West African region. These changes are made possible by ongoing inter-government efforts to liberalize regional markets within West Africa. Such efforts are supported by two overlapping regional integration projects in West Africa. The first is the Economic Community of West African States (ECOWAS), which aims at creating a free trade area among 15 West African countries, with a potential to evolve into an economic, monetary, and political union in the image of the European Union. The second field of integration is the West African Economic and Monetary Union (WAEMU), which creates an effective economic and monetary union as well as a customs union among seven francophone and one lusophone (Guinea-Bissau) countries in West Africa. WEAMU has developed a common external tariff (CET) regime that affects non-member imports, whereas within-WAEMU imports are essentially free of customs duties. The WAEMU's CET regime has been in force since January 2000. Thus, the Malian exports to regional markets over the

[12] Recall that $DFAP_w = (1 + 0.5t_{EEP})*PP_w$ and $EEpP_w = [(1 + 0.5t_{EEP})/(1 + t_{EEP})]*PP_w$, where t_{EEP} is the EEP or MFN average tariffs assumed above; $DFAP_w$, $EEPP_w$ and PP_w represent the export prices under DFA, EEP, and preferential market access regimes, respectively. Consider for example the Quad mean EEP tariff of 2.4% on groundnuts. The deviations from the calibrated preferential regime would be $1.012*PP_w$ for the duty free access and $0.988*PP_w$ for access when existing preferences are eroded (EEP). In other words, the marginal revenue from each additional unit of duty-free groundnut exports would be 1.012 times the marginal revenue under the status quo (corresponding to the prevailing regime in the base year). This marginal revenue drops to 0.988 times the base year's value, when the trade regime switches to EEP tariffs. Similar computation can be made for groundnut under the alternative EEP protection, and for cotton and gold under the two assumed EEP protection in Table 3.1.

simulation horizon will be considered as entering these markets free of duties. Commodities affected by such measures, based on the Malian social accounting matrix (Chapter V), include grains (millet, sorghum, maize and rice), beans, livestock products (cattle, sheep and goats, poultry, and hides and skins), fishery products (fresh and dry fish), and other agricultural products.

In summary, there are three border protection regimes under which Malian exports enter markets in West Africa and the rest of the world. For exports to both West Africa and ROW, the base scenario is calibrated to the country's data in 1997. The two other scenarios correspond to duty-free access (DFA) and preference erosion (EEP) regimes.

3.3. Projected Changes in World Agricultural Prices

This study is based on the premise that the implementation of WTO agricultural trade reforms will change world prices of agricultural commodities. The extent of the change is unknown, but a number of world commodity models routinely publish estimates of future trends in commodity prices. These estimates are based on a wide range of assumptions regarding expected macroeconomic and trade policy changes in major producing, consuming and trading countries, and assumed changes in other exogenous factors such as agricultural productivity and weather conditions. Projected future prices also vary with the theoretical framework used in projection models, which in turn vary in commodity and country coverage. This study considers four different price projections that are available from public sources. These include models from (i) the Food and Agricultural Policy Research Institute (FAPRI), (ii) the International Food Policy Research Institute, assuming current commercial policies will remain unchanged

(IFPRI-1), (iii) IFPRI with full trade liberalization assumption (IFPRI-2), and the Organization of Economic Cooperation and Development (OECD).

The rest of this section highlights the key features of each of these four projections and summarizes the expected changes in prices over the projection period. The degree of details available on these models varies greatly and most of these models, such as FAPRI and OECD, are constantly updated to account for new developments in world economic conditions. Thus, no attempt will be made in this study to present a detailed description of these models. Studies such as Tongeren and Meijl (1999) offer detailed technical discussions of many applied international trade model used in agriculture and related resources. The four price projection models retained for this study are also reviewed in Tongeren and Meijl (1999), although these models may have evolved in terms of expanded regional and commodity coverage since the review was completed in 1999. One of the common threads linking all the projections models considered in this study is that they represent the best conjecture stakeholders can make about the future, given a set of assumptions regarding expected dynamics in economic and policy variables over a medium run. One exception to the "medium-run" assumption is IFPRI's long-run projections to 2020. But since such projections do not diverge greatly from what they would be in 2010 (Rosegrant et al., 2001), they are included as plausible scenarios of price changes over the medium run.[13] It is an expectation of this study that by focusing on four different price projection models with different conjectures about the future, one can effectively capture an array of future possibilities, in terms of the direction and magnitude of changes in world commodity prices.

[13] See grains baseline projections in Rosegrant et al. (2001), Figures 5.1-5.4, pp. 104-106.

3.3.1. FAPRI Price Projection Model

The Food and Agriculture Policy Research Institute (FAPRI) projects the state of US and world commodity markets ten years into the future. Projection assumptions are spelled out in detail and are available online.[14] These assumptions relate to the expected general macroeconomic conditions, agricultural policies, the weather, and technological change. In general, the projections assume a normal continuation of the committed trade and agricultural policies in the United and other third countries. The FAPRI projections also assume average climatic conditions and technological change that are based on historical rates. A summary of key projection assumptions is presented later in the section. By assuming average conditions in the world commodity markets, and allowing for the continuation but not the completion of agricultural and trade policy reforms, FAPRI baseline projections may be viewed as representing an intermediate trade liberalization scenario.

The FAPRI model is a multi-country, multi-market partial equilibrium model of world agricultural markets. The model generates initial baseline projections, which are then reviewed and amended by a panel of experts. The panel includes extension specialists and industry experts, as well as scholars from various US agencies, international organizations and academia. As mentioned earlier, the FAPRI model is being upgraded, with the aim to expand both country and commodity coverage. Thus, existing documentation of the technical description of the model are out of date, though the basic structure of the model is available in Tongeren and Meijl (1999).

[14] Projection assumptions (and other information) on the 2004 outlook are available online at the following address: www.fapri.iastate.edu/outlook2004/ (viewed, May 3, 2004).

Several commodities covered by the FAPRI model are relevant to the Malian agricultural sector. These include: wheat, rice, sorghum, maize, cotton, sugar (component of the agro-industrial product category), beef, poultry and milk.

3.3.2. IFPRI Baseline Projection: The IMPACT Model

The International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) is IFPRI's simulation laboratory for alternative global food demand, supply and trade scenarios. It is a multi-region and multi-product, competitive markets, partial equilibrium model, covering the quasi-totality of world food production and consumption. A summary discussion of the IMPACT model is available in Rosegrant et al. (2001). There are two IFPRI price projections, one assuming the status quo in terms of trade and agricultural policies (IFPRI-1) and the other assuming a full liberalization of the world commodity markets (details are available below, and in a summary table later in this section).

Nine out of the 16 IMPACT commodities are relevant for the analysis undertaken in this study: wheat, maize, other coarse grains (sorghum and millet), rice, beef (cattle), sheep and goats, chicken, eggs and milk. Baseline assumptions in the IMPACT model generally refer to modest population and income growth. The model also hypothesizes a structural shift in food consumption from main staples to more processed and high-value livestock products, due to a combined effect of urbanization and improved incomes. These changes are accounted for in assumed income and price elasticities in the IMPACT model.

Like in the other projection models, world commodity prices are endogenously determined. Trade and domestic agricultural policies are modeled in the form of

producers and consumers subsidy equivalents, expressed as a percentage of world prices. These policies are maintained at their base level in the IFPRI-1 (status quo) scenario. The producer and consumer subsidy equivalents are effectively set to zero in the IFPRI-2 (full liberalization) scenario. The IMPACT model also accounts explicitly for expected change in agricultural productivity, given historical changes in the use of productivity-enhancing inputs and in the level of public investments in agricultural research and rural infrastructures.

3.3.3. OECD Baseline Projection: The AgLink Model

Projections are made to 2008 and represent what the Organization calls "a plausible medium-term future for the markets of key commodities" (OECD, 2003. p. 3). The projections are said to reflect the combined knowledge and expertise of experts in OECD member and non-member countries. The projection process is highly interactive, involving several exchanges between OECD member countries and the Secretariat (Uebayashi, 2000). Like in previous baseline projections, OECD projections are based on several assumptions regarding: (i) the existing or expected agricultural and trade policies in OECD and major non-OECD countries, (ii) the existing and expected evolution in underlying macroeconomic environment, and (iii) other developments in members and non-member countries. Like the FAPRI scenario, the OECD projections may be viewed as representing some level of increased (but incomplete) liberalization of the world commodity markets.

OECD baseline projections are based on the AgLink model. As in previous cases, AgLink is a multi-country, multi-commodity partial equilibrium model, with focus on temperate agricultural products relevant to OECD countries. Prices are the equilibrating

variables in the model, allowing the global market of each commodity to clear. Commodities covered in the OECD projections that are relevant to the Malian study include: wheat, coarse grains (maize, millet and sorghum), rice, sugar and vegetable oil (key components of agro-industrial products), beef, poultry, sheep and goat and milk.

OECD analysts acknowledge the existence of uncertainties associated with any outlook of the agricultural markets. Thus, the Organization's projections may be subject to some important uncertainties in the short run. OECD (2003) identifies these uncertainties to include: (i) unfavorable geopolitical environment of low growth in Europe and Japan, (ii) the growing twin deficits (budget and trade) in the US, and (iii) the slow down of global agricultural trade liberalization with the maintenance of high level of trade distorting support and protection to agriculture. All these factors are expected to reduce trade volume and keep agricultural prices at lower levels, with a possibility for increasing price volatility. Though OECD did not account for these uncertainties in their 2003-2008 projections, they may be reflected to some extents in IFPRI-1's conservative projections discussed earlier.

3.3.4. Summary of Model Assumptions and Projected Changes in World Commodity Prices

Table 3.2 highlights key differences between the four scenarios of change in world commodity prices. Underlying assumptions in the FAPRI and OECD price projection models are very similar. Both models are based on the expectations that the world economy at projection horizon (i.e., end of the 2000 decade) will grow on average by more than 3% annually, which is slightly higher than the average growth rate of the world economy in the base year (1996-1998). The two models also assume more than 1% growth in the world population in 2007-2009, about 20% lower than the population

growth rate in the base period. The two IFPRI scenarios also assume nearly 3% annual economic growth and 1% growth in the population, but these rates remained unchanged between the base and projection periods. In addition, the rate of urbanization is expected to accelerate over time, and this would shift consumption toward livestock and high-value food products. The accelerated urbanization assumption is not explicit under the FAPRI and OECD scenarios, but the two models expect that major world currencies will appreciate against the US dollar (the IFPRI models have no explicit assumptions on the exchange rate). All the four models assume that the climatic conditions will remain at their historical averages, although only the FAPRI model states this explicitly.

Agricultural and trade policies assumed under the FAPRI and OECD are also substantially similar. The two models assumed that current policies will remain in place over the projection horizon. In particular, they assume no change to the provisions of the 2002 US farm bill, the 2003 reforms of the European Union (EU) Common Agricultural Policy (CAP), the changes brought about by the enlargement EU to new members, and agricultural policies in other parts of the world. Regarding trade policies, the models are based on the trade reforms committed to by countries under the WTO's Uruguay Round Agreements on Agriculture (URAA). The commitments relate to limitations in the use export subsidies, expansion of tariff rate quotas, reduction of import duties, and cuts in domestic support programs. The main difference between the FAPRI and OECD models lies in the difference in commodity coverage and the magnitude of committed policies. Also, the OECD model explicitly assumes increased production efficiency over time, but this is not explicit in the FAPRI model. The two IFPRI models also assume that farm productivity will grow at a declining rate over the projection period.

Table 3.2: Key Assumptions in the Price Projection Models

Criteria	Key Projection Assumptions			
	FAPRI	OECD	IFPRI-1*	IFPRI-2
World economic growth				
2007-09 annual average growth rate	3.2%	3.2%	2.9%	Same as in IFPRI-1
Change in annual growth rate From 1996-98 to 2007-09	+ 4.2%	+ 12.2%	0.0%	
World population growth				
2007-09 annual average growth rate	1.1%	1.3%	1.0%	Same as in IFPRI-1
Change in annual growth rate from 1996-98 to 2007-09	- 19.7%	- 24.8%	0.0%	
Urbanization	Not explicit	Not explicit	Accelerated Urbanization	Same as in IFPRI-1
Currencies	Most currencies will appreciate against USD	Same as in FAPRI	Not explicit	Same as in IFPRI-1
Climatic conditions	Average	Not explicit	Not explicit	Not explicit
Agricultural policies	Include: - Provisions of the 2002 US farm bill are maintained (provisions set to expire in 2007 are extended through projection period); - Provisions of the 2003 reform of EU common agricultural policy; also account for EU enlargement; - Maintain other ag. policies	Similar to FAPRI's agricultural policies	Maintain producer and consumer subsidy equivalent (PSE and CSE) of the base year (1997)	Producer and consumer subsidy equivalent are eliminated
WTO Agreements (Uruguay Round Agreements on Agriculture)	In developed countries, maintain the 2000 level of current policies (export subsidy limits, tariff rate quota expansion, import duty and domestic support reductions); in developing countries, continue implementation of WTO commitments through 2004, and hold them fixed afterward.	Continuation of existing policy reforms and URAA commitments	No explicit reference to WTO agreements; however, trade policy reforms are implicit in the PSE and CSE measures.	Same as in IFPRI-1
Productivity	Not explicit	Increased farm productivity	Positive, but declining crop yield growth	Same as in IFPRI-1
Reference to further details	FAPRI (2004)	OECD (2004)	Rosegrant et al. (2001)	Rosegrant et al. (2001)

* The GDP growth rates for the two IFPRI scenarios indicate the 1997-2025 yearly averages. There is no change between the base year (1997) and the projection period (2025). The population is projected to grow from 5,788 in 1997 to 7,456 million in 2025, an equivalent of 1% yearly increase.

Source: Based on references indicated in the table.

Regarding the two IFPRI models, agricultural policies are captured through the aggregate producer and consumer subsidy equivalents. These subsidies, which create a price wedge between domestic and world prices, are completely eliminated in the IFPRI-2 full liberalization scenario. IFPRI trade policies are less explicit in terms of WTO trade reforms, but they are implicit in the implementation of the agricultural policy reforms (i.e., maintaining or eliminating the producers and consumer subsidies).

Projected price changes from the five models are compiled in Table 3.3. The changes are expressed with respect to the base year (1997). The projection year is 2009 for FAPRI, 2008 for OECD, and 2020 for IFPRI projections. As explained earlier, price projections to 2020 in IFPRI models do not deviate substantially from what these projections would be around 2010. For both the base (1997) year a three-year average price was used to reduce year-to-year variability in the base year prices. To be consistent with the base year average prices, a three-year average was also used for the projected prices. Price variability was not an issue with the projections, which assume parsimonious changes in underlying economic conditions. Even though the models do not assume any change in price variability with the implementation of the trade accords, policy makers in Africa do continue to be concerned about the volatility of world prices and are concerned about how the trade accords may affect that volatility. Unfortunately, that issue cannot be addressed with these models.

Table 3.3 suggests that most prices, particularly grain prices, are projected to decline. The magnitude of projected changes varies depending on commodities and projection models, but the direction of change for most commodities was consistent across projection sources.

Table 3.3: Projected Changes in World Commodity Prices with Four Projection Models (percent change between 1996-98 and 2007-2009*)

Commodities	Price Projection Models			
	FAPRI	OECD	IFPRI-1	IFPRI-2
Cattle	9.7	14.6	19.8	40.7
Chicken	1.3	7.5	..	..
Cotton	-20.3	..	..	..
Maize	-24.3	0.6	-23.4	-16.7
Milk	-29.9	-0.9	-3.2	-3.8
Millet	-16.6		-31.1	-25.5
Rice	-25.7	-18.7	-25.1	-14.7
Sheep and Goat	..	..	17.4	39.6
Sorghum	-16.6	..	-31.1	-25.5
Wheat	-18.4	-3.6	-31.2	-25.6
Agro-industrial products	-25.9	-23.8	..	..

Note:* Changes are expressed with respect 2020 (IFPRI) and the 2007-08 average (OECD)
Source: Based on projection data from various sources (discussed in the text and available online for each of the three institutions that publish price projection data).
Source: Based on references indicated in the table.

Cereal prices are projected to fall under all scenarios, except in the OECD scenario, where the price of coarse grains will remain practically unchanged. Livestock prices would increase under all scenarios, with higher increase in the IFPRI (particularly the IFPRI-2) scenarios. Cotton prices are expected to fall by 20% under the FAPRI scenario. Like the border protection regimes (Section 3.2) and the government policies (next section), each of the four prices projections would represent a scenario of changes in world commodity prices.

3.4. Government's Trade and Fiscal Policies

Several trade and fiscal policy instruments are available to the Malian government. Among them, import tariffs constitute the single major trade policy instrument available not only to the Malian government, but also to almost all governments in the developing world. In addition, the Malian government may use export taxes and export bans on selected commodities. The main fiscal policy instrument is the value-added or domestic sales tax, which is applied to both imported and domestically produced commodities. Other duties and taxes are also possible. These include

production factor taxes and direct taxes on domestic institutions. Finally, government policies may involve changes in the level of public investments. As discussed in Chapter II (Figure 2.1), such investments are critical in financing public goods necessary to improve agricultural productivity.

Although one can simulate the effects of changes in indirect domestic sales taxes, their application in the Malian context is not realistic because most of the sales of domestic output take place in hard-to-tax channels of the economy. Also possible are simulations involving direct taxes on factors and domestic institutions, such as households and firms. But these taxes are less relevant for this study, which is primarily concerned with commodity-based policies. Thus, the study will focus on three instruments: changing import tariffs, imposing export bans on cereals, and changing the level of public investments. Changes in import tariffs are a direct result of ongoing trade reforms in West Africa and the rest of the world. Cereal exports may be banned, as these bans are politically attractive in Sahelian countries, such as Mali, that are highly prone to sudden production shortages due to drought. Imposing export taxes on cereals is not explicitly examined in this study because the idea of such taxes would be inconsistent with the Malian Cereal Market Reform Program (PRMC). The PRMC is a nationwide initiative aimed at improving farmers' incomes through a strengthening of the workings

of cereal markets in Mali.[15] Finally, changes in productive public investments will affect production possibilities, and thereby incomes and food security in the country.

Import tariffs

Since January 2000, Mali has switched to a common external tariff (CET) system. The CET is implemented within a customs, monetary and economic union that includes Mali and 7 other West African countries that are members of the West African Economic and Monetary Union (Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Niger, Senegal, and Togo).

The CET regime harmonizes the rate of tariffs applied to extra-WAEMU imports, while eliminating intra-WAEMU tariffs. Imports from the rest of the world are classified into four categories, denoted 0, 1, 2 and 3. Tariff rates of 0%, 5%, 10% and 20% respectively, apply on each of these four categories. The average CET rates applied to imported goods and services considered in this study are different from the four rates indicated above, due mainly to differences in commodity aggregation.

Decaluwé, Dissou and Robichaud (2000) computed the average CET rates applicable to non-WAEMU imports in Mali, based on insights from the expert's commission of the union. A summary of these tariffs is shown in Table 3.4. The original

[15] In a recent review Dembélé, Staatz and Weber (2003) show that the PRMC had led to major improvements in farmers' incomes in Mali. Imposing export taxes would most likely erode the benefits derived from improved market efficiency associated with the program since the 1980s. Thus, the Malian government is unlikely to impose such a regressive tax, which, besides the economic costs, could also bear high political costs both nationally (with the farmers' constituency) and internationally (with the donor community, which has lent a tremendous support to the Malian market policy reforms). Some may argue that banning cereal exports is equally regressive, and that such a scenario does not constitute a plausible policy choice in Mali over the next decade. While this argument has some merits, this study takes the stand that cereal exports may be banned in periods of national grain shortage following adverse climatic shocks. The ban has the clear objective to redirect all exports towards domestic consumption, which is the desired goal of the government in period of shortage. Conversely, grain export taxes will still maintain some level of exports, unless the tax is set at a level high enough to make exports economically not profitable compared to selling the products in the domestic markets. Such a prohibitive tax would, therefore, be equivalent to a ban on exports.

figures appear by broad commodity groups, such as food crops, industrial agriculture, livestock, fish and forestry, mining, food and textile industries, and public utilities. Each of these broad categories corresponds to one or several commodities covered in this study. For example, the CET on food crops imports was 8.7%. This rate was maintained for all commodities produced from food cropping activities and which were traded outside West Africa (ECOWAS) in 1997. Based on the Malian Social Accounting Matrix (see Chapter V), eligible products include maize, roots and tubers (such as potatoes, yam and cassava), beans, other crops (mainly fruits and vegetables), and rice.

Table 3.4 Common External Tariffs on Imports from the Rest of the World (%)

Commodities	Common External Tariff (CET)
Maize	8.7
Roots and tubers (potatoes, yams, cassava)	8.7
Beans	8.7
Other crops	8.7
Rice	8.7
Tobacco	5.1
Wheat	5.1
Eggs	5.0
Milk	5.0
Firewood	10.1
Furniture wood	10.1
Fresh fish	10.1
Agro-industry & beverages	14.7
Textile	19.0
Other manufacturing goods	12.9
Electricity, water and energy	8.7
Transport & telecom services	8.7
Bank and insurance services*	15.0

Notes: CET rates were available for broad categories of commodities, such as food crops (maize, roots and tubers, beans, other crops and rice), industrial agriculture (tobacco and wheat), livestock (eggs and milk), fishery and forest products (woods and fish), food industry (agro-industry and beverages), textile industry (textile), metal industry (construction and public works), public utility (electricity, water and energy, and transport and telecommunication), and other industry (other manufacturing goods).
* Rate taken from IMF (2004)
Source: Adapted from Decaluwé, Dissou and Robichaud (2000)

The CET reform scenario is implemented in this study by setting the rates on relevant non-West African imports to those indicated in Table 3.4. These rates are set to zero on West African imports. With one external sector, the Malian CGE model uses an

aggregate CET tariff, which is computed as a weighted average of the West African and non-West African tariffs under the CET regime (the weight being the respective shares of West African and non-West African imports in total imports.) The CET simulation is run by substituting the aggregated import tariffs to the base tariffs that calibrated from the Malian data.

The CET rates available in Decaluwé, Dissou and Robichaud (2000) are exclusively based on trade activities between Mali and other WAEMU members. In this study, the definition of "West Africa" is not restrictive to WEAMU. Instead it refers to the larger group of the 15 country members of the Economic Community of West African States (ECOWAS). The WEAMU CET is assumed to be representative of the entire West African region.

Cereals Export Ban

The Malian data suggest that there were exports of millet, sorghum and maize to West Africa in the base year. One of government trade policy options is to ban these exports. One is interested in knowing how such a ban would affect welfare and food security in the country. The question is investigated by implementing a scenario of cereals export ban, in which exports of millet, sorghum and maize are effectively set to zero.

Change in Public Investment

A final possible action of the government is to allow for changes in public investments. As discussed earlier, such investments may improve agricultural productivity through a possible reduction in the prices of intermediate inputs. The SAM (Chapter V) shows that food production activities consume some government services

(such as agricultural research and extension) as intermediate inputs. Thus, increasing public investments in these services would positively affect their intermediate use in food production activities.

The implementation of the change in public investments scenario is based on real investment data from the World Development Indicators (WDI) (World Bank, 2004). The WDI data indicate that real investments in Mali increased on average by 5% over the period 1990-2002. A cumulative increase between the base year (1997) and the projection year (end of the 2000 decade) may be assumed to be approximately 50%. This rate is therefore used in this study to investigate the effects of potential change in public investments on welfare and food security in Mali. Given the general equilibrium framework used in this study, the increased public investments will be generated through either increased government savings, or increased foreign transfers, or both. Details on this type of macroeconomic closure are discussed in Chapter IV on the computable general equilibrium model.

From the Malian social accounting matrix (Chapter V), public investments were made in four goods (other manufacturing goods; buildings and public works; transport and telecommunication; and nontraded services). Since there were also private investments in the first two goods, the 50% increases in public investments will materialize into lesser increase in total investments on these two goods (22.5% for other manufacturing goods, and 15.1% for buildings and public works). The increased investments will be fully transmitted to transport and telecommunication and non-traded services into which private institutions did not invest in the base year, according to data

in the Malian social accounting matrix. The various magnitudes of changes in public investments will be accounted for in the simulation.

3.5. Scenarios Summary and Conclusion

All the scenarios discussed in this chapter are presented in Table 3.5. In addition to the base scenarios, there are four possible changes in the border protection facing key Malian exports; four possibilities of change in world agricultural prices; and three possible scenarios of government trade and fiscal policies. The combination of the three sources of changes results in 48 possible reform scenarios, which is clearly intractable. This number can double or even triple, if one takes into account the usual sensitivity analyses performed with computable general equilibrium models. It appears that there is a need to trim the number of scenarios, so as to facilitate the communication of the simulation results. One obvious way to reduce the scenarios is to focus on only two (instead of four) scenarios of border protections, one for the duty-free access (DFA) and the other for the erosion of existing preferences (EEP) market access regimes. This is because the difference between the "Quad" and "All" DFA and EEP scenarios lies in the assumed level of the EEP (or MFN) tariffs. Using the "Quad" or "All" EEP rates would change the quantitative estimates, but not the qualitative effects. In any case, quantitative estimates depend on many other factors (e.g., model parameters), so the emphasis should be put on qualitative effects. These effects will be captured a single rate, in this instance the "Quad" EEP tariff rates for DFA and EEP market access regimes.

Another way to trim the number of scenarios is to focus on individual scenarios and to compare the results with the base year scenario. Focusing on the individual scenarios will not only reduce the number of simulations to nine (EEP, DFA, FAPRI,

IFPRI-1, IFPRI-2, OECD, CET, BAN, and GINV), it will also allow cross-scenario comparisons and tests of some key hypotheses regarding trade reforms in Mali. At least four comparisons can be identified.

Table 3.5: Summary of Trade Reform Scenarios

Changes in Border Protection in Exports Markets	Changes in World Prices	Changes in Trade and Fiscal Policies in Mali
1. Base (calibrated)	1. Base (calibrated)	1. Base (calibrated)
2. Duty-free (based on mean EEP, Quad)	2. FAPRI	2. CET
3. Duty-free (based on mean EEP, All)	3. IFPRI-1	3. Export bans
4. EEP tariffs (using mean EEP, Quad)	4. IFPRI-2	4. Increase in public
5. EEP tariffs (using mean EEP, All)	5. OECD	investments (50%)

Source: Based on the discussions in Sections 3.2, 3.3 and 3.4 of the present chapter.

First, the base scenario, which calibrated from the Malian data, roughly represents a situation of no implementation of WTO trade reforms. Second, the base scenario may be compared with prices changes scenarios under partial liberalization of world agricultural markets (FAPRI and OECD) or full liberalization of these markets (IFPRI-2). These two comparisons would inform on the impacts of the so-called North-South trade expansion on welfare and food security in Mali. This is because trade reforms under these price change scenarios would originate from the rest of the world, but the changes in world commodities prices will be transmitted to the Malian economy (Mali being a country in the South). Third, the base scenario may also be compared to the CET regime, which will inform on the potential impacts of South-South trade liberalization. Fourth, the impacts of South-South trade liberalization (the CET regime) may be compared with the impacts of the North-South trade expansion, whether the expansion comes through a partial (FAPRI and OECD) or a full trade liberalization of the world commodity markets. A test of the impacts of a combined South-South and North-South trade liberalization is also possible.

As indicated earlier, it is impossible to exhaust all possible scenarios, so the study has emphasized the use of the most plausible scenarios among a nearly infinite number of possibilities. There is tremendous room for adding more scenarios, particularly as they are tailored to specific needs. For example, many more world commodity price projection models are available in the literature (for a review, see Tongeren and Meijl, 1999). Also, we have selected a limited number of government trade and investment policies. While the selected policies capture plausible government choices, alternative policies remain possible. For example, domestic sales taxes/subsidies can potentially play an important role in the Malian economy. They can be used to strike a balance between changes in consumer and producer prices as world commodity prices change. [16]

The reliability of trade reform scenarios presented in the chapter depends on the reliability of assumed changes in border protection and government policies, and in projected changes in world agricultural prices. All price projections are based on the best conjecture experts can make about the future. But not all future outcomes can be projected. Thus, the scenarios will still be characterized by some elements of uncertainty. Nevertheless, they will help see clearer through the future, even if they do not offer a perfect image of that future.

[16] This dual role of commodity (food) prices is the source classical "food price dilemma" (Timmer, Falcon and Pearson, 1983). The dilemma arises when a single price instrument is used to try to secure remunerative revenues to producers and maintain affordable prices for consumers. Facing falling commodity prices (e.g., for cereals), the government may use indirect taxes on domestic sales to raise the consumer price, generate tax revenues that can be used to increase producer prices. Similarly, the government may reduce the level of domestic sales taxes when commodity prices rise (e.g., for livestock products), partially shielding consumers from the price rise effect, thus maintaining a demand for the domestic production. These various price stabilization mechanisms could be investigated in the Malian context with an appropriate database that isolates sectors (often modern) where domestic sales taxes/subsidies can be realistically implemented. This current database does not allow such implementation.

CHAPTER IV: A COMPUTABLE GENERAL EQUILIBRIUM MODEL FOR TRADE REFORM ANALYSIS

4.1. Introduction

Among the numerous tools available for economy-wide policy analyses, computable general equilibrium (CGE) models have proven to be one of the most valuable (Dervis, de Melo and Robinson, 1982; Sadoulet and de Janvry, 1995; Wobst, 2001; 2002). It is now well accepted that CGE models "have become a standard tool of empirical policy analysis" (Lofgren, Harris and Robinson, 2002; p. 1). In particular, trade is one of the policy areas that have received a tremendous amount of attention in terms of CGE modeling (Devarajan and Robinson, 2002).

This study uses the standard CGE framework, which follows the usual single country, open economy trade model developed in the classical work of Dervis, de Melo and Robinson (1982). This chapter presents the characteristics of the CGE model applied to the Malian economy. The next section offers an overall discussion of the Malian CGE model in the context of the literature. Section 4.3 elaborates on the structure of the model and presents key equations, putting emphasis on the innovations introduced in this study. This section also discusses the macroeconomic closures of the CGE model. A supplement to Section 4.3 is available in an appendix which details all the model's equations. Section 4.4 summarizes and concludes the chapter.

4.2. The Malian CGE Model in the Context of the Literature

The basic theoretical framework of the Malian or other CGE models is a competitive market equilibrium that satisfies Walras' law (Decaluwé and Martens, 1988).

Producers are assumed to maximize profit using a concave production technology; consumers maximize utility; and factors are remunerated at the margin, with factor payments equal to their marginal-value product.[17] Only relative prices matter, and market clearing conditions allow instantaneous and simultaneous price-adjustment between supply and demand. Thus, the model is not dynamic in the classical sense that current decisions affect future states of economic variables.

This theoretical foundation can be applied using either a classical approach to trade with direct specification of production and consumption behaviors[18] (e.g., Bamou, 1998; Wobst, 2001; 2002), or a dual approach to trade (e.g., Beghin, Bureau and Park, 2003) as systematized in Dixit and Norman (1980) and widely used in many applied trade models such as Anderson and Neary (1996) and Anderson (1997). The dual approach represents technology with a production cost function, and consumption by an expenditure function. In practice, the classical approach allows for a more complete mapping of the economy, with a richer set of institutional details and interactions, than a typical dual representation.[19]

Following the modern use of the classical approach, the Malian model incorporates specific country characteristics into the standard CGE model to deal with structural rigidities. Incorporating these rigidities into the classical model transforms it

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[17] This standard neoclassical technology excludes the existence of a scale economies in the Malian production sectors, though cotton production and marketing in the country may present some features of scale economies. It is expected, however, that the standard technology will characterize the essential features of all production in Mali.

[18] This is the representation used in the Dervis, de Melo and Robinson's (1982) seminal literature. This is also the essence of substantial applied macroeconomics modeling efforts by the Trade and Macroeconomics Division (TMD) of the International Food Policy Research Institute (IFPRI). For details, see www.ifpri.org.

[19] It is, however, possible to incorporate these details into a dual representation, even if existing applications, such as Beghin, Bureau and Park (2003) or Anderson (1997) tend to use a multi-market or a CGE framework with no institutional details and typically impotent cross-sector interactions.

into a so-called "neoclassical structuralist" model. Structural rigidities of interest include an explicit accounting of households' home consumption, as in Wobst's (2002) study of five Southern African economies. This specific feature is relevant for agrarian economies, such as Mali, where many poor rural households may be unable to participate in the global markets for food, due to a lack of effective demand. By altering the relative incentive to produce for home consumption, trade reforms may still affect welfare and food security in these poor rural households.

The neoclassical structuralist CGE model also incorporates imperfect Armington constant elasticity of substitution (CES) on the demand side and imperfect Powell and Gruen's constant elasticity of transformation (CET) on the supply side.[20] This allows for substitution between domestically produced and externally traded goods. In addition, and contrary to Wobst (2002) and following Wobst (2001) and several other studies, this study uses a highly disaggregated sectoral representation of the Malian economy. The highly disaggregated framework increases intra-sector homogeneity, permitting a more accurate evaluation of the impact of trade reforms on each of the producer and consumer groups.

Closely related to this study is Beghin, Bureau and Park's (2003) investigation of the food security implications of agricultural protection in South Korea. This study covers three important aspects. First, the authors use the trade restrictiveness index (TRI) to evaluate the welfare cost and trade implications of agricultural policies (tariffs, price support, input subsidies, and consumption taxes) in the country using a multi-market dual approach following Anderson and Neary (1996). Second, they measure the restrictiveness

[20] Despite the price-taking behavior of countries, export supply will remain positively elastic, an essential feature of the neoclassical structuralist specification based on the Powell-Gruen's CET function.

of South Korean agricultural policies using Anderson and Neary's (2000) mercantilist indicator of trade restrictiveness index (MTRI). This indicator measures external costs of trade restrictions, an objective not addressed in this study. Third, they estimate the second-best optimal use of policy instruments (consumption taxes and production subsidies) that can help achieve (i) self-sufficiency in each of the staple crops and meat, and (ii) self-reliance, based on predefined targets of imports and productions of various sets of commodities.

The model proposed in this study can also provide information on the cost (in terms of welfare and food security) of the existing structure of protection in Mali, where the range of available policy instruments is likely to be narrower than in South Korea. As indicated earlier, input, factor and output tariffs or taxes seem to be the most likely policy instruments that the Malian government can use, though there may be occasional exceptions.[21] In addition, it is also possible to obtain an optimal second-best structure of tariffs that is necessary to achieve national food security, defined not as a self-sufficiency target but as a self-reliance target where both domestic production and imports play a critical role.

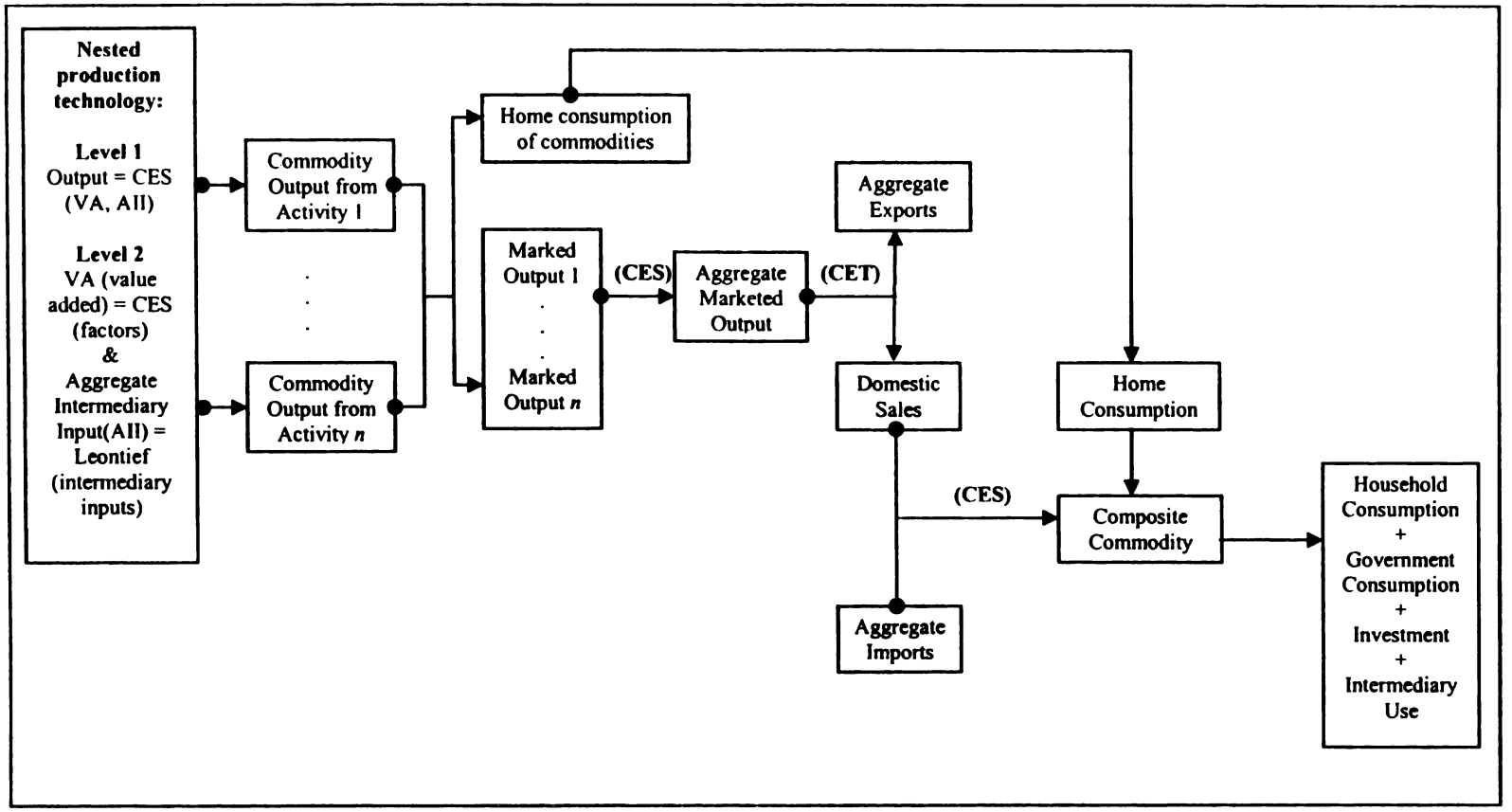
Despite the similarities, this study has some fundamental differences with the Beghin, Bureau and Park approach. First, due to the relatively small contribution of agriculture in the Korean economy (about 10% of GDP), Beghin, Bureau and Park have emphasized details in the agricultural sector, which were assumed to be separable from

[21] Other policies, such as quantitative restrictions, are illegal under WTO, although the Malian government may occasionally use them. The use of input subsidies is not compatible with bilateral and multilateral financing arrangements with, among others, the World Bank and the International Monetary Fund. WTO-legal policies, such as the "green" and "blue" boxes policies are feasible, provided governments have enough resources to invest in infrastructure, education, research, and market information systems, which are some of the policy elements allowed under these boxes. The CGE model will capture the effects of public investments through linkages with agricultural production (see illustration in Figure 2.1, Chapter II).

the rest of the economy. These linkages cannot be easily ignored in Mali, where agriculture contributes more than one-third of GDP, with an even more important contribution to labor employment. Agricultural production interacts significantly with the rest of the economy, and these interactions must be captured in a model such as the neoclassical structuralist framework adopted in this study. Second, their study is based on the representative economy model, which is silent on distributional issues. The model proposed here addresses this limitation by distinguishing several household groups in the Malian economy. Third, while their research focuses on government policy instruments, this study considers two additional sources of changes, namely, WTO-induced changes in commodity prices and changes in border protection facing Malian exports.

4.3. Structure and Equations of the CGE Model

The neoclassical structuralist model is very standard and there is no need to present it in detail in this chapter. Both the classical book by Dervis, de Melo and Robison (1982), and other references such as Lofgren, Harris and Robinson (2002) thoroughly discuss the structure of the model and document the complete set of equations. This section presents the overall structure of the Malian CGE model (Figure 4.1) which is similar to standard model in Lofgren, Harris and Robinson (2002). Appendix 4.1 provides a complete listing of equations, variables and parameters. Equations are divided into 4 blocks: prices, production and trade, institutions, and system constraints.



Notes—CES: Constant Elasticity of Substitution; CET: Constant Elasticity of Transformation; VA: Value Added; and AII: Aggregate Intermediate Input.

Figure 4.1: Commodity Flows in the CGE Model with Regional Differentiation of the Export and Import Sectors (adapted from Lofgren, Harris and Robinson, 2002; p. 12).

Prices

The price block is represented by a system of 10 equations for imports (Equation 4.1), exports (4.2), the demand price of domestic non-traded goods (4.3), the absorption (4.4), the value of marketed output (4.5), activity price (4.6), aggregate intermediate input price (4.7), and activity revenue and costs (4.8); there are also equations representing the consumer price index (4.9) and the producer price index for non-traded marketed output (4.10). While all these equations are documented in Appendix 4.1, an example is shown below:

$$(4.1) \qquad PM_c = pwm_c.(1+tm_c).EXR + \sum_{c' \in CT} PQ_{c'}.imc_{c'c}$$

Equation (4.1)[22] illustrates how the import price in local currency for commodity c (PM_c) is determined from the exogenous world prices of commodity c (pwm_c) using import tariffs (tm_c), the exchange rate (EXR), and the marketing margins incurred for moving the commodity from the border to the end user, represented by the last term in the right hand side of Equations (4.1). Marketing costs depend on the units $icm_{c'c}$ of other commodities (c') used in moving the good c from the border to the demander, c' being valued at composite commodity prices $PQ_{c'}$.

Production and Trade

Commodities are produced using a two-level nested technology. At the base of the technology tree, production factors are combined into value-added using a CES technology, whereas intermediary inputs from each activity are combined into aggregate intermediary inputs following a Leontief aggregation function. At the top level, commodities are generated from a CES combination of value added and aggregate

[22] Equation numbers follow the indexing in Appendix 4.1.

intermediate inputs. While some of these commodities are home-consumed, the remaining are marketed. The marketed output is then CES-aggregated into an aggregate marketed output, which is in turn CET-transformed into exports and domestic sales. Domestic sales are CES-combined with imports to generate the total domestic supply (Figure 4.1).

There are 17 equations in the production and trade block, all of which are detailed in Appendix 4.1. These include the following:

- An activity production function represented by a CES combination of aggregate value-added and aggregate intermediate input quantities (Equation 4.11) and the corresponding first-order condition, which is represented by the ratio of quantities of aggregate value-added and aggregate intermediate inputs (Equation 4.12);
- A CES combination of production factors into aggregated value-added (Equation 4.13) and the resulting first-order condition representing factor demand (Equation 4.14);
- A Leontief demand for aggregate value added (Equation 4.15), and for aggregate (Equation 4.16) and disaggregated (Equation 4.17) intermediate inputs;
- A commodity production (from fixed unit of activities) and allocation of the production to marketed output and home consumption (Equation 4.18);
- A CES aggregation of marketed output from activities to an aggregate marketed output for each commodity (Equation 4.19) and its corresponding first-order condition (Equation 4.20);

- A CET output transformation function of the aggregate marketed output into the aggregated exports and domestic sales (Equation 4.21), the related first-order conditions that show the optimal ratio aggregate exports to domestic supply functions (Equation 4.22), and the requirement that domestic sales and aggregate exports add up to the aggregate marketed output for commodities that are either exported or sold domestically, but not both (Equation 4.23);
- A CES composite supply combining aggregate imports and domestic supply (Equation 4.24), the corresponding first-order condition indicating the ratio of aggregate imports to domestic supply (Equation 4.25), and the condition that the sum of domestic supply and aggregate imports equal the composite supply for commodities that are either non-imported domestic sales or non-produced imports, but not both (Equation 4.26);
- Finally, there is a demand equation of marketing services defined as the sum of marketing margins on domestic sales, imports and exports (Equation 4.27).

All equations mentioned in the production and trade block are directly taken from Lofgren, Harris and Robinson (2002), and are therefore not outlined in this section.

Institutions

The CGE model allows for three domestic institutions (households, enterprises and government) and one foreign institution (ROW). As in previous cases, all the equations in the institutional block are fully documented in Lofgren, Harris and Robinson (2002). These equations refer to: total factor incomes (4.28), factor incomes to institutions (4.29), incomes to domestic non-government institutions (4.30), intra-institutional transfers (4.31), household consumption expenditures (4.32), household

consumption spending on marketed commodities (4.33), households spending on home consumption (4.34), investment demand (4.35), government consumption demand (4.36), government revenue (4.37), and government expenditure (4.38).

The model assumes that households are the only non-government institutions with final consumption of commodities. Preferences are modeled following a Stone-Geary utility function, and the corresponding linear expenditure demand system (LES) is derived for both marketed commodities (Equation 4.33) and home consumption (4.34).

System Constraints and Macroeconomic Closures

System constraints mainly refer to market clearing conditions and macroeconomic closures. Equations in this block refer to market clearing conditions in the factor (4.39) and the commodity markets (4.40). In the Malian model, most factors are location-specific and are, therefore, assumed to be sector-specific. For these location-specific factors, the quantity demanded of each factor will equate fixed supply of that factor, with the equilibrating variable being a factor wage that adjusts to clear the market. There are also flexible factors, such as wage labor, and such factors are allowed in the Malian model to move across sectors and locations in response to relative factor returns.

Regarding commodities, markets clear when there is equality between quantity supplied and quantity demanded of the composite commodity. As discussed earlier in the production and trade block, the composite supply depends on domestic marketed output and aggregates imports. Composite demand is the sum of demands for intermediate use, household and government final consumptions, investment, stock change and trade input use. With the exception of stock change, all the components of the composite demand are defined earlier in the production and trade block.

The current account balance is given in Equation (4.41).

$$(4.41) \qquad \sum_{c \in CMW} pwm_c . QM_c + \sum_{f \in F} trnsfr_{row,f} = \sum_{c \in CEW} pwe_c . QE_c + \sum_{i \in INSD} trnsfr_{i,row} + \overline{FSAV}$$

where $\overline{FSAV}$ represents foreign savings. It is common to treat these foreign savings as fixed, so that a variable real exchange rate adjusts to impose equilibrium in the current account balance equations. An alternative treatment would be to fix the real exchange rate and to flex the foreign savings, which adjusts so that the current accounts are balanced. This study maintains real exchange rate flexibility as standard and performs sensitivity analysis with the alternative specification.

The remaining system constraints in the CGE model refer to government revenue and expenditure balance (4.42), a determination of direct institutional tax (4.43) and saving rates (4.44), and the savings-investment balance (4.45). The saving-investment balance requires that the sum of foreign, private and public savings must equate total investments adjusted with the changes in stocks, both investments and changes in stock being valued at the composite commodity prices. The government balance imposes equality between government revenue, on the on hand, and the sum of government expenditures and savings, on the other. This equation is cleared in the standard model by making government savings endogenous, while fixing the direct institutional tax components of the government revenue. Alternative specifications exist where government savings are fixed whereas institutional direct tax rates vary so that government revenues equate expenditures. Variations in direct institutional tax rates may either be uniform across non-government institutions, or proportional to the initial rates for each institution. In this study, the basic treatment of endogenous government savings

is maintained, as the government policies of interest do not involve changing direct taxes on institutions.

Finally, the specification of non-government institutions' savings (Equation 4.44) is closely related to government savings. In the standard specification, the saving-investment balance is said to be investment-driven in that the value of savings adjusts to fixed levels of real investments. Institutional savings are uniformly adjusted so that total savings are in equilibrium with total investments. Lofgren, Harris and Robinson (2002) discuss four alternative saving-investment closures that are commonly used in the literature. These include: (i) another investment-driven closure similar to the standard specification, with the difference that adjustments in institutional savings are not uniform across relevant institutions, but proportional to initial savings of each non-government institution; (ii) a saving-driven balance in which all non-government saving rates are fixed whereas investments are proportionally adjusted to balance the fixed levels of institutional savings; and two so-called "balanced" investment-driven closures, which have the characteristics of the first two closures mentioned above (uniform and proportional adjustment in savings). In addition, the latter two closures are balanced, in the sense that they do not limit adjustment in absorption to the saving-investment account, but extend the adjustment to public and private consumptions as well.

Lofgren, Harris and Robinson (2002) note that a macroeconomic scenario that combines fixed real investment (i.e., investment-driven saving-investment balance), fixed foreign savings (i.e., flexible exchange rates) and with fixed government consumption (i.e., flexible government savings) "may be preferable to explore equilibrium welfare changes of alternative policies" (pp. 15-16). This combination is consistent with the

objectives of this study, and will therefore be used as the underlying specification in all simulations. Alternatively, sensitivity analyses will be performed with the saving-driven and one "balanced" saving investment closure. Each of the saving-investment closures (including the base closure) will be combined with flexible exchange rates and government savings.

Implementing the balanced macro scenarios requires three additional equations, which are defined in 4.46-4.48. Equation 4.46 defines total absorption as the sum of total household consumption (including home consumption), government consumption, investments, and the changes in stocks. Equation 4.47 and 4.48 define the ratios of investments and government consumptions to absorption, respectively. The last three equations are not necessary when implementing the model with alternative saving-investment closures that are not balanced across all components of absorption. In that case, the first 45 equations of the model form a square system that will lead to a unique general equilibrium solution. The system remains square when the last three equations are included, as they are associated with three additional endogenous variables. The CGE system of equations is solved in GAMS as a mixed complementary programming (MCP) problem, and therefore does not require a specification of an objective function. Alternatively, it can be solved as a nonlinear optimization problem. It this latter case, a dummy objective function is defined as solved subject to all the equations in the model. Details on all the 48 equations are available in Appendix 4.1.

4.4. Summary and Conclusion

This chapter discusses the structure of a neoclassical structuralist computable general equilibrium, which is applied to analyzing the impacts of global agricultural trade

reforms on welfare and food security in Mali. The model is substantially based on a standard CGE framework developed at the International Food Policy Research Institute (IFPRI), referenced in Lofgren, Harris and Robinson (2002). The chapter emphasizes the description of IFPRI's standard model, with some reference to the specificities in the Malian economy. It also discusses the Malian structural specificities in the context of the general CGE literature. The chapter finally discusses macroeconomic closures of the CGE model, which will be executed using flexible exchange rate, flexible government savings, and an investment-driven saving-investment balance. Other relevant macro closures are retained for sensitivity analysis.

The CGE model described in this chapter may be viewed as a simulation laboratory for investigating the welfare and food security impacts of various scenarios of global agricultural trade reforms. The model is static, and thus, does not carry any dynamic, inter-temporal effect. It is, however, able to capture the counterfactual impacts of trade reforms over a medium horizon. The framework is adequate for addressing the objectives of this study, but is also sufficiently flexible to accommodate, or be adjusted to, other relevant objectives. As discussed in Chapter VII, further work could focus on modifying the model to make it more dynamic.

CHAPTER V: A 1997 SOCIAL ACCOUNTING MATRIX FOR MALI

5.1. Introduction

This chapter describes the construction of a social accounting matrix (SAM) for the Malian economy. A social accounting matrix is a square matrix that maps key transactions between different accounts in a given economy (Table 5.1). It is a consistent and comprehensive data framework with an economy-wide scope. The SAM is made up of row and column accounts. By convention, row accounts receive incomes that are paid by column accounts. The principle of double-entry accounting, which underlies the construction of SAMs, dictates that the sum of receipts in a given account (the row total) must equal to payments distributed along the corresponding column (the column total).

In practice, social accounting matrices are built from different data sources that are rarely consistent. It is therefore almost always necessary to readjust initial entries to a SAM, in order to make the row totals balance with the column totals. This readjustment is known as "SAM balancing", and standard techniques exist for optimizing that process. This chapter presents one such technique, the cross-entropy method that was developed and widely used by researchers at the International Food Policy Research Institute (IFPRI).

The ultimate goal of this chapter is to produce the so-called "microeconomic SAM" or "microsam" that maps transactions between production activities, commodities, production factors and the economic agents (including West Africa and the rest of the world without West Africa) involved in the Malian economy. In order to construct a microsam that is consistent with standard macroeconomic aggregates of the economy, it

Table 5.1: Structure of a Social Accounting Matrix

Accounts	Activities	Commo-dities	Factors	Enterprises	Household	Govt recur-rent	Govt In-vestment	Saving Invest-ment	ROW	Stock Change	Total
Activities		Marketed output			Home consumed output						Gross output
Commodities	Interme-diate con-sumption	Marketing margin			Final consump-tion	Govt final consump.	Govt investment	Private investment	Exports	Change in stocks	Domestic demand
Factors	Value added								Incomes and transfers from ROW to factors, firms, households and the government		Value added at factor cost
Enterprises			Value added capital								Enterprise income
Household			Value added labor	Distributed profits		Subsidies and social security					Household income
Government Recurrent		Sale taxes, import duties	Factor tax/ income to govt	Surplus to govt, corporate tax	Households income tax, surplus to govt						Govt recurrent receipts
Government Investment								Govt investment			Govt investment
Capital Investment				Firms saving	Household saving	Govern-ment saving			Foreign savings		Savings
Rest of the World		Imports	Factor income to ROW	Surplus to ROW	Household transfers to ROW	Govt transfers to ROW					Payments abroad
Stock Change								Change in stocks			Change in stocks
Total	Gross output	Total commod. Supply	Value added at factor cost	Enterprise expenditure	Household expenditure	Govt expendi-ture	Govt investment	Total Investments	Receipts from abroad	Change in stocks	

Source: Sadoulet and de Janvry (1995); Wobst (2001; 2002); Lofgren, Harris and Robinson (2002) ; Thurlow and Wobst (2003).

is usually standard to assure the consistency of microeconomic entries in the SAM with known macroeconomic aggregates. Therefore, the construction of a balanced "macroeconomic SAM" (macrosam) becomes a necessary step towards building a consistent microsam.

This chapter first describes the structure of, and entries to, a 1997 macrosam for Mali. Second, the chapter briefly presents the cross-entropy SAM balancing method, which is applied to the initial (unbalanced) macrosam. Third, the structure of, and entries to, a 1997 microsam for Mali are presented along with data sources. The third section also discusses characteristics of the balanced microsam, obtained after applying the cross-entropy method to the unbalanced microsam. The last section in this chapter draws the conclusions from this challenging exercise of constructing a consistent social account matrix from the poor Malian data.

5.2. A 1997 Macroeconomic SAM for Mali

The year 1997 was chosen to present the Malian economic transactions within a social accounting matrix framework for several reasons. First, keeping in mind that the macrosam is just a first stage towards the construction of a microsam, we have considered general availability of survey data on microeconomic transactions. Most of the available data (as will be discussed in Section 5.3) were from 1997 or earlier dates. A second reason motivating the choice of 1997 is associated with the medium to long-term forecast horizon that characterizes static general equilibrium models. Thus, it was necessary to pick a base year that was close enough to the 1995 (when the WTO process began) in order to capture the situation of the Malian economy in the early stages of the WTO process. In addition, the base year should also permit the projection of the impacts

of market reform scenarios to a time horizon that reflects the current situation of the Malian economy, bearing in mind the medium-to-long term forecast horizons associated with CGE models.

National accounts for the Malian economy constitute the main source used for the 34 nonzero entries in the 1997 macrosam. These accounts are compiled and published by the national statistical office, the *Direction Nationale de la Statistique et de l'Informatique* (DNSI). Additional information is obtained from auxiliary (unpublished) accounts available with DNSI, and from the *Banque Centrale des États de l'Afrique de l'Ouest* (BCEAO), which is the central bank of 9 West African states. Also, the *Tableau Économique Intégré* (TEI), which is a preliminary data framework on the Malian macroeconomic accounts, was important in finalizing the construction of the macrosam, as the TEI provided key information regarding institutional saving rates, the distribution of factor income to institutions, and transfers between institutions. The TEI, along with other macroeconomic summary tables, are being compiled by DNSI with the assistance of the *Observatoire Économique et Statistique d'Afrique Subsaharienne* (AFRISTAT), an international organization in charge of improving economic statistics in Sub-Saharan Africa in general, but with more visibility in francophone Africa.

Table 5.1 presents the structure of the Malian macrosam, with explanation of transactions between the row (receipts) and column (expenditures) accounts; Table 5.2 shows the 34 nonzero entries in the matrix. The proposed structure of the macrosam has 10 accounts in the row and a similar number of accounts in the column. In addition to activities, commodities and factors accounts, there are 6 institutional accounts (two of

Table 5.2: A 1997 Unbalanced Macroeconomic Social Accounting Matrix for Mali (in million CFAF)

	Activities	Commo-dities	Factors	Enterprises	Households	Govt recurrent	Govt investment	Capital investment	Rest of the world	Stock change	Row Total
Activities		1719077			320311						2039388
Commodities	729045	126500			663356	221564	110893	237200	361610	11170	2461338
Factors	1310343								11097		1321440
Enterprises			153924						5509		159433
Household			1048274	58		28489			58785		1135606
Govt Recurrent		149700	75555	42392	28850				99306		395803
Govt Investment								110893			110893
Capital Investment				130619	60467	123466			24634		339186
Rest of the World		486200	43687	13800	12024	39327					595038
Stock change								11170			11170
Column Total	2039388	2481477	1321440	186869	1085008	412846	110893	359263	560941	11170	

Source: *Direction Nationale de la Statistique et de l'Informatique* (DNSI); *Banque Centrale des Etats de l'Afrique de l'Ouest* (BCEAO); and International Monetary Fund (IMF).

which describe government recurrent and investment transactions), and one account recording changes in stocks. The other four institutional accounts are households, enterprises, saving-investment and the rest of the world. The explanation and sources of these entries are discussed in Appendix 5.1.

5.3. A SAM Balancing Cross-Entropy Method[23]

Balancing a SAM using the cross-entropy (CE) method is now a standard procedure in most SAM-based modeling. The method is formalized in two recent publications by IFPRI researchers (Robinson, Cattaneo and El-Said, 2000; Robinson and El-Said, 2000), but it has roots in both information theory (Shannon, 1948; Theil, 1967) and maximum entropy econometrics (Golan, Judge and Robinson, 1994; Golan, Judge and Miller, 1996). As explained in Robinson, Cattaneo and El-Said (2000), the CE approach has been widely used to estimate social accounting matrices in Eastern and Southern African countries (Botswana, Malawi, Mozambique, Tanzania, Zambia and Zimbabwe), as well as in other countries, including Brazil, Mexico, North Korea and the United States.

Traditionally, balanced social accounting matrices are estimated or updated using the RAS method. This method particularly suits situations where new information becomes available regarding the row and column sums of a SAM, with no knowledge on the new flows between various accounts of the SAM.

The RAS method can be represented as follows. Let **T** be an (n x n) SAM with each entry t_{ij} representing the payment from column account j to row account i. By definition, every row sum of a SAM must equal the corresponding column sum, and this can be represented as follows:

[23] This section is mainly based on Robinson, Cattaneo and El-Said (2000).

(5.1) $$y_i = \sum_j t_{ij} = \sum_j t_{ji}$$

Define **A** to be a SAM coefficient matrix with each entry a_{ij} representing the ratio t_{ij}/y_j. Let **y** be the (n x 1) vector of y_j, it follows from the double-entry bookkeeping convention underlying SAMs that:

(5.2) $$\mathbf{y} = \mathbf{A}\mathbf{y}$$

As **y** changes to **y***, there is a need to obtain a new SAM coefficient matrix **A***, which is close to the original matrix **A**, such that the equation (5.2) holds:

(5.3) $$\mathbf{y}^* = \mathbf{A}^*\mathbf{y}^*$$

Robinson, Cattaneo and El-Said (2000) follow Bacharach (1970) and discuss how the matrix **A*** can be obtained by means of *biproportional* row and column operations on the original matrix **A**. Let $\hat{\mathbf{R}}$ and $\hat{\mathbf{S}}$ be diagonal matrices of elements r_i and s_j, respectively. The *biproportionality* condition can be written as follows:

(5.4) $$\mathbf{A}^* = \hat{\mathbf{R}}\,\mathbf{A}\,\hat{\mathbf{S}}$$

The form of this equation has lent its name to the procedure known as the "RAS" method. By imposing the *biproportionality* condition, one effectively reduces a problem of n^2 unknowns (the n x n cells of a SAM) to (2n-1) unknowns, which are fully and uniquely determined by the (2n-1) independent adding-up restrictions corresponding to the new row and column totals. It therefore is possible to find a unique set of positive elements of **A***, and the elements of $\hat{\mathbf{R}}$ and $\hat{\mathbf{S}}$ can be recovered by iteration.[24]

The cross-entropy method adds more flexibility to the traditional RAS approach. The method can incorporate information regarding not only new row and column totals,

[24] Bacharach (1970) discusses conditions under which a solution exists and Robinson, Cattaneo and El-Said (2000) summarize some of these conditions, including the need that **A** is "connected", that is, all rows and columns must be nonzero.

but also prior knowledge on any part of the SAM. It can also incorporate errors in variables and various forms of constraints to any part of the SAM. For example, a single value of households' factor income can be disaggregated into F*H figures corresponding to the incomes to H types of households from F different factors. Using the CE method, one can impose the restriction that the sum of the F*H factor incomes to households be equal to the aggregate value from the macrosam.

As indicated above, Robinson, Cattaneo and El-Said (2000) have explained that the CE method is built on information theory, as developed by Shannon (1948) and brought to economics by Theil (1967). The main idea is that the expected information value of additional data can be expressed as a Kullback-Leibler (1951) cross-entropy distance *I(p:q)* between the prior (q) and posterior (p) probability distributions of a set of n events.

$$-I(p:q) = -\sum_{i=1}^{n} p_i \ln \frac{p_i}{q_i} \tag{5.5}$$

The objective of the CE problem is to find the set of p_i that minimize (5.5), using information on the prior and the data. With regards to SAM estimation or updating, the problem is to find a new SAM coefficient matrix **A*** that minimizes the CE distance between itself and the prior (or initial and probably unbalanced) coefficient matrix **A**. Let a_{ij}^* and a_{ij} be the respective elements of **A*** and **A**, the minimization problem can be written as follows:

$$\underset{a_{ij}^*}{Min}\left[\sum_i \sum_j a_{ij} \ln \frac{a_{ij}^*}{a_{ij}}\right] \tag{5.6}$$
$$\text{subject to}: \sum_j a_{ij}^* y_j^* = y_i^*; \sum_j a_{ji}^* = 1; \text{and } 0 \le a_{ji}^* \le 1$$

Problem (5.6) does not have a closed form solution, and it needs to be solved numerically, after setting up the Langragian. It is, however, possible to express the optimal solution a_{ij}^{*} as a function of both the Lagrange multipliers λ_i associated with the row and column sums, and the initial coefficient a_{ij}:

$$a_{ij}^{*} = \frac{a_{ij} \exp(\lambda_i y_j^{*})}{\sum_{i,j} a_{ij} \exp(\lambda_i y_j^{*})} \tag{5.7}$$

Robinson, Cattaneo and El-Said (2000) discuss how (5.7) is comparable to Bayes' rule, in which "the posterior distribution [...] is equal to product of the prior distribution [...] and the likelihood function [...], dividing by a normalization factor to convert relative probabilities to absolute ones" (p. 7). Thus, Equation (5.7) may be seen as an efficient information processing rule that satisfies Zellner's (1988) information conservation principle. That is, it does not ignore any of the input information and neither does it produce any false information. The authors also draw on Golan, Judge and Miller (1996) to argue that the CE estimator is consistent and has maximum likelihood properties under some distributional assumptions.

The basic minimization problem in (5.6) can be made richer by incorporating aggregation constraints and measurement errors. For k restrictions, a typical aggregation constraint may be expressed as follows:

$$\sum_i \sum_j g_{ij}^{(k)} t_{ij} = \gamma^{(k)} \tag{5.8}$$

where g_{ij} are elements of a (n x n), zeros-ones[25] aggregator matrix **G** and γ is the value of the macrosam aggregate. Similarly, measurement errors are incorporated as follows:

[25] The ones (zeros) correspond to the cells included (excluded) in the definition of a specific aggregate.

(5.9) $$y = x + e$$

where y is a vector of row sums and x, measured with error e, is the vector of known column sums. The error is expressed as a weighted average of known constants v_{iw}:

(5.10)
$$e_i = \sum_w w_{iw} \cdot v_{iw}$$
$$\sum_w w_{iw} = 1 \text{ and } 0 \leq w_{iw} \leq 1$$

The weights are treated as probabilities, which are estimated together with the elements of the matrix **A***. The estimation procedure used in this study is based on five weights that are symmetric about zero. The minimization problem (5.6) is solved, subject to Equations (5.8), (5.9) and (5.10). The CE procedure is applied to the initial SAM in Table 5.2 and the result is shown in Table 5.3, which is the balanced macrosam for Mali. The figures in parentheses indicate the percentage change between the initial entries in Table 5.2 and new estimates in Table 5.3.

In general, most estimates are within a 5% margin from initial figures. However, a few higher adjustments were necessary, particularly regarding the incomes (+8.6%) and expenditures (-7.3%) of enterprises as well as in the saving rates of households (+20.6%) and the rest of the world (+12.4%). Also noticeable are a 10.5% decline in household income from abroad and a 10.3% increase in the transfers from the rest of the world to the government recurrent account. These various adjustments can be sources of many speculations. For example, firms may be viewed as more profitable than the raw data may suggest, as their incomes increase while their costs fell in the final SAM. Second, households may be underreporting their real level of savings, which would be consistent either with cultural valuation of diffidence in most parts in Sub-Saharan Africa, or with

Table 5.3: A Balanced 1997 Macroeconomic Social Accounting Matrix for Mali

	Acti-vities	Commo-dities	Factors	Enter-prises	House-holds	Govt recurrent	Govt invest-ment	Capital invest-ment	Rest of the world	Stock change	Row Total
Activities		1717633			321873						2039506
		(-0.1)			(0.5)						0.0
Commodities	729931	130195			675463	214458	110889	227132	371967	11170	2471206
	(0.1)	(2.9)			(1.8)	(-3.2)	(0.0)	(-4.2)	(2.9)	(0.0)	(0.4)
Factors	1309575								11085		1320659
	(-0.1)								(-0.1)		(-0.1)
Enterprises			168014						5159		173173
			(9.2)						(-6.4)		(8.6)
Households			1033397	52		25016			52603		1111069
			(-1.4)	(-10.4)		(-12.2)			(-10.5)		(-2.2)
Govt		151152	75560	39205	28850				109521		404288
Recurrent		(1.0)	(0.0)	(-7.5)	(0.0)				(10.3)		(2.1)
Govt								110889			110889
Investment								(0.0)			(0.0)
Saving				121466	72943	127103			27679		349191
Investment				(-7.0)	(20.6)	(2.9)			(12.4)		(3.0)
Rest of the		472226	43688	12450	11940	37711					578014
World		(-2.9)	(0.0)	(-9.8)	(-0.7)	(-4.1)					(-2.9)
Stock change								11170			11170
								(0.0)			(0.0)
Column Total	2039506	2471206	1320659	173173	1111069	404288	110889	349191	578014	11170	
	(0.0)	(-0.4)	(-0.1)	(-7.3)	(2.4)	(-2.1)	(0.0)	(-2.8)	(3.0)	(0.0)	

* Figures in parenthesis show the deviation (in percentage) of the new values from the initial entries. For example, the aggregate marketed output [Activities, Commodities] was reduced by 0.4%, from 1,729,196 to 1,722,160 and so forth.
Source: Author (based on data from Table 5.2)

the fear to pay taxes on declared incomes/savings. Third, foreign transfers to government may be higher than reported, and some of the difference may be thought of as being leaked into corruption channels. Finally, it may as well be that the observed differences are a simple indication of measurement errors associated with some of the flows in the SAM. It is obvious that none of these speculations are formally warranted by the simple exercise of putting together macroeconomic data in a consistent SAM framework. But for the Malian macroeconomic flows in 1997 to pass a basic consistency test, the adjustments are necessary, even if the forces driving them remain unidentified in this study.

All the 34 nonzero entries in the balanced macrosam should, in principle, be used as the right-hand side figures in the aggregation constraints discussed in Equation (5.8). Doing this would be necessary to ensure that entries in the disaggregated SAM (see the next section) add up to their corresponding aggregates in the macrosam. However, the prior disaggregated SAM that was obtained from the best available information (on detailed transactions in the Malian economy) was so highly unbalanced that the cross-entropy minimization problem would not converge, unless less binding aggregate control conditions were imposed. This is further discussed in the next section, which elaborates on the structure, entries and the balancing of the Malian microsam.

5.4. Structure and Entries in the Malian Microsam

Structure of the Microsam

The structure of the microsam is based on the 1997 input-output table for the Malian economy, as well as on the 1997 survey of agriculture. Both the I-O table and the agricultural survey data were obtained from DNSI officials. There were 17 sectors in

the I-O table, and each of them represents one activity in the microsam. There are four cropping activities, two for food cropping (rice; and other food crops), and the other two for industrial agriculture (cotton; and other industrial crops). In addition to the four cropping activities, there are two other agricultural activities: fishery-livestock keeping, and forestry-gathering. The last activity belonging to the primary production sector is mining. The secondary or industrial sector is mapped into five activities (agro-industry, beverage and tobacco; textile; other manufacturing goods; electricity, water and energy; and construction and public works). The remaining five activities describe the service sector. These activities include trade and four other services (transport and communication; other traded services; banking and insurance; and nontraded services). Table 5.4 shows all the 17 activities, along with other accounts in the microsam.

The second category of accounts in the microsam consists of 37 commodities, 25 of which are agricultural. Following the tradition of the Malian national statistical office (DNSI), "agriculture" is broadly defined in this study to include not only crop production, but also livestock keeping, gathering, forestry and fishery activities. Based on the structure of the I-O table, the food cropping activity (excluding rice) produces seven commodities (millet; sorghum; maize; fonio; roots and tubers such as potatoes, yams and cassava; beans; and others). The industrial cropping activity (excluding cotton) produces three commodities (groundnuts, tobacco and wheat). There is one-to-one mapping between rice and cotton production activities and rice and cotton commodities, respectively. The activity "livestock keeping and fishery" produces 10 commodities (cattle; sheep and goats; pork; donkeys and camels; poultry; eggs; milk; hide and skins; fresh fish; and smoked fish), whereas the activity "forestry and

Table 5.4: Structure of the Malian Microsam

Account Category	Account Number	Account Name	Account Description
Activities	1	AFOOD	Food production, excluding rice production
	2	ARICE	Rice production
	3	AINAG	Industrial agriculture, excluding cotton production
	4	ACOTT	Cotton production
	5	ALIFI	Livestock keeping and fishery
	6	AFOGA	Forestry and Gathering
	7	AMINI	Mining
	8	AAIDT	Agro-industry, beverage & tobacco
	9	ATEXT	Textile production
	10	AOMGG	Production of other manufacturing goods
	11	AEWEN	Production of electricity, water and energy
	12	ABBTP	Construction and public works
	13	ATRAD	Trade
	14	ATTEL	Transport and telecommunication
	15	AOTSE	Other traded services
	16	ABISE	Bank and insurance services
	17	ANTSE	Nontraded services
Commodities	18	CMILL	Millet
	19	CSORG	Sorghum
	20	CMAIZ	Maize
	21	CFONI	Fonio
	22	CROOT	Root crops (potatoes, yam, cassava)
	23	CBEAN	Beans
	24	COTHE	Other crops
	25	CRICE	Rice
	26	CGNUT	Groundnuts
	27	CTOBA	Tobacco
	28	CWHEA	Cotton
	29	CCOTT	Wheat
	30	CCATT	Cattle
	31	CSHGT	Sheep and Goats
	32	CPORC	Pork
	33	CDKCM	Donkeys and Camels
	34	CPOUL	Poultry
	35	CEGGS	Eggs
	36	CMILK	Milk
	37	CSKIN	Hide & Skins
	38	CFFIS	Firewood
	39	CSFIS	Furniture wood
	40	CFWOO	Hunting/Gathering products
	41	CWOOD	Fresh fish
	42	CGATH	Smoked fish
	43	CPGLD	Gold
	44	CAIDT	Agro-industry and beverages
	45	CTEXT	Textile products
	46	COMGG	Other manufacturing goods
	47	CEWEN	Electricity, water and energy

Table 5.4: Structure of the Malian Microsam (Continued)

Account Category	Account Number	Account Name	Account Description
Commodities (continued)	48	CBBTP	Construction and public works
	49	CTRAD	Trade services
	50	CTTEL	Transport and telecommunication services
	51	COTSE	Other traded services
	52	CBISE	Bank and insurance services
	53	CNTSE	Nontraded services
Marketing margins	54	MMDOM	Marketing margins on domestic sales
	55	MMIMP	Marketing margins on imports
	56	MMEXP	Marketing margins on exports
Production factors	57	FCAPI	Capital
	58	FWLAB	Wage labor
	59	FIENT	Independent entrepreneurship
	60	FTRAD	Composite factor for trading services
	61	FOUAC	Composite factor for other urban activities
	62	FFCKS	Composite farming factor in Rural Kayes-Sikasso
	63	FFCRV	Composite farming factor in Rural River Region
	64	FFOTH	Composite farming factor in other rural
	65	FORAC	Composite factor for other rural activities
Households	66	HBMKO	Bamako residents
	67	HOURB	Residents in other urban zones
	68	HRUSK	Residents in Rural Kayes-Sikasso Region
	69	HRURV	Residents in Rural River Region
	70	HORUR	Residents in other rural zones
Enterprises	71	ENTRE	Formal enterprises
Taxes	72	GRVAT	Value-added taxes for government recurrent account
	73	GRTAR	Tariff incomes for government recurrent account
	74	GROTP	Other taxes on products
	75	GRFAC	Factor taxes for government recurrent account
	76	GRDTA	Direct tax on institutions
	77	GROTH	Other incomes for government recurrent account
Government Recurrent	78	GRECU	Government recurrent account
Government Investment	79	GINVE	Government investment account
Saving Investment	80	SINVE	Saving investment account
Rest of the World	81	WESTA	West Africa
	82	ROROW	Rest of the world, excluding West Africa
Stock change	83	STCHG	Change in stock

Source: Author.

gathering" produces three commodities (firewood; furniture wood; and hunting and gathering products). The mining activity produces essentially the commodity "gold",

although some national figures show traces of phosphate production in 1997. All the remaining activities each produce each one commodity.

Besides the 17 activities and the 37 commodities, the Malian microsam includes three marketing margin accounts, one for each of domestic sales, imports and exports. It also includes nine production factors, five household types and 6 tax accounts, in addition to the private and public saving-investment accounts, the rest of the world (West Africa and rest of the rest of the world) accounts, and a last account for the change in stocks.

Entries to and Balancing of the Microsam

The entries to each account in the microsam are documented in Appendix 5.2. In order to complete the prior (unbalanced) microsam, it was necessary to use data from various (and often inconsistent) sources. These include the 1997 input-output table, the 1997 national agricultural surveys, the 1997 employment survey, the 1989 and 1994 household consumption and expenditure surveys, the DNSI trade statistics and other auxiliary information. The entries involve two steps. In the first step, the aggregate figures from the unbalanced macrosam were disaggregated into the corresponding micro accounts, based on detailed activity and commodity information in the DNSI database, or on disaggregation assumptions that are outlined in Appendix 5.2. The second step was to readjust the initial entries using the balanced macro aggregates, so that each entry in the new microsam is proportional to the initial entry. The proportionality coefficient is equal to the ratio of the aggregate entry in the balanced macrosam to the corresponding aggregate entry in the unbalanced macrosam. The resulting new microsam is balanced in the aggregate but remains substantially unbalanced in the

details. The disparities are illustrated in Appendix 5.3, which shows to the ratio of column totals (expenditures) to row totals (incomes) for the 83 micro accounts.

The disparities are most acute with the commodity accounts, the highest being observed with grains and livestock products. For instance, the total expenditures by the millet commodity account (made of payments to activities, marketing margins and taxes) cover only 16% of the incomes received in the same account (the incomes are generated from the use of millet as intermediate input, final consumption good by households, and exports while accounting for the changes in stocks). At the other extreme, total expenditures by the gathering/hunting commodity make up more than 8 times the incomes received in the same account (Appendix 5.3). These disparities are mainly explained by the existence of inconsistencies in the various sources of data used to obtain commodities' total supply (expenditures by the commodity accounts) and demand (incomes received in these accounts). In particular, the supply data, which are mainly based on the 1997 I-O table and DNSI's national agricultural surveys, may have been underestimated because of the importance of the traditional sector in the Malian agricultural economy. Most of the transactions in this sector may not be reflected in existing national statistics available with DNSI. Conversely, the demand data that are based on older household surveys, such as the 1989 *Enquête Budget Consommation* (EBC 1989) and the 1994 *Enquête Malienne de Conjoncture Economique et Sociale* (EMCES 1994), may have been overestimated in many instances. This may be partly due to the use of the possibly inflated data from EMCES 1994, which took place less than four months after a historic 50% devaluation of the Malian currency, the CFA franc (CFAF). Though efforts were made to correct for the possible upward bias in the

demand data, using more recent surveys (e.g. the 1999 urban consumption survey in Mali, by the West African Economic and Monetary Union), discrepancies remained important.

There is no unique way of dealing with this problem. Given that the best available information was used in constructing the prior SAM, the readjustment of the disparities was left to the cross-entropy SAM balancing process. This process has the merit of effectively optimizing the use of all information contained in the unbalanced SAM. The drawback in applying the CE method to such an inconsistent base matrix is that the balancing process may sacrifice valuable information on the structure of the economy, a necessary cost for obtaining a feasible solution. The Malian SAM was no exception. The structure of the final microsam (Appendix 5.4) presents structural differences with the initial unbalanced matrix. But given that the initial matrix was itself inconsistent in terms of the transaction flows between accounts, it is unclear which of the balanced and the unbalanced matrices present a structure close to the "true", but unobserved, social accounting matrix for Mali in 1997. The premise throughout this chapter was that whatever this true SAM may be, it is fairly well approximated by the balanced SAM, which makes the best use of all information contained in the prior and unbalanced SAM. The rest of this chapter further discusses the microsam's accounts while presenting the structure of key transactions in the 1997 balanced SAM.

Production Factors

There are nine factor accounts in the microsam (Table 5.4). Factors receive income in the form of value-added from activities, and from the rest of the world. They pay this income to households and to government factor tax account. The choice of the

nine factors was based on the results of the EMCES 94, which provided basic information of the relative shares of each of these factors in the production process of most activities retained in the SAM. The EMCES data was completed with additional information obtained from employment surveys. Due to data limitations, it was not possible to disaggregate factor returns exclusively into standard production factors, such as capital, labor and land. Instead, we retained two standard production factors (capital and wage labor) in addition to seven unconventional (but widely used) composite production factors: (i) independent entrepreneurship, (ii) trading services factors, (iii) other urban factors, (iv) other rural factor, (v) farming factor in Kayes-Sikasso, (vi) farming factor in the River region, and (vii) farming factor in other rural areas. These seven factors are consistent with the notion of "composite production factor", which has been widely used in the literature (e.g., Thurlow and Wobst, 2003). The rationale for using composite factors lies in the impossibility of obtaining accurate information of the shares of each of the classical production factors (land, labor and capital) in the total returns to production activities in either the small-scale farming or to other informal sectors. Returns to such activities are best viewed as an aggregate return to the household composite factors, mainly composed of family labor, but also including other assets such as capital and land.

The seven composite factors included in the microsam inform on both the geographical locations and the socioeconomic groups of active households.[26] Though conceptually different from the five households included in the matrix, they represent unique regional and socio-professional characteristics, and this uniqueness could enrich

[26] The location of these regions is indicated in the next section, which deals with household disaggregation.

Table 5.5: Distribution of the Value-Added Across Sectors

	FCAPI	FWLAB	FIENT	FTRAD	FOUAC	FFCKS	FFCRV	FFOTH	FORAC
AFOOD	0.0	0.0	0.0	0.0	8.6	21.1	21.0	18.7	20.2
ARICE	0.0	0.0	0.0	0.0	1.9	4.4	4.3	6.8	7.3
AINAG	0.0	0.0	0.0	0.0	0.6	2.7	1.6	1.4	1.8
ACOTT	0.0	0.0	0.0	0.0	0.0	21.6	6.3	1.0	10.6
ALIFI	12.4	0.0	0.0	0.0	6.7	0.7	26.1	33.9	1.1
AFOGA	0.0	0.0	0.0	0.0	0.0	2.4	14.1	18.4	0.0
AMINI	0.0	0.0	0.0	0.0	0.0	22.9	0.0	0.0	0.0
AAIDT	0.0	42.9	3.9	0.0	0.0	0.0	0.0	0.0	0.0
ATEXT	0.0	7.0	0.0	0.0	0.0	0.7	0.2	0.0	0.4
AOMGG	11.3	0.1	0.7	0.0	0.4	0.1	0.7	2.6	1.7
AEWEN	0.0	20.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ABBTP	18.6	1.4	19.5	0.0	5.0	2.0	3.0	0.9	7.2
ATRAD	19.9	10.4	19.1	84.6	15.9	16.3	13.7	5.3	28.1
ATTEL	1.7	3.3	29.3	0.0	30.4	0.9	2.9	5.0	5.3
AOTSE	0.0	4.0	20.7	3.1	24.3	4.0	4.8	3.6	13.0
ABISE	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ANTSE	36.2	5.3	6.8	12.3	6.3	0.2	1.3	2.3	3.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 5.6: Distribution of the Value-Added Within Sectors

	FCAPI	FWLAB	FIENT	FTRAD	FOUAC	FFCKS	FFCRV	FFOTH	FORAC	Total
AFOOD	0.0	0.0	0.0	0.0	2.7	36.1	30.3	18.0	12.9	100.0
ARICE	0.0	0.0	0.0	0.0	2.4	29.5	24.4	25.4	18.3	100.0
AINAG	0.0	0.0	0.0	0.0	1.9	47.9	24.5	13.6	12.0	100.0
ACOTT	0.0	0.0	0.0	0.0	0.0	68.6	16.9	1.9	12.6	100.0
ALIFI	14.5	0.0	0.0	0.0	2.5	1.4	43.3	37.5	0.8	100.0
AFOGA	0.0	0.0	0.0	0.0	0.0	9.8	48.3	41.8	0.0	100.0
AMINI	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
AAIDT	0.0	94.5	5.5	0.0	0.0	0.0	0.0	0.0	0.0	100.0
ATEXT	0.0	68.3	0.0	0.0	0.0	21.0	5.6	0.8	4.3	100.0
AOMGG	68.9	0.3	1.6	0.0	0.7	1.0	6.2	14.8	6.6	100.0
AEWEN	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
ABBTP	45.5	1.9	17.2	0.0	3.8	8.0	10.4	2.1	11.0	100.0
ATRAD	16.3	4.8	5.7	12.2	4.1	22.5	15.8	4.1	14.5	100.0
ATTEL	4.6	5.1	28.4	0.0	25.5	4.0	10.9	12.7	8.9	100.0
AOTSE	0.0	5.2	17.4	1.3	17.7	15.8	15.8	7.9	18.9	100.0
ABISE	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
ANTSE	69.3	5.7	4.7	4.2	3.8	0.7	3.5	4.2	4.0	100.0
Total	14.1	8.0	5.1	2.5	4.4	23.7	20.0	13.3	8.9	100.0

Notes to Tables 5.5 and 5.6:

Activities: AFOOD: Food cropping (excluding rice); ARICE: Rice production; AINAG: Industrial agriculture (excluding cotton); ACOTT: Cotton production; ALIFI: Livestock keeping and fishery; AFOGA: Forestry and gathering; AMINI: Mining; AAIDT: Agro-industry and beverage; ATEXT: Textile production; AOMCG: Production of other manufacturing goods; AEWEN: Production of electricity, water and energy; ABBTP: Construction and public works; ATRAD: Trade; ATTEL: Transport and telecommunication; AOTSE: Other traded services; ABISE: Banque and insurance services; and ANTSE: Nontraded services.

Factors: FCAPI: Capital; FWLAB: Wage labor; FIENT: Independent entrepreneurship; FTRAD: Composite factor for trading services; FOUAC: Composite factor for other urban activities; FFCKS: Composite farming factor in Rural Kayes-Sikasso Region; FFCRV: Composite farming factor in Rural River Region; FFOTH: Composite farming factor in other rural; FORAC: Composite factor for other rural activities.

Source: SAM

the impact assessment of various trade reforms simulated in this study. Factor allocation is likely to change in response to trade reforms, and it will be possible to depict these changes in terms of households' location and socio-professional orientations. The two remaining factors—capital and wage labor—also capture other aspects of the production structure in the Malian economy. The distribution of factor incomes is shown below in Tables 5.5 and 5.6. Table 5.5 shows the distribution of what each factor earns across sectors while Table 5.6 shows the distribution of value added in a given sector across factors. Details of these distributions are available in Appendix 5.2 and in the balanced microsam (Appendix 5.4). In general, returns to capital were restricted to six activities in which investments were made, and these returns were assumed to be proportional to the investments. This assumption is reasonable if factor (capital) price equalizes across sectors. The share of wage labor in activities' value added was obtained in most case from employment surveys (e.g. Doumbia and Kamaté, 1997). Aggregate payments to the seven composite factors were obtained as residuals, after paying the returns to capital and wage labor. These aggregate payments are further disaggregated using shares obtained for employment surveys. Essentially, value added was distributed in proportion to employment, under the assumption that that labor productivity is equal across activities.

The distribution of factor incomes to domestic non-government institutions (households and enterprises) is also explained in Appendix 5.2. Following standard practices, it was assumed that the capital factor belongs to enterprises, so that the entire return to this factor goes to these enterprises (with the exception of direct capital incomes to government received in the other government recurrent income account, i.e.

the GROTH account). Enterprises also received payments from other factors, including the "independent entrepreneurship", the "other urban" and the "other rural" factors (Tables 5.7 and 5.8). These three factors, which contribute more than 50% of total enterprise income, are central to production in the informal business sector.

Table 5.7: Distribution of Factor Incomes to Households and Enterprises

	Bamako	Other urban	Rural K-S	Rural River	Rural Other	Enterprise	Total
FCAPI	0.0	0.0	0.0	0.0	0.0	100.0	100.0
FWLAB	39.3	23.9	2.2	9.5	25.1	0.0	100.0
FIENT	18.4	14.6	1.6	16.6	7.7	41.1	100.0
FTRAD	31.9	33.1	5.3	18.5	11.3	0.0	100.0
FOUAC	0.0	67.1	0.0	0.0	0.0	32.9	100.0
FFCKS	0.0	0.0	100.0	0.0	0.0	0.0	100.0
FFCRV	0.0	0.0	0.0	100.0	0.0	0.0	100.0
FFOTH	0.0	0.0	0.0	0.0	100.0	0.0	100.0
FORAC	0.0	0.0	14.2	32.7	13.9	39.2	100.0

Table 5.8: Sources of Income to Households and Enterprise

	Bamako	Other Urban	Rural K-S	Rural River	Rural Other	Enterprise
FCAPI	0.0	0.0	0.0	0.0	0.0	46.0
FWLAB	64.7	29.3	0.7	3.0	11.3	0.0
FIENT	18.4	10.8	0.3	3.1	2.1	15.2
FTRAD	16.9	13.0	0.5	1.9	1.6	0.0
FOUAC	0.0	46.9	0.0	0.0	0.0	11.5
FFCKS	0.0	0.0	93.6	0.0	0.0	0.0
FFCRV	0.0	0.0	0.0	80.4	0.0	0.0
FFOTH	0.0	0.0	0.0	0.0	77.7	0.0
FORAC	0.0	0.0	5.0	11.7	7.2	27.4
Total	100.0	100.0	100.0	100.0	100.0	100.0

Notes to Tables 5.7 and 5.8: Factors: FCAPI: Capital; FWLAB: Wage labor; FIENT: Independent entrepreneurship; FTRAD: Composite factor for trading services; FOUAC: Composite factor for other urban activities; FFCKS: Composite farming factor in Rural Kayes-Sikasso Region; FFCRV: Composite farming factor in Rural River Region; FFOTH: Composite farming factor in other rural; FORAC: Composite factor for other rural activities.
Source: SAM

Wage labor is used in the formal production sector, and the returns to this factor are distributed to households (Table 5.7 and 5.8). Bamako residents receive more than 60% of their incomes from wages, but other household groups also receive wage incomes (Table 5.8). The combined wage incomes for urban households (Bamako and other urban residents) make more than 60% of the total wage income (Table 5.7). Like

wage labor, the composite trade and independent entrepreneurship factors also contribute to incomes in the five household groups, with important contributions to incomes in the two urban households (Table 5.7 and 5.8). The three types of composite farming factors pay all their incomes to their corresponding household groups. Also, the composite factor for other urban activities pays its incomes to other urban households and to enterprises, whereas the other rural activities' composite factor pays the three rural households in addition to enterprises. Further details on production factors and their interactions with other accounts are either discussed in the Appendix 5.2 or are available in the balanced microsam (Appendix 5.4) and in Tables 5.7 and 5.8.

Households

The microsam contains five household types, which are defined based on the place of residence of the population. This disaggregation, which originates from the results of EMCES 94, distinguishes two urban households (Bamako and other urban dwellers) and three rural (Kayes-Sikasso, River, and Other Rural dwellers). Regional composition of these rural households is shown in Table 5.9, and their geographical location is indicated in the political map of Mali (Figure 5.1).

Table 5.9: Regional Composition of Household Groups (and Composite Rural Farming Production Factors)

Locations	Composition
Rural Kayes-Sikasso	Sikasso Region (plus Dioila Circle) Kayes Region (minus Nioro Circle)
Rural River	Koulikoro Region (minus Dioila and Nara Circles) Segou Region (minus Niono Circle) Mopti Region (minus Bandiagara, Koro, Bankass, Douentza Circles)
Rural Other	Tombouctou Region Gao Region (plus Nioro, Niono, Bandiagara, Koro, Bankass, Douentza Circles)

Source: Based on Charmes (1994; p. 19)

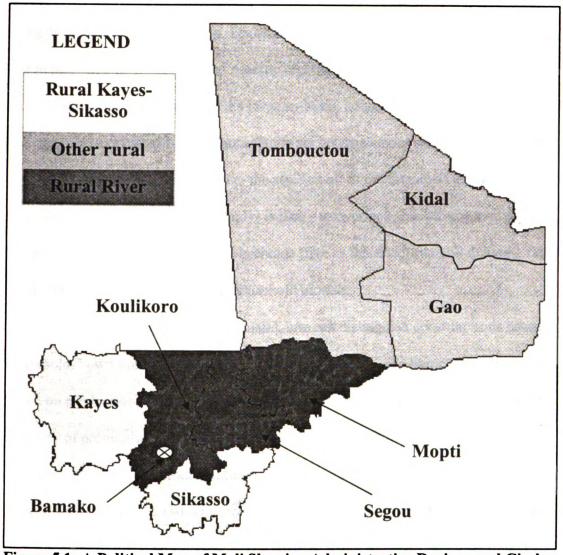


Figure 5.1: A Political Map of Mali Showing Administrative Regions and Circles (Source: University of Texas)

Charmes (1994) originally gives the name "Southwest" to the Kayes-Sikasso Region. This is because it is composed of the Southern Sikasso and the Western Kayes regions (Figure 5.1). The term "Southwest" is confusing, however, so we explicitly call the region "Kayes-Sikasso" in this study. It appears that Charmes (1994) was trying to distinguish between households based on their core agricultural and pastoral activities. One can note that Kayes and Sikasso households essentially live off an entirely rainfed

agriculture. Both rainfed and irrigated agriculture is practiced by households living along the Niger River (Koulikoro, Ségou and Mopti), and the Other Rural households live in predominantly pastoral and desertic regions (Tombouctou, Gao and Kidal).

One obvious limitation of the location-based household disaggregation is that the socioeconomic characteristics of households are heterogeneous within each of these geographic zones. As a consequence, the assessment of the impact of global agricultural trade reforms (undertaken in this study) is likely to overlook this heterogeneity. Nevertheless, as small number of households (five in this case) can still deliver a richer result than will the standard single-household models.

Turning now to household demand, one can distinguish consumptions based on households' own productions from the market demands. Since home consumption is based on production, the structure of that consumption was determined based on the intensity of production activities in each of the five household groups. Home consumption was concentrated in the three rural households (Kayes-Sikasso, River and Other), with the home consumption of livestock products primarily important in the River and Other Rural households.[27] The share of some activities in households' home consumption in the balanced SAM changed substantially with respect to the unbalanced SAM. For example, the relative share of Kayes-Sikasso in the home consumption of food cropping the activity (excluding rice) increased to more than 53% in the balanced SAM, from an initial value of 36% (Table 5.10). This increase may help compensate the drastic decline in the share of commodities produced by that activity (i.e., food

[27] Home consumption of livestock products in the Kayes-Sikasso households turned out much smaller than anticipated. This was one of the drastic changes in the initial structure of the SAM, due to SAM-balancing procedure. This problem could have been avoided, if the initial data presented greater consistency between the demand and supply sides of the economy.

cropping) observed in the balanced SAM for the Kayes-Sikasso region. As suggested earlier, this disparity may stem from the undervaluation of marketed output, or the lack of valuation of home-consumed staples, due to the dominance of a traditional mode of agricultural production and trade in Mali.

Table 5.10: Home Consumption of Activities by Household Groups (in percent)

Activities	Bamako	Other urban	Rural Kayes/ Sikasso	Rural River	Rural, Other	Total
Food production, excluding rice	0.36	0.52	53.22	44.72	1.19	100.00
Rice production	0.15	1.60	29.53	23.15	45.58	100.00
Industrial agric., excl. cotton	0.30	1.06	51.24	24.46	22.94	100.00
Livestock keeping and fishery	0.18	1.52	0.00	52.33	45.97	100.00
Forestry and gathering	0.00	0.00	10.10	47.41	42.49	100.00
Other traded services	1.68	3.23	27.31	25.37	42.42	100.00
Total	0.25	0.94	26.91	41.56	30.34	100.00

Source: SAM

Households' final consumption is presented in Table 5.11, which shows the budget shares for the 37 commodities in each of the five households. The initial budget shares were based on the structure of households' expenditure from the EMCES 94, completed with selected figures from EBC 89 and from the 1996 and 1999 WAEMU consumption surveys in Bamako. Details on the home and marketed final consumptions are found in the Appendix 5.2.

Some anomalies arise from Table 5.11, which shows no consumption of roots and tubers by the Rural Kayes-Sikasso households, or of beans in the River and Other Rural regions. Optimal households' consumption of these products was zero following the cross-entropy balancing process. This reduction to zero, from a nonzero basis, was the cost to pay in order to attain a feasible solution for the balancing problem. The disappearance of such effective consumptions will necessarily alter the initial budget shares, reducing substitution possibilities between commodities. In many cases,

however, the initial consumptions were sufficiently small that they may be viewed as negligible in terms of their welfare and food security impacts.

Table 5.11: Budget Shares by Household Groups

Commodities	Bamako	Other Urban	Rural, K-S	Rural, River	Rural, others
Millet	3.26	3.40	3.31	9.39	13.42
Sorghum	2.68	2.84	4.32	4.97	7.47
Maize	0.85	0.89	1.82	2.08	3.05
Fonio	0.10	0.10	0.28	0.26	0.50
Roots & tubers (potatoes, yam, cassava)	1.44	0.65	0.00	0.44	0.28
Beans	0.00	0.01	0.02	0.00	0.00
Other crops	4.97	5.25	6.53	6.06	6.26
Rice	9.06	9.38	4.58	5.23	7.31
Groundnuts	0.03	0.03	0.25	0.45	0.00
Tobacco	0.78	1.05	1.61	1.02	1.19
Wheat	2.37	0.89	1.52	0.85	1.77
Cotton	0.00	0.00	0.00	0.00	0.00
Cattle	5.05	5.41	3.94	1.62	1.62
Sheep and Goats	1.58	1.71	3.88	0.26	0.47
Pork	0.04	0.04	0.07	0.00	0.00
Donkeys and Camels	1.33	1.50	1.91	0.79	0.91
Poultry	0.46	0.52	0.98	0.41	0.40
Eggs	0.23	0.14	0.17	0.00	0.12
Milk	2.49	1.46	2.09	3.01	3.62
Hide & Skins	0.14	0.16	0.00	0.00	0.00
Firewood	1.99	3.03	3.35	4.74	4.52
Furniture wood	0.60	0.74	0.43	0.59	0.31
Hunting & gathering	0.18	0.15	0.88	1.09	0.30
Fresh fish	0.03	0.03	0.00	0.00	0.00
Smoked fish	0.21	0.13	1.15	1.11	0.47
Gold	0.00	0.00	0.00	0.00	0.00
Agro-industry & beverages	15.43	14.86	17.62	14.06	15.31
Textile	5.31	6.68	7.74	8.50	8.92
Other manufacturing goods	8.75	10.36	15.22	12.84	10.59
Electricity, water and energy	2.66	7.97	3.93	4.84	4.85
Construction & public works	4.30	2.54	0.20	0.47	0.24
Transport & telecom services	19.38	13.89	8.61	11.52	2.67
Other traded services	3.83	4.01	3.58	3.39	3.42
Bank and insurance services	0.45	0.19	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00

Source: SAM

Trade

The data on external trade contained in the microsam originate from various sources, including DNSI, FAO, BCEAO and some published analyses on the Malian

external trade (Diakite and Samake, 2002). As highlighted throughout this study, the external sector was differentiated into regional and non-regional accounts. One of the characteristics of trade statistics is that they are highly inconsistent, depending on sources. For example, while the I-O table showed no trade in cereals in Mali in 1997, Diakité and Samaké (2002) documented the existence of trade in cereals between Mali and its neighbors. These discrepancies are usually attributed to the existence of a dynamic informal trade within West Africa, and this trade tends to escape official channels of trade recording. These disparities are accounted for in the most pragmatic way in the unbalanced microsam, and further explanations are available in Appendix 5.2.

Table 5.12 describes the structure of the regional and non-regional commodity imports and exports, showing the share of each commodity in total exports and imports, both at regional and non-regional levels. It appears from the table that imports are dominated by the commodity "COMGG" (other manufacturing goods), which constituted nearly 62% of total imports in Mali in 1997. Regarding exports, they are dominated by cotton (about 42%) and gold (nearly 34%) in 1997. Currently, gold is the main export from Mali, overtaking cotton since 1998. Table 5.12 also shows the West African and non-West African shares in the commodity trade. All of Mali's exports of cereals, livestock and fish went to the West African region, and the quasi-totality of its roots and tuber imports came from within West Africa. All rice and wheat imports and most of the milk, tobacco and maize imports were from non-regional origins. Details are provided in Table 5.12 and in the balanced microsam (Appendix 5.4).

Table 5.12: Commodity Shares in West African and ROW Trade in Mali, 1997

Goods and Services	Imports			Exports		
	Total	W. Africa	ROW	Total	W. Africa	ROW
Millet	0.0	n.a.	n.a.	0.3	100.0	0.0
Sorghum	0.0	n.a.	n.a.	0.0	100.0	0.0
Maize	0.1	7.9	92.1	0.1	100.0	0.0
Fonio	0.0	n.a.	n.a.	0.0	n.a	n.a
Roots & tubers (potatoes, yam, cassava)	0.1	94.1	5.9	0.0	n.a	n.a
Beans	0.0	16.3	83.7	0.1	100.0	0.0
Other crops	0.5	74.3	25.7	0.7	100.0	0.0
Rice	3.8	0.0	100.0	0.0	100.0	0.0
Groundnuts	0.0	n.a.	n.a.	1.6	0.0	100.0
Tobacco	1.3	3.2	96.8	0.0	n.a	n.a
Wheat	1.3	0.0	100.0	0.0	n.a	n.a
Cotton	0.0	n.a.	n.a.	41.8	0.0	100.0
Cattle	0.0	n.a.	n.a.	5.1	100.0	0.0
Sheep and Goats	0.0	n.a.	n.a.	3.1	100.0	0.0
Pork	0.0	n.a.	n.a.	0.0	n.a	n.a
Donkeys and Camels	0.0	n.a.	n.a.	0.0	100.0	0.0
Poultry	0.0	n.a.	n.a.	0.2	100.0	0.0
Eggs	0.0	100.0	0.0	0.0	n.a	n.a
Milk	2.0	3.0	97.0	0.0	n.a	n.a
Hide & Skins	0.0	n.a.	n.a.	1.0	100.0	0.0
Firewood	0.3	100.0	0.0	0.0	100.0	0.0
Furniture wood	0.1	100.0	0.0	1.3	100.0	0.0
Hunting & Gathering	0.0	n.a.	n.a.	0.0	n.a	n.a
Fresh fish	0.9	100.0	0.0	0.0	n.a	n.a
Smoked fish	0.0	n.a.	n.a.	0.0	n.a	n.a
Gold	0.0	n.a.	n.a.	33.6	0.0	100.0
Agro-industry & beverages	5.1	88.7	11.3	0.0	n.a	n.a
Textile	4.5	37.8	62.2	0.0	n.a	n.a
Other manufacturing goods	61.9	7.1	92.9	0.0	n.a	n.a
Electricity, water and energy	13.3	99.5	0.5	0.0	n.a	n.a
Construction & public works	0.0	n.a.	n.a.	0.0	n.a	n.a
Trade services	0.0	n.a.	n.a.	0.0	n.a	n.a
Transport & telecom services	2.3	1.7	98.3	10.0	100.0	0.0
Other traded services	0.0	n.a.	n.a.	0.9	56.4	43.6
Bank and insurance services	2.5	51.9	48.1	0.0	n.a	n.a
Nontraded services	0.0	n.a.	n.a.	0.0	n.a	n.a
Total	100.0	27.1	72.9	100.0	22.6	77.4

Source: SAM

Marketing margins

The main source of information about marketing margins on domestic sales and imports (as percentage of marketed output) was the DNSI's I-O table. Marketing

margins on the two main exports (gold and cotton) were assumed to be integrated into the operating costs of gold mining companies and the cotton parastatal. These margins would be captured through intermediate consumption of the marketing services. The situation of these companies (which were operating at what may be called a meso-economic level) may be viewed as different from that of micro agents who performed independent trading activities involving commodities that were sold domestically, imported or exported. Marketing margins on exports were, therefore, restricted to commodities traded on smaller scales, such livestock and cereals. Margins were taken from the existing literature, such as Diakite and Samaké (2002), who evaluated the marketing margin of livestock exports to be about 12% of the export values. Entries for the marketing margins are explained in Appendix 5.2 and final marketing margins are available in the balanced microsam (Appendix 5.4).

Other entries to the microsam

All the remaining microsam entries not discussed above are fully explained in Appendix 5.2, and their final values are indicated in the balanced microsam (Appendix 5.4). The main categories include (i) intermediate inputs, (ii) government receipts in the form on taxes and tariffs, (iii) transfers between domestic and foreign institutions, (iv) institutions' saving rates, (v) public and private investments and (vi) changes in stocks.

5.5. Conclusion

This chapter was concerned with the work of building a detailed social accounting matrix (SAM) for Mali, the first for the country. The matrix focuses on the

details of the agricultural sector. Constraints related to data availability and the medium run impact assessment needs have dictated the choice of 1997 as the base year for the matrix. The final matrix is composed of 83 accounts including accounts for 17 activities, 37 commodities, three marketing margins, nine production factors, five household groups, one enterprise, seven taxes and tariffs (pooled into one government recurrent account), one public and one private saving-investment account, two rest of the world accounts, and one account for the changes in stocks.

Various data sources were used for entries of transactions between these different accounts in the SAM. As result, the initial matrix was highly unbalanced, with incomes on some commodities making up eight times the expenditures on these commodities. It was therefore necessary to balance the initial matrix, using the best available information on the transactions between the various accounts in the matrix and controlling detailed entries with known aggregate values. The balancing process was performed using the cross-entropy optimization procedure, which minimizes the entropy distance between the unbalanced and balanced SAMs. The resulting SAM is the final social accounting matrix for Mali, calibrated to 1997. Due to the high disparities in income and expenditure data in the initial SAM, an optimal solution was only possible at the cost of altering the structure of transactions in the initial matrix. But since the initial matrix was in itself inconsistent, the alteration may be viewed as an improvement, although it is impossible to ascertain this since balancing is not per se a virtue. Given the limited information available, this study will proceed under the assumption the balanced SAM represents an acceptable approximation of the true, but unobserved, Malian social accounting matrix in 1997.

The exercise of building a detailed SAM for the Malian economy uncovers the serious data limitations in Mali, which points to areas where efforts for future data gathering may be concentrated. First, the discrepancies between incomes and expenditures suggest a total disconnect between the supply and demand sides in terms of data gathering. Perhaps the results of recent household surveys, once publicized, may reduce the inconsistencies between supply and demand figures in the Malian economy. Otherwise, future efforts should be aimed at narrowing the inconsistency gap between the supply and demand sides of the economy. SAMs provide an excellent framework for such a consistency check.

Second, though the structure of the Malian economy has evolved since the base input-output table was developed, probably in the mid-eighties, this initial table constitutes the basis for all projected I-O tables in Mali. There is an ongoing effort between the Malian national statistical office in Mali (DNSI) and AFRISTAT (*Observatoire Statistique et Economique de l'Afrique Subsaharienne*) to develop a new I-O table as part of the implementation the 1993 United Nations's Systems of National Accounts (SNA). It will be useful if the new table emphasizes a detailed representation of the Malian economy, and ensures among other things a one-to-one mapping between key activities and goods and services.

Third, given the usefulness of social accounting matrices in policy analysis, and given the latest interest on poverty assessment in Mali and elsewhere in Sub-Saharan Africa (SSA), it will also be useful to implement the 1993 SNA so as to encourage the construction of a poverty-focused SAM in Mali. Incorporating a fine household and production factor disaggregation (in addition of a detailed representation of activities,

commodities and government policy instruments) will improve substantially the present SAM that relies on both "composite" production factors and location-based grouping of households.

Finally, it will be useful to encourage inter-departmental cooperation that, with its pool of skills, could improve on the limitations associated with the 1997 SAM presented in this chapter. Policy analyses will certainly benefit such an effort. The current SAM will serve as a useful base for future improvements.

CHAPTER VI: CGE MODEL IMPLEMENTATION AND RESULTS

6.1. Introduction

The Malian CGE model was implemented using computer codes supplied by the International Food Policy Research Institute (IFPRI), as documented in Lofgren, Harris and Robinson (2002). Model implementation consists of applying the theoretical model (Chapter IV) to an aggregated version of the Malian social accounting matrix from the previous chapter using additional exogenous data on behavioral parameters. The Malian CGE model was solved numerically with the General Algebraic Modeling Systems (GAMS) software using the CONOPT2 nonlinear programming solver.

The remainder of this chapter is organized in five sections. Section 6.2 describes the aggregation of the Malian SAM into a smaller number of accounts used in the CGE model. Section 6.3 discusses the calibration of the re-specified CGE model, with emphasis on the behavioral parameters assumed for the analysis. Most of the materials in this chapter are concentrated in Section 6.4, which presents and discusses the CGE base year and simulation results. The stability of these results is tested in Section 6.5, which presents the results of various sensitivity analyses involving model parameters and macroeconomic closure rules. The last section (Section 6.6) presents further discussions and conclusions.

6.2. Aggregation of the Malian Social Accounting Matrix

As indicated throughout this dissertation, this study is interested in the impacts of trade reform scenarios on welfare and food security in Mali. Such an inquiry requires the quantification of the direction and magnitude of price and policy shocks associated

with these reforms. Chapter III provided detailed information on scenario design. The inquiry also requires the identification of the main components of welfare and food security in Mali. Chapter V documents the structure of the Malian economy in terms of the sources of incomes and the destination of expenditures. This study defines food security broadly as changes in food consumption, without going into details regarding the nutritional and utilization aspects of food security. Such changes could be computed for food product groups, which are more aggregated than those discussed in Chapter V. Changes and welfare can also be measured, irrespective to the degree of aggregation of food commodities. The CGE model can be kept more tractable, and abnormally lower entries in the SAM could be eliminated, if some commodities were aggregated in the final specification of the model. Given these reasons, the Malian CGE model was run using a more aggregated SAM. The aggregation was also justified on a more practical ground. Indeed, an initial attempt to run the CGE model with more disaggregated data did not result in a feasible solution, primary because of the extremely small entries in the SAM.

Two types of aggregation were made. First, the two external sectors (West Africa and Rest of the World) were aggregated into a single rest of the world sector, which is consistent with the CGE model outlined in Chapter IV. Second, the 37 commodities in the original matrix were grouped into twenty product categories shown in Table 6.1. The first two columns in the table show the 37 initial commodities and their corresponding SAM accounts, and the last two columns present the same information for the 20 aggregated product groups.

Table 6.1: Mapping the Original 37 Commodities Into 20 Aggregated Commodities

Original Commodities	SAM Account	Aggregated Commodities	New SAM Account
Millet	CMILL	Coarse grains	CCORS
Sorghum	CSORG		
Maize	CMAIZ		
Fonio	CFONI		
Root and tubers	CROOT	Other food	COFOO
Beans	CBEAN		
Other crops	COTHE		
Rice	CRICE	Rice	CRICE
Groundnuts	CGNUT	Other industrial. ag products	CINAG
Tobacco	CTOBA		
Wheat	CWHEA		
Cotton	CCOTT	Cotton	CCOTT
Cattle	CCATT	Cattle and sheep and goats	CCASG
Sheep and Goats	CSHGT		
Pork	CPORC	Other livestock	COLIV
Donkeys and Camels	CDKCM		
Poultry	CPOUL		
Eggs	CEGGS		
Milk	CMILK		
Hide & Skins	CSKIN		
Fresh fish	CFFIS	Fish	CFISH
Smoked fish	CSFIS		
Firewood	CFWOO	Forestry & gathering products	CFOGA
Furniture wood	CWOOD		
Hunting/Gathering products	CGATH		
Gold	CPGLD	Mining products	CPGLD
Agro-industry and beverages	CAIDT	Agro-industry and beverages	CAIDT
Textile products	CTEXT	Textile products	CTEXT
Other manufacturing goods	COMGG	Other manufacturing goods	COMGG
Electricity, water and energy	CEWEN	Electricity water and energy	CEWEN
Construction & public works	CBBTP	Construction & public works	CBBTP
Trade services	CTRAD	Trade	CTRAD
Transport & telecom. Services	CTTEL	Transport & telecom.	CTTEL
Other traded services	COTSE	Other traded services	COTSE
Bank and insurance services	CBISE	Bank and insurance services	CBISE
Nontraded services	CNTSE	Nontraded services	CNTSE

Source: Based on the Malian Social Accounting Matrix (Chapter V)

Most of the aggregation refers to crops and livestock products. For example, four cereals (millet, sorghum, maize and fonio) from the initial SAM were aggregated into single product (coarse grains); Roots and tubers, beans and other crops from the initial SAM were grouped into the "other food" product category; products from the industrial agricultural activity (groundnuts, tobacco, and wheat) were combined into a single

"other industrial agriculture" product. Given the importance of products such as cotton and rice in the Malian economy, they were kept unchanged in the aggregated SAM. Also, there was a one-to-one mapping between commodities of the initial SAM and the remaining 11 products in the aggregated SAM (from mining products to nontraded services in Table 6.1).

Additional mappings included two livestock product groups: (i) cattle, sheep and goats, and (ii) other livestock, which includes commodities such as pork, donkeys and camels, poultry, eggs, hide and skins, and milk; there was also a group for fishery products and another group for forestry and gathering products.

Besides contributing to eliminate marginal values and provide more tractability to the CGE results, there is another good rationale for aggregating the commodities in the SAM. The construction of the detailed matrix SAM relied on simplifying assumptions in order to facilitate the disaggregation of commodity groups into individualized products. Since these assumptions may cause distorsions in the estimated SAM, the aggregated SAM may be viewed as less distorted than the detailed SAM.

6.3. Model Calibration

The Malian CGE model was calibrated using IFPRI's computer codes written in General Algebraic Modeling Systems (GAMS) language. The model was solved numerically using the CONOPT2 nonlinear programming solver. Inputs to the model included the Malian social accounting matrix (SAM) and other behavioral parameters on production technology, commodity trade, and consumer preferences. These parameters were taken directly from the literature.

The model has two types of production elasticities, characterizing the two levels of the nested production technology (described in Chapter IV). At the bottom of the technology nest, production factors are CES aggregated into value added. Production elasticities at this first level are characteristic of the rate of substitution between production factors. These elasticities were obtained from Decaluwé, Dissou and Robichaud (2000) who used them in a multi-country CGE study in seven West African countries, including Mali. They range from as low as 0.45 on cropping activities to as high as 2 on services (see Appendix 6.1). At the top of the production nest, value added and aggregate intermediate inputs are aggregated into outputs using a CES production technology. The second group of production elasticities corresponds to the substitution between aggregated production factors (or value added) and aggregate intermediate inputs. These elasticities were set to a generic 0.6, as suggested in Lofgreen, Harris and Robinson (2002). The model also contains an output aggregation elasticity, which was set to 6 for all activities, again following Lofgreen, Harris and Robinson (2002).

Similar to the case of production elasticities, there are two types of trade elasticities. The first represents the demand side of the economy and corresponds to the substitution between imports and local sales of domestic output. The second characterizes the supply side of the economy and shows the rate of transformation of total output into domestic sales and exports. These two sets of elasticities were taken from Delacuwé, Dissou and Robichaud (2000). For each commodity, the CES and CET elasticities are equal to each other, taking the values of either 1.5 (e.g., agricultural and mining products) or 2 (e.g., services). Details are available in the Appendix 6.1).

Finally, parameters for the linear expenditure demand system (LES) are calibrated from the aggregated SAM entries, along with assumed values for expenditure elasticities and the Frisch parameter. The Frisch parameter (Frisch, 1959) measures the negative of the marginal utility of income with respect to income, also known as the flexibility of the marginal utility of income. Following Lofgreen, Harris and Robinson (2002), the Frisch parameter was set to -2 for all five households.[28] Because quantities consumed in the Malian CGE model were expressed in monetary units, changes in consumption expenditures will be fully transmitted to changes in consumed quantities. Thus, expenditure elasticities were set to unity for all commodities.

With all the calibrated values, the model can be solved for a base year solution that replicates the aggregated SAM. A model that successfully replicates the base year solution is said to be properly calibrated. With a few exceptions, most of the calibrated figures were within +/-10% of base values (for details, see Appendix 6.2). These deviations are high but remain nonetheless reasonable, given all the problems associated with the Malian social accounting matrix (see discussions in Chapter V). A more consistent database would probably lead to smaller deviations between the base and calibrated figures.

Armed with the calibrated model, one can perform simulation analyses. Base and simulation results are presented in Section 6.4. The calibrated model will also serve as the basis for sensitivity analyses, discussed in Section 6.5.

[28] The negative of the inverse of the Frisch parameter measures the average price elasticity of substitution of a good i for a good j (Sato (1972). With a Frisch parameter of -2, the average elasticity of substitution is 0.5.

6.4. Results

The interest of this study lies in the impacts of trade and government policy reforms on welfare and food security in Mali. Most of the results will primarily emphasize the welfare and food security dimensions of these policy reforms. However, in order to elucidate the channels through which reforms are likely to affect welfare and food security, the section will also present additional results on changes in other economic variables, whenever this is relevant.

The results are organized in six parts, defined by the various impacts and scenarios examined in this study. The first four parts focus on the measure of welfare changes under various scenarios. Part 1 (Section 6.4.1) compares the results of two the scenarios of incomplete reforms in the world commodity prices (FAPRI and OECD). Part 2, (Section 6.4.2) compares the two IFPRI scenarios, which assumes no and full implementation of WTO agricultural trade reforms. The two scenarios of change in market access to Malian exports (DFA and EEP) are compared in Part 3 (Section 6.4.3), whereas Part 4 (Section 6.4.4) discusses three government policy scenarios (BAN, CET and GINV). Part 5 is exclusively dedicated to a discussion of the food security impacts of the nine scenarios presented in Parts 1, 2, 3 and 4 of this Section. Finally, Part 6 (Section 6.4.6) examines the interaction between global trade reforms and productivity gains in Mali and the welfare and food security impacts of this interaction.

6.4.1. Partial Reforms in World Commodity Markets: FAPRI and OECD Scenarios

(i) Overview of the Scenarios

The FAPRI and OECD scenarios are part of the four price change scenarios discussed in Chapter III.[29] Although the key differences between these two scenarios are detailed in Chapter III (see Table 3.2), a quick reminder is useful for understanding what assumptions underlie the results. The two scenarios are based on price projection models that assume an average world GDP growth rate of approximately 3% and a world population growth averaging 1%. The FAPRI and OECD models are built on the expectation that major world currencies will appreciate against the US dollar. They also assume that the climatic conditions will remain at their historical averages, though only the FAPRI model states this explicitly. Also, the OECD model explicitly assumes increased production efficiency over time, but this is not explicit in the FAPRI model.

The assumed agricultural and trade policies under the FAPRI and OECD are also substantially similar. The two models assumed that current agricultural policies will remain in place over the projection horizon, i.e. by 2010. Examples of such policies include provisions of the 2002 US farm bill, the 2003 reform of the European Union Common Agricultural Policy, and agricultural policy provisions for major agricultural exporters and importers. The magnitude of policy provisions may differ between the two models, hence the differences in the projected price changes (as shown in Table 6.2 later in the section).

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[29] Table 6.2 (below) presents the magnitude of change in commodity prices under the FAPRI and OECD as well as the two IFPRI scenarios. These magnitudes are obtained by aggregating expected changes in the prices of individual commodities (Table 3.2, Chapter III) into the corresponding product categories, as described in Table 6.1. The value of each commodity is used as a weight in the aggregation.

Regarding trade policies, the FAPRI and OECD models are based on trade reform commitments made by countries under the WTO Uruguay Round Agreements on Agriculture (URAA). The commitments relate to limiting the use of export subsidies, expanding tariff rate quotas, and reducing import duties and domestic support programs. These commitments have been worked into national agricultural policies, which they complement. Again, the main difference between the FAPRI and OECD models lies in the difference in commodity coverage and the magnitude of committed policies.

The committed URAA reforms are assumed to be implemented through the projection period under the FAPRI and OECD. While reducing worldwide protection of agricultural markets, implementation of current URAA commitments will not result in complete liberalization of these markets. Thus, the level of world trade liberalization under the FAPRI and OECD scenarios may be viewed as an intermediate stage of trade liberalization.

Table 6.2 shows the projected changes in world commodity prices for the FAPRI and OECD scenarios and the two IFPRI scenarios (see Section 6.4.2 for more discussion the IFPRI scenarios). The table is derived by aggregating price changes in Table 3.3 (Chapter III), using the key provided in Table 6.1. The share of each commodity in the total consumption value of the commodity group is used as a weight in the aggregation.

Table 6.2: Projected Changes in World Commodity Prices: FAPRI and OECD Scenarios (% change from base)*

Commodity groups	FAPRI	OECD
Coarse grains	-17.2	0.1
Rice	-25.7	-18.7
Other industrial agricultural products	-2.3	-0.4
Cotton	-20.3	-
Cattle, sheep and goats	6.4	9.6
Other livestock	-6.1	1.6
Agro-industry and beverages	-25.9	-23.8

Source: Based on Table 3.3, Chapter III.

There are several important differences in the projected change in world commodity prices between the FAPRI and OECD scenarios. For example, one of the main differences between FAPRI and OECD scenarios is a 20.3% projected decline in world cotton prices under the FAPRI scenario compared to no change in the OECD scenario. In addition, coarse grain prices are expected to decline sharply (-17.2%) under FAPRI, while remaining substantially unchanged under OECD projections (+0.1%). Similarly, FAPRI projects a 6.1% fall in the prices of other livestock products, compared to a slight increase of 1.6% under the OECD scenario. Rice prices are projected to fall under the two scenarios, with a sharper decline under FAPRI projections (25.7% against 18.7%). The price of the "cattle, sheep and goats" would increase under the two scenarios, with a slightly larger rise in the OECD scenario (9.6% against 6.4%).

(ii) Change in Welfare in the FAPRI and OECD Scenarios

If the FAPRI and OECD prices were the prevalent world prices in Mali in 1997, the country could have experienced a nearly 3% gain in welfare. This gain would be concentrated in urban areas, but most rural households would lose only marginally from the price changes. For example, for an average resident of Bamako and other urban zones, welfare would rise by 11.7% and 9.9%, respectively, under the FAPRI price change scenario. Under the same scenario, welfare would rise by 2.9% in Other Rural zones, and fall slightly (-0.3% to -0.2%) in the rural Kayes-Sikasso and River regions (Table 6.3).

Table 6.3: Equivalent Variation: FAPRI and OECD Scenarios (% change from base)*

		Global (WTO)	
Households	**BASE**	**FAPRI**	**OECD**
Bamako	139.5	11.7	11.6
Other urban	93.1	9.9	9.5
Rural S-K	321.5	-0.2	1.7
Rural River	273.9	-0.3	-1.4
Other rural	228.7	2.9	1.4
Total	**1056.8**	**2.9**	**2.8**

There are three major factors driving these results: (i) the expected changes in world commodity prices, (ii) the resulting changes in factor rental rates, and (iii) the macroeconomic adjustment effects on the real exchange rates.

First, changes in commodity prices are one of the two channels through which policy changes can affect household wealth, as discussed in Bourguignon, de Melo and Suwa (1991).[30] The Malian model is built on the assumption that the country will not participate in the worldwide efficiency gain that would drive down world commodity prices. In other words, the Malian input-output coefficients will remain constant. Thus, Malian producers will face lower world prices that will not be offset by productivity-induced lower unit costs of production. The direct consequence of lower agricultural prices is reduced agricultural revenues, which have a negative impact on household welfare in the heavily agricultural Kayes-Sikasso and River zones.[31] On the other hand, urban households benefit from decreased real food prices, which have positive welfare impact. Contrary to the Kayes-Sikasso and River households, the Other Rural households consume a very low share of their own food production. They behave very

[30] In fact, Bourguignon, de Melo and Suwa (1991) identify three channels. The other two channels are: (i) changes in factor incomes, and (ii) capital gains and losses and portfolio decisions in models incorporating assets markets. The latter channel is irrelevant for the Malian model, which does not explicitly incorporate assets markets.

[31] In Chapter V, households were classified based on the dominant farming system. The Kayes-Sikasso region was characterized by rainfed agriculture; in the River region uses a combination of rainfed and irrigated agriculture; and the Other Rural regions are essentially pastoral or desert.

similarly to urban households, which are predominantly net food purchasers. Thus, they would benefit from the fall in real food prices, but lose only marginally in agricultural revenues. Consequently, the overall welfare effect is positive for the Other Rural households under the FAPRI and OECD scenarios.

Second, changes in domestic commodity prices are also associated with changes in factor incomes, also known as the functional distribution of income (Dixon and Norman, 1980; Khan, 1998). Changes in factor incomes will, in turn, be translated into welfare changes. This is the second channel, identified in Bourguignon, de Melo and Suwa (1991), through which welfare can change following policy reforms. Changes in world commodities prices have similar effects on factor incomes under the FAPRI and OECD scenarios (Table 6.4). Table 6.4 is divided into two parts: the first part shows the changes in factor incomes resulting from changes in product prices, and the second part presents the shares of domestic institutions (households and firms) in total factor income. Consistent with expectations, changes in households' welfare appear to be highly correlated with changes in the incomes of factors in which these households are most endowed. For example, the results show that incomes to the Rural River composite farming factor would fall by nearly 5% under the OECD scenario. This change is translated into 1.4% loss in welfare (Table 6.3). The Rural River composite farming factor (FFCRV) is 100% owned by the Rural River households.

Other links between factor endowment, changes in factor incomes and welfare changes can be established from Table 6.4. Noteworthy is the strong effect changes in wage incomes has on welfare changes in the urban (Bamako and Other urban) and the

other rural households. Nearly 90% of labor wages is distributed among these three households (Table 6.4).

Table 6.4: Disaggregated Factor Income Distribution: FAPRI and OECD Scenarios (% change from base)

Items	FCAPI	FWLAB	FIENT	FOUAC	FFCKS	FFCRV	FFOTH	FORAC
Initial factor return	119.3	184.1	46.6	48.1	310.6	232.2	173.7	80.0
Scenarios	Percentage change from base							
FAPRI	-5.6	24.6	5.2	0.7	-1.5	-2.9	-3.3	-1.9
OECD	-5.3	20.2	1.6	-1.8	0.0	-4.8	-5.8	-1.0
Institutions	Share of domestic institutions in factor income							
Bamako	0.0	39.3	18.4	0.0	0.0	0.0	0.0	0.0
Other urban	0.0	23.9	14.6	67.1	0.0	0.0	0.0	0.0
Rural K-S.	0.0	2.2	1.6	0.0	100.0	0.0	0.0	32.7
Rural River	0.0	9.5	16.6	0.0	0.0	100.0	0.0	14.2
Other rural	0.0	25.1	7.7	0.0	0.0	0.0	100.0	13.9
Firms	100.0	0.0	41.1	32.9	0.0	0.0	0.0	39.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Notes: Factors include: capital (FCAPI) and wage labor (FWLAB), as well as composite factors for independent entrepreneurship (FIENT), other urban activities (FOUAC), Rural Kayes-Sikasso farming (FFCKS), Rural River farming (FFCRV), Other Rural farming (FFOTH), and other rural activities (FORAC).

While it is straightforward that changes in factor incomes would partly drive welfare changes, it is less clear how the changes in world agricultural prices have affected the returns to production factors. The general relationship between product prices and factor rental rates is described under various versions of the Stolper-Samuelson theorem. In a "two goods and two factors economy" changes in product price are positively transmitted to changes in returns to the factor intensively used to produce that good. This equivalence breaks down once one considers an economy with several goods and factors, as is the case in this study. All attempts to generalize the Stolper-Samuelson theorem to a multi-good, multi-factor environment have not produced a useful grid through which the Malian results may be interpreted (a review is available in Lloyd (1998)). Most discussions point to the necessity of having at least one positive and one negative element in every row and every column in the Stolper-

Samuelson derivative matrix.[32] No indication is made, however, on the exact location of these mandatory positive and negative elements. In the Malian specific context, the use of composite production factors adds another dimension of ambiguity regarding the determination of the Stolper-Samuelson effects. Given the overall ambiguity, one may expect any change in factor wages as a response to changes in relative good prices. This was precisely what the Malian results reveal, with some factors gaining and others losing from each of the six exogenous policy shocks. The patterns of these gains and losses are similar to those described earlier regarding welfare changes. Changes in the relative prices of final and intermediate demands appear once again to be the key driver of the observed changes. Specifically, changes in product prices will be positively correlated with changes in incomes of household-location composite factors in regions that are net sellers of these products.

The third and final factor driving welfare changes is the adjustment in the real exchange rate. Results suggest that the real exchange rate would appreciate under the FAPRI and OECD scenarios (Appendix 6.4). The aggregate price index of nontradable goods increased faster than the decline in the price index of tradable goods in these two scenarios. It follows that the price ratio of tradables to nontradables declined, leading to the appreciation of the real exchange rate. This appreciation would sharply raise the demand for agro-industrial imports (Appendix 6.5). With at least 15% of the budget share (Chapter V), agro-industrial products are important components of household consumption. These products, which are based on value-added processing, tend to have

[32] The Stolper-Samuelson derivative matrix in a N goods and M factors economy is given by the M x N matrix $[(\partial w_m/\partial p_n)^*(p_n/w_m)]$, where the expression in the square bracket represents a proportionate change in the rental rate of the m-th factor (w_m) with respect to change in the price of the n-th good (p_n).

higher income elasticity. Thus, changes in the consumption would closely reflect changes in households' incomes.

(iii) The Malian Welfare Results in the Context of the CGE Literature

The magnitude of changes in overall national welfare (as shown in Table 6.3) lies within a range of one to three percent of the initial level. This range is consistent with standard welfare effects in applied general equilibrium analysis. For example, the 2002 Global Economic Prospects (World Bank, 2001) indicates that world trade liberalization would increase real income in developing countries by 1.6% (static gains). These gains could reach 5% if productivity is allowed to grow in response to trade reforms. Goldin, Knudsen and Van der Mensbrugghe (2003) revisit the 2002 Global Economic Prospect estimates and project a 1.4% gain in world real income from full merchandise trade reform. According to these authors, the gains in low income countries would average 3%. Also, Mattoo and Subramanian (2004) summarize findings that suggest that a 50% reduction in developed countries' domestic support programs would increase per capita GDP by 3% in the least developed countries (LDCs). A recent review by Cline (2004) also suggest that trade liberalization in developed countries would result in less-than-one percent static welfare gains in developing countries. Total gains (including dynamic gains) would range from one to three percent.

Specifically to Sub-Saharan Africa, Clines (2004) estimates that full trade liberalization in the world would increase per capita GDP by 1.4%. In terms of individual countries effect, the increases would be 3.2% in Mozambique, 1.3% in Uganda, and 4.1% in Tanzania. The only CGE result available in Mali is the one presented by Decaluwé, Dissou and Patry (1998) regarding the implementation of a

common external tariff (CET) regime in West Africa. The authors distinguish three scenarios: (i) the creation of a free-trade area among WAEMU countries; (ii) the CET regime itself (free trade area within WAEMU and common external tariff on non-WAEMU imports); and (iii) a unilateral, indiscriminate liberalization. Their results indicate that welfare would remain unchanged in the WAEMU free trade area scenario. It would rise slightly (by about 0.2%) under the CET regime, and by nearly 1.3% under overall liberalization.

It appears from these various welfare impacts that the Malian estimates are close to those commonly found in the literature, even it is generally very difficult to compare results from applied general equilibrium models. These models are usually different in many ways, including size, regional and sectoral coverage, policy instruments, time horizon, market structure, closure rules, database and functional form). These differences will necessarily yield different results, but it is reassuring that the Malian CGE results fall within the ranges generally found in the literature.

6.4.2. No and Full Market Reforms: IFPRI-1 and IFPRI-2 Scenarios

(i) Overview of the Scenarios

The two IFPRI models have common features with the FAPRI and OECD scenarios. In addition, IFPRI models explicitly assume an increased rate of urbanization, which is expected to shift food consumption toward high-value commodities, such as livestock products. The models further expect farm productivity to grow at a declining rate over the projection period, i.e. 2020. This gain in productivity, combined with some increase in production in low-cost regions of the world as trade barriers fall, is expected to increase global supply and drive down the world price of most commodities.

Livestock products constitute an exception, as livestock prices will increase due to faster growth in demand relative to supply.

The IFPRI models capture agricultural policies through the aggregate producer and consumer subsidy equivalents. These subsidies, which create a price wedge between domestic and world prices, are maintained under IFPRI-1 scenario and are completely eliminated in the IFPRI-2 full liberalization scenario. IFPRI trade policies are less explicit, but they are implicit in the implementation of IFPRI agricultural policy reforms (i.e., maintaining or eliminating the producers and consumer subsidies). Table 6.5 shows the projected magnitudes of changes in commodity prices under the two IFPRI scenarios. Cereal prices are expected to fall, with higher rates of reduction in IFPRI-1 scenarios. Conversely, livestock are expected to rise, with higher increases in the IFPRI-2 scenario.

Table 6.5: Projected Changes in World Commodity Prices: IFPRI-1 and IFPRI-2 Scenarios (% change from base)*

Commodity groups	IFPRI-1	IFPRI-2
Coarse grains	-29.7	-24.0
Rice	-25.1	-14.7
Other industrial agricultural products	-3.8	-3.1
Cotton	-	-
Cattle, sheep and goats	19.0	40.4
Other livestock	-0.7	-5.5
Agro-industry and beverages	-	-

Source: Based on Table 3.3, Chapter III.

(ii) Change in Welfare in the Two IFPRI Scenarios

Overall welfare is expected to increase in Mali under the two IFPRI scenarios (1.7% for IFPRI-1 and 1% for IFPRI-2). There are substantial differences between the two scenarios regarding the cross-household distribution of this welfare gain. While IFPRI-2 shows a welfare gain patterns similar to those of the FAPRI and OECD

scenarios (see Section 6.4.1), changes in household welfare are reversed in the IFPRI-1 scenario (Table 6.6).

Table 6.6: Equivalent Variation: IFPRI-1 and IFPRI-2 Scenarios (% change from base)

		Global (WTO)	
Households	**BASE**	**IFPRI-1**	**IFPRI-2**
Bamako	139.5	-5.0	3.6
Other urban	93.1	-2.0	5.9
Rural S-K	321.5	9.1	-0.3
Rural River	273.9	0.8	-0.4
Other rural	228.7	-1.8	1.2
Total	**1056.8**	**1.7**	**1.0**

To a large extent, this result is puzzling because the magnitudes of change in the cereal prices are similar under the two IFPRI scenarios. One would expect that reductions in the prices of the main staples (cereals) would increase the real incomes of net urban consumers and translate into higher welfare for these consumers. This was, however, not the case, since other forces—such as changes in the real exchange rate—have had a much greater influence on rural and urban welfare in the IFPRI-1 and IFPRI-2 scenarios. For example, the depreciation negatively affected agro-industrial imports, which fell by nearly 40% under the IFPRI-1 scenario. Conversely, these imports increased by more than 26% in IFPRI-2 scenario where the real exchange rate appreciated (Appendix 6.5). With at least 15% of the budget share (Chapter V), agro-industrial products are important components of household consumption. These products, which are based on value-added processing, tend to have higher income elasticity. Thus, changes in the consumption would closely reflect changes in households' incomes.

In addition to changes in commodity prices and in the real exchange rate, the resulting changes in factor incomes also contributed to observed movements in welfare

under the two scenarios (Table 6.7). For example, incomes to the Rural Kayes-Sikasso composite farming factor would increase by 7.7% under IFPRI-1 scenario (Table 6.7). This change is translated to 9.1% welfare gain (Table 6.6), offsetting the negative effects of the fall in real food prices under the same scenario.[33] Also, returns to wage labor are expected to fall by more than 17%, contributing 5% and 2% falls in welfare in Bamako and other urban zones, respectively.

Table 6.7: Disaggregated Factor Income Distribution: IFPRI-1 and IFPRI-2 Scenarios (% change from base)

Items	FCAPI	FWLAB	FIENT	FOUAC	FFCKS	FFCRV	FFOTH	FORAC
Initial factor return	119.3	184.1	46.6	48.1	310.6	232.2	173.7	80.0
Scenarios	Percentage change from base							
IFPRI-1	-7.5	-17.4	6.7	12.8	7.7	2.7	1.9	6.9
IFPRI-2	-9.3	14.7	9.1	8.0	-0.4	-1.2	-2.0	-0.1

Notes: Factors include: capital (FCAPI) and wage labor (FWLAB), as well as composite factors for independent entrepreneurship (FIENT), other urban activities (FOUAC), Rural Kayes-Sikasso farming (FFCKS), Rural River farming (FFCRV), Other Rural farming (FFOTH), and other rural activities (FORAC).

6.4.3. Duty-Free Access and Preference Erosion: DFA and EEP Scenarios

(i) Overview of the Scenarios

As explained in Chapter III, the two market access regimes (DFA and EEP) affect the economy mainly through their effects on the net price received by Malian exporters. The EEP export regime will increase existing duties facing the Malian exports in the importing countries, leading to a reduced net price of these exports. Conversely, the duty-

free regime will eliminate these duties, thus increasing the net price of exports.

(ii) Change in Welfare in the DFA and EEP Scenarios

[33] These effects are also driven partly by the nearly 10% expected rise in the domestic price of "other livestock" products under the IFPRI-1 scenario. In the Malian model, the Rural Kayes-Sikasso household produces but does not home-consume their livestock output. They will, therefore, derive higher revenues from selling this output in a market where the price is expected to rise by 10%.

Total welfare in Mali would increase by 1.3% if the Malian had effective duty-free access to its export markets for cotton and other industrial agricultural products in 1997. The gain would be concentrated in urban households, with some rural household in the Kayes-Sikasso and the River zones incurring some losses. Conversely, the country would lose about 3.5% in welfare if it did not benefit from preferential access to its major export markets. This loss would affect all households, with high impacts in urban households (Table 6.8). The EEP regime is clearly less favorable than the base year export regime, which was assumed to represent a preferential trade regime. Thus, the 3.5% decline in welfare may be viewed as the welfare cost of potential erosion in tariff preferences currently enjoyed by the Malian government.

Table 6.8: Equivalent Variation: EEP and DFA Market Access Scenarios (% change from base)

		Preference Regimes	
Households	**BASE**	**DFA**	**EEP**
Bamako	139.5	10.1	-8.7
Other urban	93.1	6.8	-6.4
Rural S-K	321.5	-0.8	-0.3
Rural River	273.9	-1.8	-2.5
Other rural	228.7	0.4	-5.0
Total	**1056.8**	**1.3**	**-3.5**

The EEP regime may be viewed as a negative shock to the country's export earnings. This shock would create an imbalance in the current account balance, forcing the real exchange rate to depreciate, reducing imports and restoring equilibrium in the current account balance. This depreciation affects urban welfare by weakening the purchasing power of imports (e.g., agro-industrial imports—see Appendix 6.5). The depreciation will also weaken the purchasing power for intermediate inputs, which would prevent rural producers from taking advantage of a more favorable export environment brought about by the depreciation.

The strong correlation between factor returns and household welfare, discussed earlier under the first four scenarios, has also been evidenced in the two market access scenarios. For example, the returns to wage labor would increase by nearly 24% if exports opportunities in Mali are expanded under the duty-free access scenario. These returns would fall by nearly 16% if existing trade preference margins were to be removed (Table 6.9).

Table 6.9: Disaggregated Factor Income Distribution: EEP and DFA Market Access Scenarios (% change from base)

Items	FCAPI	FWLAB	FIENT	FOUAC	FFCKS	FFCRV	FFOTH	FORAC
Initial factor return	119.3	184.1	46.6	48.1	310.6	232.2	173.7	80.0
Scenarios	Percentage change from base							
DFP	-7.9	23.9	-2.1	-5.8	-1.0	-5.6	-7.0	-2.2
EEP	-16.5	-15.9	3.2	6.8	2.5	0.0	-0.5	3.8

Notes: Factors include: capital (FCAPI) and wage labor (FWLAB), as well as composite factors for independent entrepreneurship (FIENT), other urban activities (FOUAC), Rural Kayes-Sikasso farming (FFCKS), Rural River farming (FFCRV), Other Rural farming (FFOTH), and other rural activities (FORAC).

6.4.4. Government Policy Reforms: BAN, CET and GINV Scenarios

(i) Overview of the Scenarios

This examines the welfare and food security impacts of three government policies, which include: (i) applying the common external tariff (CET), (ii) imposing cereal export ban (BAN), and (iii) increasing public investment by 50% (GINV). While Chapter III discusses in detail the rationale underlying the choice of these three scenarios, a brief justification of the scenarios is presented in this section.

First, the Common External Tariff regime (CET) represents a harmonized tariff regime between eight West African countries. The regime eliminates tariffs on internal trade between these countries, while imposing a common tariff on non-member imports. The CET simulation uses tariffs rates from Chapter III, and synthesized in Appendix

6.7.[34] The simulation results are interpreted as the potential impacts of the CET regime, were the regime in place in the base simulation year (i.e. 1997). Since the CET rates are based on WAEMU averages, they may be viewed as higher than rates computed from the average rates of all ECOWAS countries. The reason is that the scope of intra-ECOWAS trade liberalization is likely to be higher than the intra-WAEMU liberalization. In such a case, the CET simulation results reported in this study would probably understate the impacts of a fully-implemented ECOWAS free trade area. On the other hand, the ECOWAS and WAEMU free trade areas are not fully implemented in reality. In such a case, the simulated results would probably overstate the real impact of the WAEMU CET regime.

Second, banning cereal exports (BAN) increasingly appears implausible in Mali, as the country moves toward greater market liberalization. Yet, there is evidence that the country has resorted to this option in the past, and it may still ban cereal exports if faced with sudden food shortages. This scenario would clearly be more relevant if combined with conditions (such as adverse climatic shocks) that will force its use by the government. The Malian CGE model, however, is not designed to address unexpected shocks to the production. Simulation results from this scenario will therefore reflect what changes a ban on cereal exports would induce in a normal (average) production year.

[34] The CET regime was implemented by weighting the CET tariffs with the share of the rest of the world in the total imports of each commodity. Under the CET regime, intra-West African tariffs are eliminated whereas a harmonized tariff regime is applied to imports originating from outside the West African region. Thus, for commodities which are 100% imported from outside the region (e.g., rice), the CET rate would remained unchanged. Commodities that are entirely imported from within West Africa (e.g., fish and forestry and gathering products) will enter the region duty-free. The zero-duty on regional imports will lower import duties on aggregate imports for commodities that are sourced from the two regions (e.g., coarse grains and agro-industrial products). Appendix 6.7 shows more details.

Finally, the GINV represent as scenario of 50% increases in public investments. Increased public investments (in "other manufacturing goods", "building and public works", "transport and telecommunication", and "nontraded services") are expected to affect the price of intermediate inputs, which will in turn affect their demand, and thereby the level of activity. As explained Chapter III, the 50% increase is based on a historic annual rate of 5%, cumulated over ten years.

(ii) Change in Welfare in the CET, BAN and EEP Scenarios

Overall welfare is expected to increase under the three scenarios (Table 6.10). The highest rise would occur under the CET regime (3%), followed by the scenario of 50% increased government investments (1%). Total welfare would remain largely unchanged if cereal exports were banned. As before, disaggregated effects would vary with households. While all households would benefit from increased public investments (with a very slight decline in the Other Rural households), the losses from cereal export ban would be concentrated in rural (producing) zones (over 2% in Rural Kayes-Sikasso and River), while gains will be reaped by urban dwellers (over 6%). Higher urban gains, in order of nine percent or more, are expected under the CET regime. Rural River households would lose about 1% of the welfare under the same regime.

Table 6.10: Equivalent Variation Under Government-Controlled Scenarios (% change from base)

Household	BASE	CET	BAN	GINV
Bamako	139.5	13.9	7.1	0.5
Other urban	93.1	8.6	6.4	3.3
Rural S-K	321.5	1.3	-2.1	2.1
Rural River	273.9	-1.2	-2.5	0.2
Other rural	228.7	1.5	-0.2	-0.2
TOTAL	**1056.8**	**3.0**	**0.2**	**1.0**

A combination of changes in final and intermediate demand prices, as well as adjustments in factor incomes, will again explain most the expected movements in

welfare under these three scenarios. Most of the gains to urban households, both under the CET and BAN scenarios, would come from increased wage incomes (19% to 20% rise) and decreased real commodity prices.[35] Also, there would be falls in factor incomes in the three rural households (BAN Scenario), and in the River and Other rural households (CET Scenario). For example, the Other Rural households would lose more than 6% of the composite farming factor income under the CET scenario and more than 7% with the BAN regime (Table 6.11). Additional results are shown in Appendices 6.8 and 6.9.

Table 6.11: Disaggregated Factor Income Distribution Under Government-Controlled Scenarios (% change from base)

Items	FCAPI	FWLAB	FIENT	FOUAC	FFCKS	FFCRV	FFOTH	FORAC
Initial factor return	119.3	184.1	46.6	48.1	310.6	232.2	173.7	80.0
Scenarios	Percentage change from base							
CET	-3.4	20.2	-0.3	-6.2	0.8	-5.5	-6.4	0.0
BAN	-4.2	18.7	4.0	-0.7	-2.3	-6.4	-7.5	-1.3
GINV	2.7	-2.4	10.2	7.1	1.7	-2.4	-2.4	4.5

Notes: Factors include: capital (FCAPI) and wage labor (FWLAB), as well as composite factors for independent entrepreneurship (FIENT), other urban activities (FOUAC), Rural Kayes-Sikasso farming (FFCKS), Rural River farming (FFCRV), Other Rural farming (FFOTH), and other rural activities (FORAC).

These functional income distribution effects are exacerbated by the impact of reduced commodity prices on household incomes. Reduced commodity prices would decrease the value of households own production. Because own production is an important component of real household incomes in rural areas, reduced valuation is equivalent to lower the incomes received by households.

Banning cereal exports would lower their domestic prices (in order of 3%), which in turn will negatively affect rural income while boosting real incomes in urban

[35] The ban on cereal exports would generate domestic marketable surplus, which would increase the volume of cereal trade. The trading activity pays 10% of its income to wage labor, so an increase in trading activities would translate into higher wage incomes. Compared to cereal exports, domestic cereal sales have additional linkages in the economy, and this explains the larger returns to trading activities in this scenario.

areas. By closing the surplus-controlling circuit, which export markets represent, the ban would generate marketable surplus domestically, thus driving down prices. In addition to the price effect, returns to rural farming factors would decrease, while wage labor will gain in incomes. The overall effects are welfare losses in rural areas and gains in urban households. Banning exports would therefore penalize sellers (concentrated in rural zones) while favoring purchasers (mostly in urban zones).

Finally, welfare in Mali would positively respond to increased government investments (GINV Scenario), although the effects are likely to be small (1% welfare gain). Public investments would result in lower prices of intermediate demands for key activities, such the production of "other trading services" (-11.7%) and livestock keeping (-9.5%). The investments would also lower the intermediate demand prices in the production public utilities (as indicated by a 4.6% fall in these prices for the "electricity, water and energy" activity), and public services (a nearly 1% fall the "nontraded services" activity). A small cost reduction (-0.7%) is also expected in the delivery cost of transportation and telecommunication services (Table 6.11). Cost reductions at activity level would translate into higher profits (factor incomes) for all factors, except wage labor and the composite farming factors in the River and Other Rural zones. The decreased wage incomes would negatively affect wage-dependent urban dwellers, but the effects would be tempered by gains to the "independent entrepreneurship" and the "other urban activities" composite factors (Table 6.11). The latter factor paid most of its income to other urban households, who would gain a 3.3% increase in welfare. Government investments would also translate into lower consumer

prices for some commodities (see Appendix 6.10 for details), which would strengthen effective household demands, and thereby increase real household incomes.

Although lower prices would induce lower factor incomes in producing regions such as the River and Other Rural areas, they would also strengthen consumption. These two opposing effects would leave welfare nearly unchanged in these two areas. Thus, among all policy options examined in this study, increased public investments may lead to the most Pareto-compatible distributional effects: the policy would unambiguously increase welfare in the urban and the Rural K-S households, without worsening it in the other two households.

6.4.5. Food Security

Changes in the state of food security are measured in two ways: changes in households' food consumption, and in the country's capacity to pay for current food imports out of export earnings. The presentation in this section closely follows the discussion in the four previous sections. Specifically, the two partial trade reform scenarios (FAPRI and OECD) are compared against each other, and so are the two IFPRI scenarios, and the two market access or preference regime scenarios (DFA and EEP). Food security results are also discussed with respect to the three government policy scenarios (CET, BAN and GINV). The results of all nine scenarios are shown in detail in Table 6.12 and 6.13, and this section makes frequent reference to these two tables.

Household food consumption is divided into eight food categories: (i) coarse grains, (ii) other food (roots, tubers, fruits and vegetables), (iii) rice, (iv) other industrial agricultural products (e.g., groundnuts), (v) beef, sheep and goats, (vi) other livestock,

Table 6.12: Changes in Households' Food Consumption Under Global, Bilateral, and Government Trade Policy Scenarios (% change from base)

		Trade Reform Scenarios								
		Partial Reforms		No and Full Reforms		More or Less Preferences		Government Policy Reforms		
Household food demand	BASE	FAPRI	OECD	IFPRI1	IFPRI2	DFA	EEP	CET	BAN	GINV
Coarse grains	**178.1**	**6.3**	**0.5**	**5.7**	**7.6**	**0.2**	**-4.1**	**1.5**	**0.3**	**0.0**
Bamako	10.6	20.1	11.8	-4.3	14.4	12.9	-11.0	14.8	11.8	0.3
Other urban	7.0	18.8	10.3	-0.8	17.3	10.0	-8.6	10.0	11.3	2.6
Rural S-K	67.6	4.0	0.7	13.1	6.6	-0.3	-0.7	2.0	-0.7	1.6
Rural River	59.3	3.8	-2.7	3.7	6.0	-2.6	-4.0	-2.1	-2.3	-1.2
Other rural	33.7	8.2	0.3	-0.9	8.1	0.3	-7.9	0.6	0.6	-1.8
Other food	**75.6**	**9.2**	**5.1**	**8.7**	**2.4**	**5.2**	**-4.5**	**5.1**	**3.0**	**6.4**
Bamako	8.3	23.6	16.3	0.9	7.8	18.1	-10.8	18.3	13.9	7.9
Other urban	4.8	21.3	14.0	3.6	10.5	14.3	-8.3	12.8	12.8	9.2
Rural S-K	31.7	5.8	4.2	14.7	0.8	3.5	-1.7	4.2	1.1	7.5
Rural River	22.7	5.5	0.7	5.9	0.8	1.1	-4.2	0.4	-0.4	4.2
Other rural	8.1	11.1	4.4	3.6	2.8	4.9	-7.6	4.0	2.8	4.8
Rice	**100.5**	**8.2**	**5.7**	**3.9**	**4.2**	**1.0**	**-5.0**	**8.0**	**0.9**	**0.2**
Bamako	10.2	26.3	19.9	2.0	12.2	9.9	-10.5	27.5	8.9	0.6
Other urban	7.7	21.7	15.9	3.5	13.3	7.3	-7.8	19.0	8.3	2.4
Rural S-K	26.3	3.3	4.0	11.0	1.8	-0.7	-1.2	6.0	-1.1	1.8
Rural River	19.2	3.3	0.9	3.4	1.7	-2.5	-3.7	2.3	-2.3	-0.6
Other rural	37.0	6.4	3.4	-0.3	3.2	0.2	-6.3	4.8	0.4	-1.1
Other ind. ag	**19.5**	**4.7**	**3.5**	**4.7**	**0.0**	**3.3**	**-7.0**	**2.0**	**1.1**	**-3.0**
Bamako	2.0	15.1	12.0	-3.6	4.9	13.1	-13.0	12.0	9.5	-2.7
Other urban	0.9	13.4	10.1	-0.3	6.9	9.9	-10.0	7.5	8.6	-0.8
Rural S-K	8.6	2.1	2.8	9.8	-1.4	1.9	-4.6	1.2	-0.3	-2.2
Rural River	3.9	2.0	0.1	3.1	-1.2	0.1	-6.1	-1.4	-1.4	-3.7
Other rural	4.1	5.7	2.8	0.9	0.0	2.8	-9.1	0.9	0.9	-4.8
Beef, sheep, goats	**75.1**	**7.3**	**23.7**	**8.2**	**2.1**	**4.5**	**-5.2**	**8.3**	**4.4**	**7.5**
Bamako	8.1	22.5	61.2	10.4	7.2	18.8	-9.7	28.9	17.5	14.6
Other urban	6.1	19.3	48.7	10.7	9.5	14.1	-7.3	20.3	15.2	14.0
Rural S-K	16.1	5.8	36.7	24.6	0.6	4.4	-1.1	12.0	4.0	13.4
Rural River	22.1	1.6	6.7	3.0	-0.2	-0.8	-4.1	0.2	-0.6	3.2
Other rural	22.7	5.3	10.8	0.2	1.4	1.9	-6.9	3.1	2.1	3.2
Other livestock	**24.5**	**13.8**	**0.7**	**-3.1**	**6.1**	**1.2**	**4.8**	**16.5**	**11.4**	**10.1**
Bamako	3.1	26.4	8.1	-9.6	11.4	9.9	0.5	31.4	22.2	12.0
Other urban	1.8	22.5	6.5	-6.0	12.6	7.0	1.7	23.1	19.2	12.1
Rural S-K	9.5	9.4	-0.9	0.9	4.0	-0.8	7.2	13.8	7.7	10.4
Rural River	6.7	12.0	-1.5	-3.7	4.9	-0.8	5.7	10.6	7.4	8.4
Other rural	3.3	13.6	-0.6	-6.0	6.0	0.0	2.0	16.2	12.0	10.0
Fish	**33.7**	**-8.3**	**9.7**	**1.1**	**-4.0**	**23.0**	**-0.1**	**9.0**	**5.1**	**6.5**
Bamako	2.5	-3.7	23.4	-4.4	-1.8	46.6	-3.8	24.8	16.3	9.5
Other urban	2.5	-2.6	19.2	-1.5	1.3	36.7	-2.2	17.7	14.2	9.9
Rural S-K	6.3	-10.8	9.8	8.2	-5.5	23.4	3.6	9.4	3.6	8.7
Rural River	11.9	-9.1	5.2	1.2	-4.7	15.8	0.5	4.3	1.7	4.9
Other rural	10.4	-8.2	9.1	-1.5	-4.1	22.0	-1.6	8.1	4.8	5.4
Agro-industry	**82.8**	**0.0**	**-0.1**	**-0.4**	**0.0**	**-0.3**	**-1.1**	**-3.8**	**-5.1**	**-2.6**
Bamako	0.6	11.2	10.8	-7.6	5.2	11.5	-7.0	1.1	-1.6	-3.5
Other urban	0.3	10.3	9.2	-4.0	7.7	8.8	-4.8	-0.8	-0.9	-1.5
Rural S-K	12.3	-1.8	1.0	6.8	-0.9	-0.1	2.1	-4.8	-6.6	-1.7
Rural River	34.8	-1.5	-1.8	0.0	-0.8	-1.9	-0.4	-6.0	-6.5	-2.9
Other rural	34.9	1.9	0.9	-3.2	0.8	1.0	-2.8	-5.6	-6.2	-3.9

(vii) fish, and (viii) agro-industrial products, such as sugar and cooking oil (Table 6.12). The table shows the percentage deviation in food consumption between the base year and the nine scenarios examined in this study.

(i) Changes in Food Consumption in the FAPRI and OECD Scenarios

For the country as a whole, and with minor exceptions, food consumption is expected to increase in both the FAPRI and OECD scenarios. Exceptions include a more than 8% fall in fish demand in the FAPRI scenario, and a very marginal decline in the consumption of agro-industrial goods OECD scenario (Table 6.12). This aggregate national impact hides, however, important cross-household differences. Following a pattern identified earlier with welfare impacts, changes in food consumption would be larger in urban zones (Bamako and other urban households). Under the FAPRI scenario for example, all positive changes in food consumption are expected to be greater than 10% for the two urban households. The magnitude of changes would average more than 20% for five out of the seven food categories for which positive changes are expected. Under the same price change scenario, average positive changes in food consumption in rural households would be as low as 1.6% for beef, sheep and goats in the Rural River region, and as high as 13.6% for "other livestock" products in Other Rural households (Table 6.12). Earlier discussions emphasized the fact that expected increases in welfare in urban and "Other Rural" households could be attributed to combination of lower real agricultural prices, real exchange rate appreciation, and higher factor incomes. This positive welfare impact would translate into increased real consumption (Appendix 6.6), both for food and nonfood products.[36]

[36] Changes in households' consumption of nonfood products are not shown, as the interest of the study lies primarily in food products.

With the exception of the Rural River households, the consumption of coarse grains, other food, rice, other industrial agricultural products, as well as this of "beef, sheep and goats" are expected to increase in all households under both the FAPRI and OECD price change scenarios. With sharper price falls for crop-based products under the FAPRI scenario, the corresponding increased consumption would generally be larger than the increases with the OECD scenario. Similarly, the consumption of other livestock products would increase in response to falling prices under the FAPRI scenario, while declining in rural areas in response to a slight rise in prices under the OECD scenario. Contrary to intuition, however, urban consumption of other livestock products is expected to increase, despite the slight price rise. As explained earlier, domestic conditions ultimately determined movements of consumer prices, which in turn determined the changes in the final demand. Consumer prices of other livestock products fell by more than 25% (Appendix 6.3), resulting in nearly 14% rise in overall demand (Table 6.5) under the FAPRI scenario. Both final prices and demands remained largely unchanged in the OECD scenario. Also counterintuitive are the substantial increases in the consumption of beef, sheep and goat products under the two scenarios, despite the 6.4% and 9.6% rises in world prices under FAPRI and OECD scenarios, respectively. Again the price rises—whether modeled as affecting both imports and exports or only imports—would result in lower domestic prices, which in turn triggered higher demands. Here also, the downward pressure on livestock prices may result from the overall reduction in cereal prices. [37]

[37] The expected decline in the consumer prices of most livestock products with its associated increased demand, even as the world prices these products are expected to increase, raises question about the equilibrium process at work in the model. Initial reaction to higher prices would normally be a short-run cut in supply, as producers hold back breeding stocks from the market. By doing so, they might

In conclusion, despite expected decline in fish consumption in all households and in the consumption of agro-industrial products in the Rural Kayes-Sikasso and River households, the FAPRI price change scenario would unambiguously increase food consumption in Mali. Similarly, despite a fall in the consumption of a few products under the OECD price change scenario, overall food consumption would improve in all households (except perhaps in the Rural River households, where consumption fell by 2.7% for coarse grains, 1.5% for other livestock, and 1.8% for agro-industrial products).

(ii) Changes in Food Consumption in the Two IFPRI Scenarios

As was the case with the FAPRI and OECD scenarios, food consumption in Mali is also expected to increase under the two IFPRI scenarios, although exceptions exist (the demand for "other livestock" would fall 3.1% in IFPRI-1 scenario and the demand for fish would decline by 4% in the IFPRI-2 scenario.) Again, there are important cross-household differences regarding the magnitude of changes in food consumption.

Also important are the expected increases in agro-industrial food consumption in urban areas in the IFPRI-2 scenario, and a fall in urban agro-industrial food demand in the IFPRI-1 scenario. With its relatively higher income elasticity (e.g., as compared to coarse grains which are mainly sourced from own production), the demand for agro-industrial products is highly dependent on fluctuations in households' incomes. The reduced urban consumption of agro-industrial products in the IFPRI-1 scenario may be viewed as a direct consequence of the negative shocks to factor incomes (and thereby

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"overshoot" in their supply response to higher prices, thus ultimately leading to lower prices. But the overshooting is not in itself an equilibrium result, and cannot be a solution of this CGE model. The most plausible explanation remains, therefore, the induced effects of lower cereal prices. In any case, it would be a useful extension to investigate the time-dynamic path of breeding stock adjustment, an issue not addressed in the present static study.

total income) in urban households. These shocks appear to be reversed as one switches from the IFPRI-1 (status quo) to IFPRI-2 (full trade liberalization) scenarios.

One of the main difference between IFPRI-1 and IFPRI-2 scenarios lies in a sharper increase in the world prices of livestock products in IFPRI-2, particularly for the "beef, sheep and goats" (19% against 40%, as shown in Table 6.2). The increased world prices appeared, however, not to be transmitted to the domestic economy, where consumer prices for "beef, sheep and goats" fell by about 20% and 3% under IFPRI-1 and IFPRI-2 scenarios, respectively (Appendix 6.3). This lack of transmission reflects the assumption that price shocks affect the domestic economy primarily through imports. But since there was no importing activity involving "beef, sheep and goats", the expected world price changes for this product were not directly recorded in the domestic economy. The observed prices resulted from the relative demand of all products (both agricultural and non agricultural) in the general equilibrium. There appeared to be a downward pressure on the domestic price of livestock products, as other products (particularly cereals) became less expensive in the domestic market. This is because lower cereal prices would reduce the real incomes of rural producers, thus shifting downward the market demand of livestock products. This shift will particularly be important, because livestock products are generally luxury goods in Malian households, with income elasticity greater than unity (Camara, 2004). Rural households consume about 70 percent of the total livestock and fish demand in Mali (see Appendix 5.4), so that overall a reduction of their income could translate into overall decline in livestock prices.

The assumption that international prices are transmitted to the domestic economy through imports is restrictive. An alternative (and a more realistic) specification would be to apply the expected changes in world prices to both imports and exports. This experiment was performed, and results suggest that the domestic price of livestock products would still decline, inducing increases in consumer demand of these products. Some of the implications of this result are discussed later in this section, but one should already note that this result is puzzling. Mali exports its livestock products to the West African regional market, with Côte d'Ivoire absorbing a substantial amount of these exports. It is expected that increases in the world price of livestock products will be transmitted to import demand prices in importing countries in West Africa. Beef import prices in Côte d'Ivoire, for example, are directly linked to the Malian cattle export prices, so increases in the first should be reflected in increases in the second. A rise in export prices would in turn be reflected in increases in domestic livestock prices. The Malian livestock prices (particularly for cattle, sheep and goats) were instead reduced in the equilibrium. A possible explanation is that while rising international prices would bid up domestic livestock prices, the equilibrium prices result from the imperfect substitutability between the domestic and foreign demand. The results seem to indicate that the rising international prices has tempered, but not offset, the downward pressure that falling cereals prices put on livestock prices.

To a large extent, this result may be an artifact of the distortions in the social accounting matrix. For example, the Malian SAM did not show home-consumption of livestock in the rural Kayes-Sikasso households, shifting all their livestock consumption to the market. The market demand of livestock is therefore probably overestimated

(cattle, sheep and goats share about 8% of the consumer budget in the Kayes-Sikasso Rural area, compared to 2% or less in other rural areas; see Table 5.11). It follows that the magnitude of fall in livestock prices is also probably overestimated to a point that it offsets rises in international livestock prices. The results are likely to different with a more accurate data on home-consumption of livestock in the Kayes-Sikasso region.

(iii) Changes in Food Consumption in the DFA and EEP Scenarios

For the country as a whole, food consumption of the eight food categories increased under the DFA scenario. The alternative export regime, that is, the EEP export regime, would unambiguously decrease food consumption in Mali, mainly due to higher domestic prices of food (Appendix 6.3). The average country effects, as described above, hide important differences across households.

First, a shift to the EEP export regime would unambiguously reduce food consumption in all five households, with larger impacts in urban areas. This result is consistent with observed evidence in West Africa, where Diagana et al. (1999) found evidence of declined cereal consumption as a result of the 1994 devaluation of the local currency, the CFA franc. Singare et al. (1999) specifically reported a similar evidence for Mali. The EEP regime had a devaluation-like effect, exerting a 12% depreciation of the real exchange rate. This led to increased intermediate and final demand prices, which resulted in fall in consumption. With no productivity growth, moving from the current preferential export regime to the less favorable EEP regime would therefore unambiguously decrease food consumption in Mali.

Second, the alternative duty-free export regime (DFA) would lead to increased food consumption in urban and "other rural" households, while having mixed effect in

rural Kayes-Sikasso and River households. The consumption of coarse grains, rice, other livestock, and agro-industrial products would fall slightly in these latter two households, mainly due to negative factor income shocks.

(iv) Changes in Food Consumption in the CET, BAN and GINV Scenarios

Changes in national food consumption would very closely follow the expected welfare changes discussed in Section 6.4.4. Except for 5% or less falls in the consumption of agro-industrial products in the three scenarios as well as a 3% reduction in the consumption of "other industrial products" in the GINV scenario, national food consumption would increase in Mali under the three scenarios (Table 6.12). The decreased consumption of the agro-industrial products would be marginal relative to increases in the quantity consumed of other commodities. From the Malian national perspective, food consumption would therefore increase with the implementation of the CET regime, a ban on cereal exports, or a 50% increases in government investments.

From the perspective of household groups, however, the picture is less clear-cut. With minor decreases in for Rural River households in the BAN scenario (-0.4% for other food and -0.6% for beef, sheep and goats), the consumption of "other food", "fish" and livestock products (beef, sheep and goats; and other livestock), would increase for all remaining households under the three scenarios. The consumption of the remaining products in Table 6.12 (except agro-industrial products) would also increase in urban households under the three scenarios. Thus, food consumption would improve on average for urban dwellers when CET rates are applied, cereal exports are banned or government investments are increased. Higher increases are expected with the CET scenario, followed by the BAN, and finally the GINV scenarios, which are consistent

with the expected welfare changes in urban areas (Section 6.4.4). As before, the increased urban food consumption would be driven by falls in consumer prices (Appendix 6.10) and increased factor incomes (Table 6.11 above).

In rural areas, Kayes-Sikasso households would benefit from increased food consumption under the CET regime and the GINV scenario. Incomes to the composite Rural Kayes-Sikasso factor would increase under these scenarios, which would more than offset the decreased value of their own production following the induced price falls. The net food purchasers within this household group would, however, benefit from commodity price falls, as these falls would strengthen their effective demand for these commodities. As one can see from Table 6.12, Rural Kayes-Sikasso households faced with cereal export bans would on average decrease their consumption for coarse grains (-0.7%), rice (-1.1%), other industrial products (-0.3) and agro-industrial goods (-6.5%). While the decreased demand of agro-industrial products can be clearly linked to nearly 20% price increases (Appendix 6.10), fall in other consumptions (even as their associated prices decline) may be traced to reduced factor incomes. For net food purchasers in Rural Kayes-Sikasso, the negative effects of falling factor incomes on food demand could outweigh the positive effects of reduced prices that trigger larger effective demand. Net food sellers, faced with the need to maintain their sales income, would sell larger quantities of their production, while cutting the own consumption (if production remained unchanged). Additional results (not reported here) suggest that overall coarse grain sales would rise by 1.5%, while home consumption would fall by nearly one percent in Rural Kayes-Sikasso households. The decline in home

consumption could even be higher in households that rely heavily on domestic cereal sales.

The cereal export ban would have more pronounced effects in Rural River household, where incomes to the main endowment would fall by more than 6%. This household group would also face a decreased consumption of coarse grains and other industrial products (in addition to agro-industrial goods) under the CET regime. Under the GINV scenario, the consumption of agro- and other industrial products would fall in all households. In addition, the River and Other Rural households would consume less coarse grains and rice. The driving forces of the changes remain those discussed throughout this chapter: all scenarios are associated with changes in the prices of final and intermediate demands (Appendix 6.10), which directly affect the effective food demand, and indirectly the households' factor incomes. Similar to welfare effects, the food consumption effects of increased government investments will most likely favor consumers in the urban centers (through lower food prices) and farmers in the Kayes-Sikasso agricultural zone (through increased returns to their main production factor, the Rural Kayes-Sikasso composite farming factor).

(v) Ratio of Food Imports to Total Exports

The share of food imports in total exports measures, as explained in Chapter II, the capacity of the country to pay for *current* imports using export receipts. A decrease in this ratio suggests a strengthened capacity to pay for current food imports out of export revenues, as the country would devote a smaller share of these revenues to food imports. But, as will be shown below, the capacity to pay for current imports may be strengthened without improvements in food security.

In computing the food imports/total exports ratio, food was defined to include the following commodities: coarse grains (CCORS), other food products (COFOO, which includes, fruits, vegetables, roots and tubers), rice (CRICE), beef, sheep and goats (CCASG), other livestock products (COLIV), fish (CFISH) and agro-industrial products (CAIDT). The commodity "other industrial agricultural products" (CINAG) was excluded in the definition of food because it contains tobacco (in addition to some food products), which is not a food product. This omission will have little effect on the results because the CINAG commodity group constitutes a very small share of household demand (see base year figures in Table 6.13).

Table 6.13: Ratio Food Imports/Total Exports Under Global, Bilateral, and Government Trade Policy Scenarios (% change from base)

		Trade Reform Scenarios								
		Partial Reforms		No and Full Reforms		More or Less Preferences		Government Policy Reforms		
Household food demand	**BASE**	**FAPRI**	**OECD**	**IFPRI1**	**IFPRI2**	**DFA**	**EEP**	**CET**	**BAN**	**GINV**
Real food imports	72.3	19.3	6.8	-22.1	12.4	4.4	-15.8	12.4	-0.3	-3.6
Total real exports	479.9	-0.2	2.7	0.3	-2.9	2.4	-0.1	4.3	0.3	-0.2
Ratio (% Δ base)	**15.1**	**+19.5**	**+4.0**	**-22.3**	**+15.7**	**+1.9**	**-15.8**	**+7.9**	**-0.6**	**-3.4**

Food imports represented about 15% of export receipts in the base year. With the exception of the IFPRI-1 price change and the duty-free (DFA) export regime, the capacity to pay for current food imports from export revenues diminished under all the nine scenarios. In other words, the share of food imports in total exports increased in all but the IFPRI-1 and DFA scenarios (Table 6.13).

These changes are explained either by changes in food imports, changes it total exports, or both. But changes in imports appeared to be highly correlated with changes in the food imports/total exports ratio. For example, the ratio increased by 19.5% under the FAPRI price change scenario. Real food imports rose by about a similar magnitude (19.3%) under the same scenario. Similarly, the ratio fell by 22.3% under IFPRI-1 and

by nearly 16% under EEP export regime; real food imports fell by similar magnitude under the two scenarios, respectively. To a minor extent, changes in real exports attenuated or exacerbated the magnitude of change in real food exports. This may be seen under the IFPRI-2, OECD and DFA scenarios. Under IFPRI-2, a 12% increase in real food imports combined with nearly 3% fall in exports resulted in nearly 16% rise in the share of food imports in total exports. Under the OECD and DFA scenarios, both food imports and total exports increased, so that the resulting changes in the food imports/total exports ratio were smaller than changes to food imports (Table 6.13).

Compared to the first food security indicator, that is, actual levels of household food consumption, the food imports/total exports ratio showed that a strengthened capacity to pay for current food imports (that is, a decreased ratio—as under IFPRI-1, EEP, BAN and GINV scenarios) did not necessarily translate into increased food consumption. Instead, an opposite effect seemed more likely. Despite the strengthened capacity under IFPRI-1 and EEP scenarios, real food imports simultaneously declined, with an ultimate negative effect of food consumption (food consumption unambiguously worsened under the EEP scenario). Conversely, the capacity to pay for current imports worsened under the remaining scenarios (FAPRI, IFPRI-2, OECD, DFA and CET). Yet, in at least one of these scenarios (FAPRI), food consumption unambiguously increased, mainly due to a combination lower real food prices and higher factor incomes.

These results confirm observations in the literature (e.g., FAO, 2003) about how a government's goal to reduce its food import dependency (by improving the food imports/total exports ratio) may be incompatible with the more crucial goal of ensuring food security (broadly defined as increased food consumption). For example, real food

consumption and the capacity to pay for current food imports moved in opposite directions under the FAPRI and EEP scenarios, implying that the share of food imports in total exports revenue is not a perfect measure of food security. Therefore, one needs to be very cautious about interpreting falling import dependency as an unambiguous sign of greater food security. This food imports/total exports ratio can only be meaningfully interpreted in light of more fundamental indicators of national and household food security.

6.4.5. Global Trade Reforms With Productivity Gain in Mali

Up to now, the CGE simulation results are obtained under the assumption Mali will be insulated from the worldwide gains in productivity, which is the main driver of the expected decline in global commodity prices in the FAPRI, OECD, IFPRI-1 and IFPRI-2 scenarios. In this section, we relax this assumption by allowing a 10% gain in productivity in Mali. The productivity gain scenario is simulated as a 10% increase in output using the same levels of inputs (i.e. aggregate intermediate input and aggregate production factors; see Chapter IV for details). We analyze the productivity shock scenario within the IFPRI-2 price shock scenario. Table 6.14 shows the welfare results and Table 6.15 show the food security impacts under the productivity shock scenario.

Table 6.14: Welfare Impacts of a 10% Productivity Gain Under the IFPRI-2 Global Commodity Price Change Scenario

		Productivity Scenarios	
Households	**BASE**	**IFPRI-2 With No Productivity Gain**	**IFPRI-2 With 10% Productivity Gain**
Bamako	139.5	3.6	4.3
Other urban	93.1	5.9	6.0
Rural S-K	321.5	-0.3	-0.1
Rural River	273.9	-0.4	-0.5
Other rural	228.7	1.2	1.1
Total	**1056.8**	**1.0**	**1.4**

As can be seen from Table 14, a 10% increase in productivity in Mali would add an extra 0.4 percentage point to the country's welfare, had the IFPRI-2 prices prevailed in the base year (i.e., 1997). The price reduction, whether this is driven by a domestic productivity gain or a fall in the exogenous world market prices, would benefit urban consumers. Under the IFPRI-2 scenario, a 10% productivity gain in Mali would increase the welfare gain in Bamako and other urban households by 0.7 and 0.1 percentage points, respectively.

With respect to the base year, welfare in the two main agricultural regions (Kayes-Sikasso and River) would fall when agricultural productivity increases in Mali under the IFPRI-2 price. The gain in productivity would mitigate the fall in welfare loss for Kayes-Sikasso households (the loss decreases from -0.3% to -0.1% of initial welfare level). However, under the same IFPRI-2 price change scenario, River households would lose marginally (the loss increases from -0.4% to -0.5% of the initial welfare level) from the shock. As before, the combined effects of productivity gain and world price fall would result in lower domestic prices, which in term determine factor returns and institutional incomes. In the Rural Kayes-Sikasso, output gain effects would dominate lower price effects, hence the smaller loss in welfare. In the River households, the increased output (income) induced by productivity gain would fall short of compensating the lower-price-induced income losses. Higher productivity could lead to larger increases in output, which could more than compensate income losses resulting from lower prices. But the exact effects can only be established through empirical analyses.

Table: 6.15: Food Security Impacts of a 10% Productivity Gain Under the IFPRI-2 Global Commodity Price Change Scenario

		Productivity Scenarios	
Household food demand	**BASE**	**IFPRI-2 With No Productivity Gain**	**IFPRI-2 With Productivity Gain**
Coarse grains	**178.1**	**7.6**	**7.4**
Bamako	10.6	14.4	13.9
Other urban	7.0	17.3	16.8
Rural S-K	67.6	6.6	6.5
Rural River	59.3	6.0	5.9
Other rural	33.7	8.1	8.0
Other food	**75.6**	**2.4**	**2.4**
Bamako	8.3	7.8	7.8
Other urban	4.8	10.5	10.5
Rural S-K	31.7	0.8	0.8
Rural River	22.7	0.8	0.8
Other rural	8.1	2.8	2.8
Rice	**100.5**	**4.2**	**4.2**
Bamako	10.2	12.2	12.5
Other urban	7.7	13.3	13.4
Rural S-K	26.3	1.8	1.8
Rural River	19.2	1.7	1.7
Other rural	37.0	3.2	3.1
Other ind. ag	**19.5**	**0.0**	**0.0**
Bamako	2.0	4.9	4.9
Other urban	0.9	6.9	6.9
Rural S-K	8.6	-1.4	-1.4
Rural River	3.9	-1.2	-1.2
Other rural	4.1	0.0	0.0
Beef, sheep, goats	**75.1**	2.1	2.1
Bamako	8.1	7.2	7.1
Other urban	6.1	9.5	9.3
Rural S-K	16.1	0.6	0.6
Rural River	22.1	-0.2	-0.2
Other rural	22.7	1.4	1.4
Other livestock	**24.5**	**6.1**	**6.2**
Bamako	3.1	11.4	11.5
Other urban	1.8	12.6	12.7
Rural S-K	9.5	4.0	4.1
Rural River	6.7	4.9	5.0
Other rural	3.3	6.0	6.1
Fish	**33.7**	**-4.0**	**-4.1**
Bamako	2.5	-1.8	-1.8
Other urban	2.5	1.3	1.3
Rural S-K	6.3	-5.5	-5.7
Rural River	11.9	-4.7	-4.8
Other rural	10.4	-4.1	-4.2
Agro-industry	**82.8**	**2.7**	**2.9**
Bamako	0.6	6.3	6.5
Other urban	0.3	7.5	7.8
Rural S-K	12.3	0.9	1.0
Rural River	34.8	0.8	0.8
Other rural	34.9	2.3	2.4

As was the case with welfare effects, the level of food consumption would change only marginally when the productivity increases by 10% (Table 6.15). Compared to the no productivity gain scenario, food consumption in the increase farm productivity scenario would deviate by a maximum of -/+2% percentage points. For examples, overall rise in the consumption of coarse grains would decline by 0.2 percentage points (from 7.6% to 7.4%) in the agricultural productivity scenario. Also, the increase in agro-industrial demand would increase from 2.7% to 2.9%. The intra-household distribution patterns of gains and losses would remain substantially unchanged (Table 6.15).

6.5. Sensitivity Analysis

The sensitivity analysis is performed with respect to model parameters and macroeconomic closure rules. Model parameters of interest include factor substitutability (elasticity of substitution between production factors), output aggregation elasticity and the CES (Armington) and the CET (Powell-Gruen) elasticities. The sensitivity analysis consists of a 50% decrease and a 50% increase in the initial value of each of these parameters. Macroeconomic closures refer to the equilibrium conditions at work in the factor markets, the saving-investment balance, and the foreign exchange market. The stability of the initial results is tested under each of these alternative closure rules. In all cases, the welfare indicator (EV) is used to illustrate how variations in model parameters or in the choice of macroeconomic closures would affect deviations from the base year solutions. All the changes apply to the OECD price change scenario.

6.5.1. Sensitivity to Model Parameters

As discussed in Chapter IV, the Malian CGE model is based on a nested production technology in which production factors are combined into value added, and intermediate inputs into aggregate intermediate demands. Outputs are then generated from an additional combination of value added and aggregate intermediate inputs. Both factor aggregation and output production follow a CES technology, whereas aggregate intermediate inputs are generated from a Leontief technology. Also characteristic of the production technology is the aggregation of a total output of a commodity produced by various activities. Regarding production, the sensitivity analysis of interest relates to factor aggregation and output production. The sensitivity analysis does not cover parameters involved in the formation of aggregate intermediate demand and the aggregation of outputs. The formation of aggregate intermediate demand follows a Leontief production technology with fixed aggregation coefficients derived from the Malian social accounting matrix. A sensitivity involving these coefficients would be equivalent to changing the structure of the matrix, a task not undertaken in this study. Regarding output aggregation, it applies to commodities that are produced from more than one activity. This does not apply for the modified model presented in this chapter.

As can be seen in Figure 6.1, increased factor substitutability exacerbates welfare gain in urban areas and losses in rural areas under the OECD price change scenario. Decreased substitutability would lead to the opposite effect, thus reducing the variability in welfare effects between urban and rural zones. This is because rural production factors, such as the composite farming factors, are location-specific are relatively fixed compared to urban production factors (e.g., wage labor) which are more

mobile and more substitutable. Increased factor mobility will therefore work against less mobile factors, whereas decreased mobility will work against relatively more mobile factors. The initial results appear highly stable to changes in the second production elasticity of interest, that is, the elasticity of substitution between aggregate factors (value added) and aggregate intermediate inputs. Changes in overall EV in the OECD and other scenarios (not shown here) remained largely identical to their initial levels. This suggests that, at a national level, the relative mix of aggregate production factors or intermediate demands may have a little bearing on how trade reform scenarios would affect welfare (and consequently food security) in Mali.

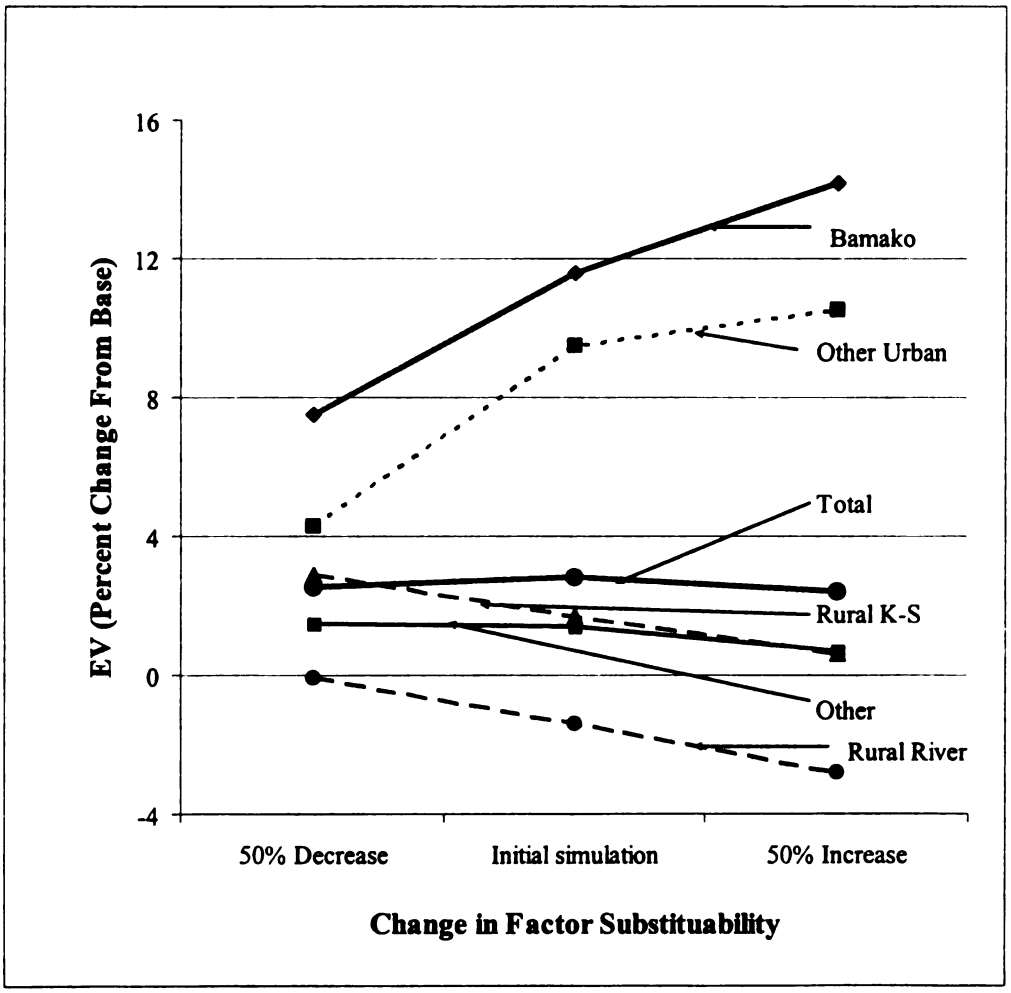

Figure 6.1: Change in EV in Response to Change in Factor Substitutability

(e.g. of OECD Price Change Scenario)

Changes in trade elasticities are indicated in Figures 6.2 and 6.3. The CET elasticity characterizes the degree to which domestic sales can be converted into exports, and the CES elasticity shows the degree to which imports can replace sales from domestic output. The higher these elasticities, the faster domestic sales will be converted into exports, or be displaced by imports. Regarding CET elasticities, the Rural Kayes-Sikasso appeared to be the biggest loser from a potential reduction in the tradability of exports with respect to domestic sales (a more than 10% loss with respect to initial parameters.) Kayes-Sikasso is the most agricultural region of the country, so the decreased export opportunities may increase domestic surplus, lower producer prices, and consequently reduce farmers' incomes. The effects are comparable to those observed under the cereal export ban scenario under which both the Kayes-Sikasso and the River rural households are expected to lose. Surplus-induced lower prices would benefit urban households. These effects are reversed when the CET elasticity is increased (Figure 6.2).

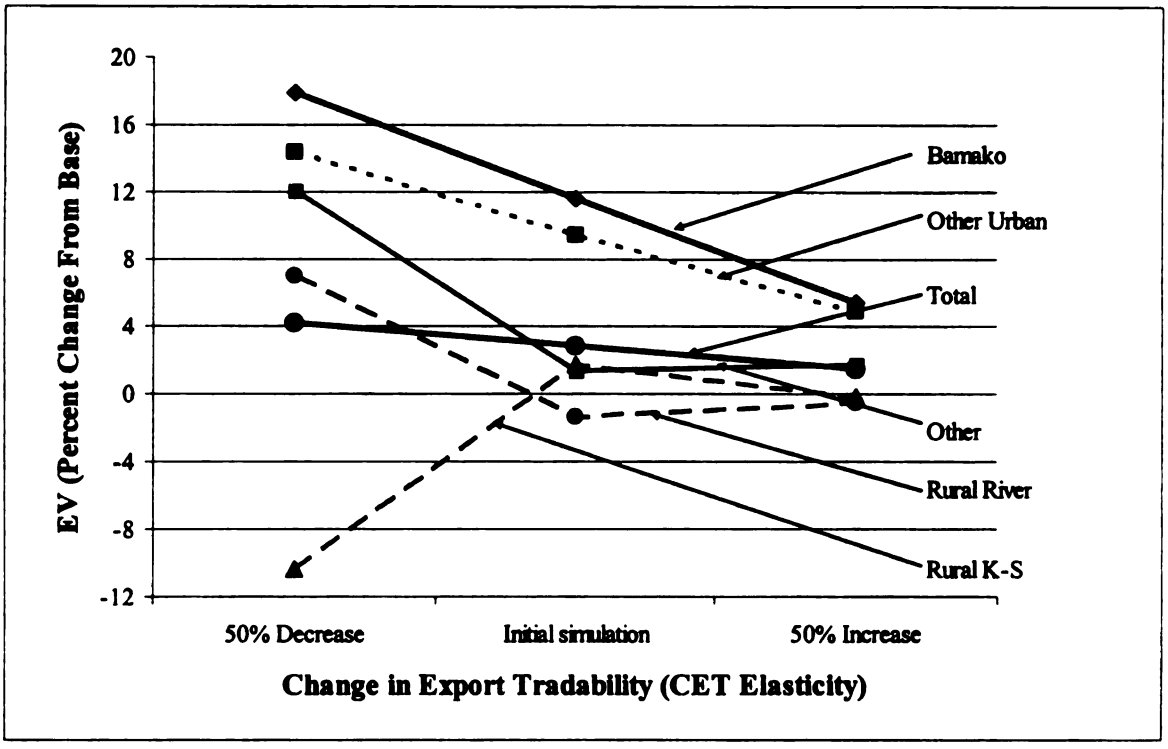

Figure 6.2: Change in EV in Response to Changes in Export Tradability (e.g. of OECD Price Change Scenario)

Regarding Armington elasticities, changes would also result in differential effects in urban and rural areas (Figure 6.3). Decreased substitutability between domestic sales and imports would reduce consumption flexibility, thus penalizing urban dwellers in an international environment where commodity prices are expected to decline (the OECD scenario). Conversely, increased tradability would work against rural residents who will experience real income fall following the lower domestic prices associated with relatively less expensive imports. In practice, both export and import tradability can be influenced by policy levers, such as the development of grades and standards.

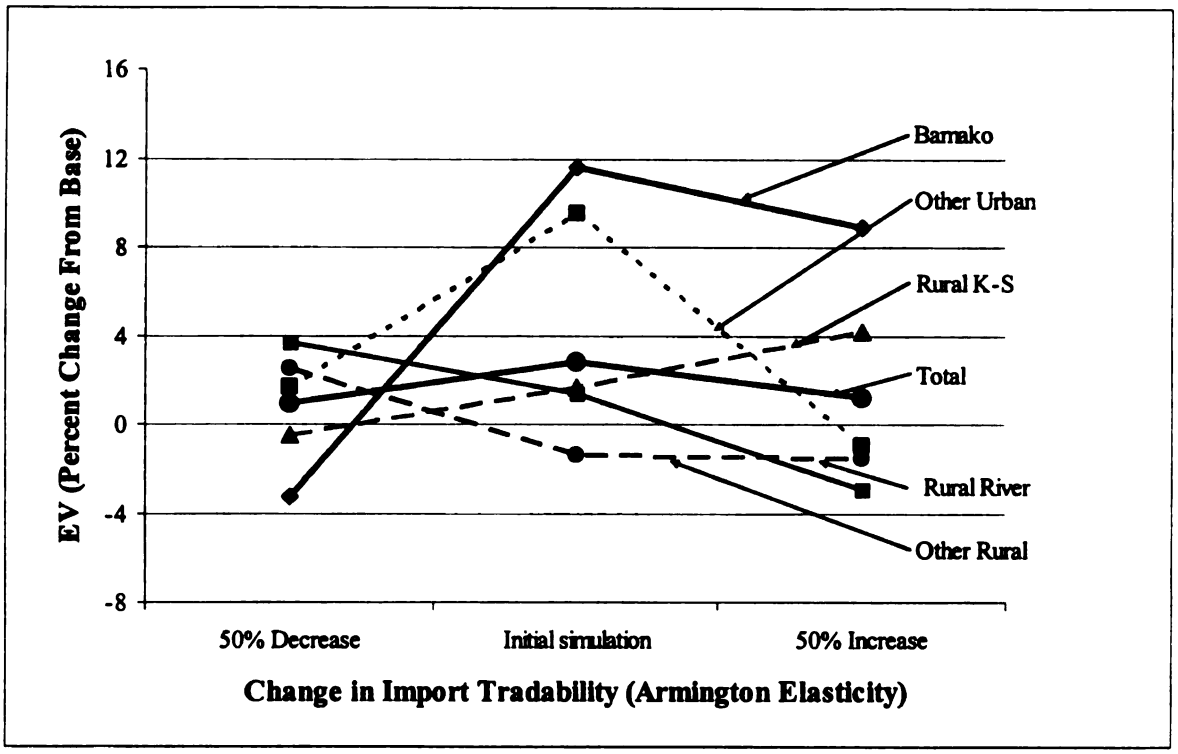

Figure 6.3: Change in EV in Response to Changes in Import Tradability (e.g. of OECD Price Change Scenario)

Overall, the results are less stable than often thought in CGE analyses (e.g., Wobst (2001) and Mbabazi (2002)). Quantitative changes in welfare are important under alternative factor substitution, export transformation and import substitution elasticities, and so are the qualitative changes. In many instances, changes in elasticities would determine whether a household lose or gain from the OECD price change scenario. It is worth remembering that the Malian CGE model is based on a peculiarly low quality data, and this may partly explain this relative instability that characterizes some of the results.

6.5.2. Sensitivity to Macroeconomic Closures

In the base model, all factors are fully employed. In addition, wage labor and capital were allowed to be mobile across sectors, whereas the composite factors were constrained to be sector-specific. This constraint was justified on the grounds that

composite production factors are not conventional in the neoclassical sense, because they represent a mixture of household labor, land and capital endowments. Thus, they are location-based and very specific to activities. They cannot, therefore, be mobile across sectors. The restriction on factor mobility proved justified when performing sensitivity analyses in which composite production factors were allowed to move across sectors. Under such a specification, the Malian CGE model did not have a feasible solution. Factor mobility would be more meaningful when the various components of the composite factors were isolated, so that factor returns are truly determined by inter-sectoral arbitrage opportunities. This would require a re-design of the Malian social accounting matrix, provided information on classical factor allocation is available.

The foreign market closure in the base model allowed for fixed foreign savings and flexible exchange rate, which adjusts to balance the trade account. The alternative closure is to allow the foreign savings to vary, while maintaining a fixed exchange rate. This alternative closure makes sense in the context of Mali where the nominal exchange rate is fixed, as the local currency (the CFA franc—CFAF) is pegged to Euro as part of a monetary cooperation between the West African Central Bank and the French Treasury. But since most international transactions are executed in US dollars (USD), the fluctuations in the USD-Euro exchange rate are automatically reflected in the nominal exchange rate between CFAF and USD. Thus, specifying a flexible exchange rate seems to be the most realistic in the Malian situation. Notwithstanding the fact, we examine how the initial results would change were the exchange rate to be fixed. The welfare results are depicted in Figure 6.4.[38] Fixing the exchange rate would free foreign

[38] Other evidence supporting the interpretation of the results are not presented here. The main effect is, nonetheless, consistent with previous observations, as explained in the remaining part of the section.

savings, which would nearly double (a 179% increase) under the OECD scenario. The inflow of foreign capital would lead to higher appreciation of the real exchange rate (12% against 3% in the initial simulation), which would result in export contraction. In addition, lower import prices (from the OECD scenario) would translate into lower producer prices. Real urban income would increase in response to lower domestic prices, which, together with decreased export opportunities, would reduce real rural incomes. The effects would be most severe in the Rural Kayes-Sikasso, where welfare effects could be reversed as one moves from flexible to fixed exchange rate (i.e. for fixed to flexible foreign savings).

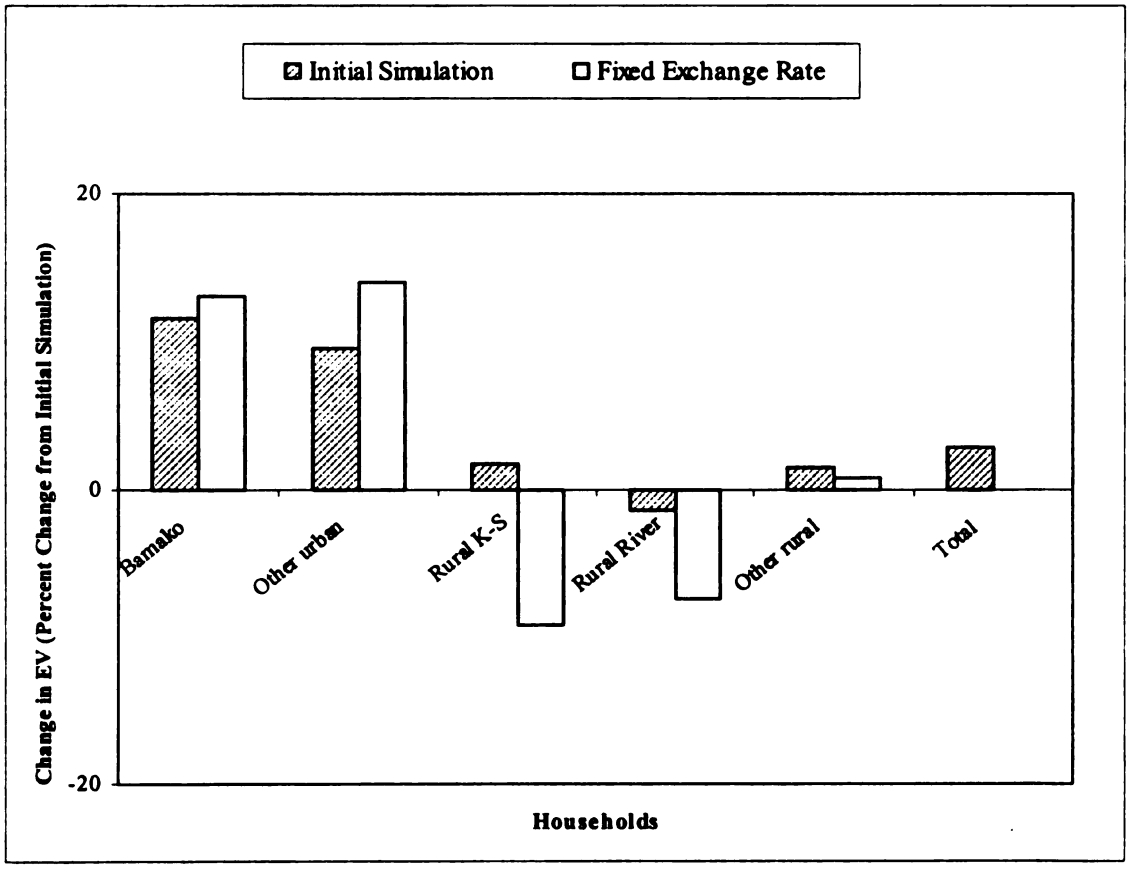

Figure 6.4: Comparison of the Changes in EV with Flexible (Initial Simulation) and Fixed Exchange Rates (e.g. of the OECD Price Change Scenario)

The last series of sensitivity analysis involves the savings-investment closure. In the standard model, the closure is said to be "investment-driven", that is, savings adjust endogenously to equilibrate the demand for fixed investments. We consider two alternative saving investment closure rules, one is saving-driven (i.e., investments are endogenously determined) and the other is a balanced saving-investment closure (all components of the total absorption adjust to balance the savings- investment account). Welfare results under these two alternative closures (along with the initial results for the OECD price change scenario) are shown in Figure 6.5.

It follows from the figure that, under the saving-driven closure (savings are fixed), investments must adjust and clear the fixed savings of the saving-investments account. The increased investments would mainly come, in rural areas, from increased stocks of livestock.[39] Rural consumption would then be reduced, resulting in rural welfare loss. Urban consumption would remain largely unchanged (slight increases were observed), and the overall national welfare would still improve under the OECD scenario, albeit by a lower margin. This result, because it is confined to a single period is misleading, as current investments would have future returns that are clearly not accounted for when evaluating welfare losses in rural areas. Lofgren, Harris and Robinson (2002) warn about this possibility and suggest that welfare results are more reliable when investments are fixed (this is the initial simulation).

The balanced saving-investment closure considered here is investment-driven (investments are fixed) and it involves uniform adjustment in saving rates and changes

[39] Domestic livestock prices would increase under this specification, and this would trigger a short-run withholding of breeding stocks from the markets (or vice versa, i.e. increased supply would reduce domestic supply leading to the price increase—the direction of causality in not clear from the single-period model used in this study). Detailed results are not shown here.

in direct taxes across domestic institutions (based on Equation 4.58, Chapter IV). Using this closure rule would reverse initial welfare effects in urban areas. These effects would

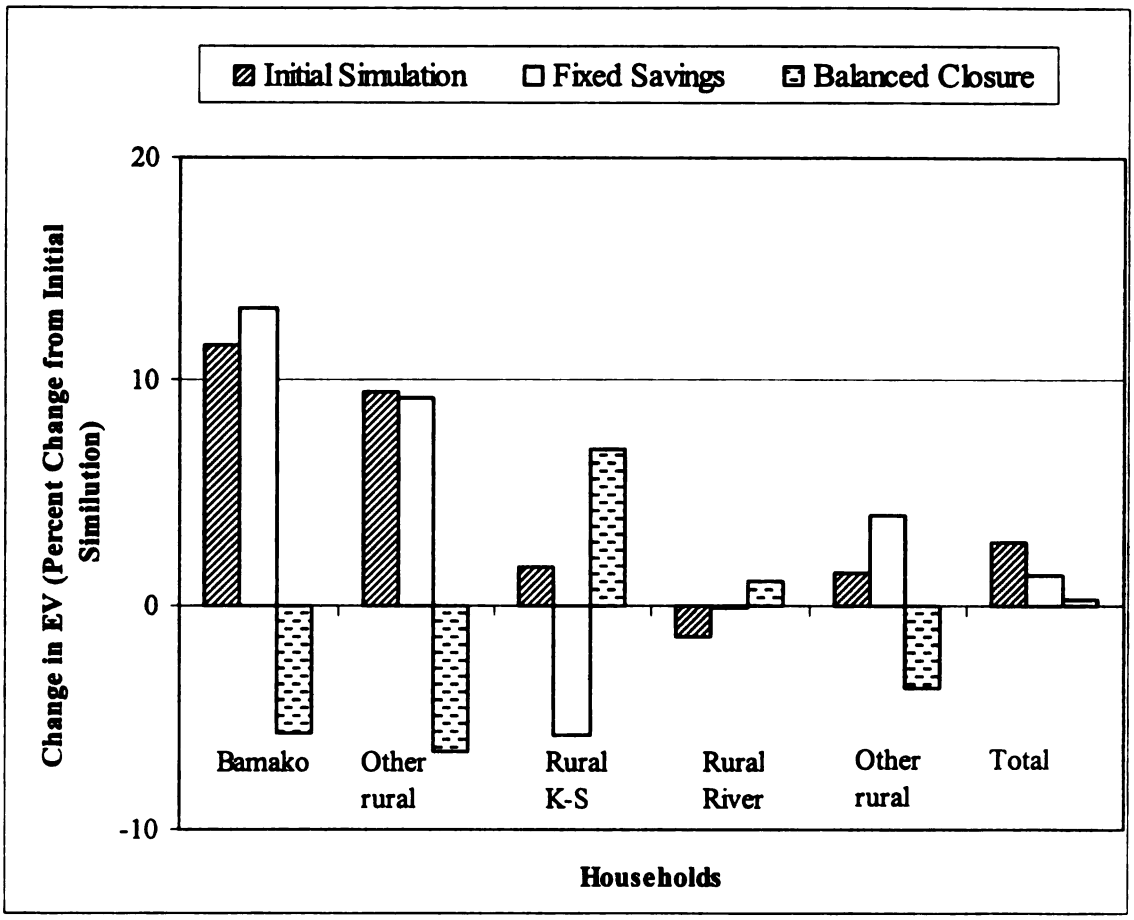

Figure 6.5: Changes in EV with Alternative Closures of the Saving-Investment Account (e.g. of the OECD Price Change Scenario)

mainly stem from higher taxes on wage labor, which would reduce wage incomes and decrease urban welfare. Change in national welfare, however, would remain marginally positive. The various macroeconomic closures appeared to preserve the direction of change in overall welfare, though there are differences at household levels. This seems to confirm observations made in Devarajan, Lewis and Robinson (1990) and Lofgren, Harris and Robinson (2002) that under full factor employment, various macroeconomic closures would have no or little effect on aggregate income. Despite this observation, the Malian CGE model results can be said to be less stable than standard results in CGE

analyses, partly due to the understandably lower data quality in the Malian analysis. The results remain useful in understanding the linkages between global trade policies, welfare and food security in Mali, even if the magnitudes of expected effects would vary depending on model parameters and macroeconomic closure rules.

6.6. Summary and Conclusion

This chapter discusses the implementation and the results of the Malian CGE model. The interest lies in understanding how changes in world commodity prices and domestic policy reforms would affect welfare and food security in the country. Welfare changes are measured by the equivalent variation, and changes in the state of food security were assessed through direct changes in food quantities consumed. The analysis is done for the country as a whole and for each the five household groups defined in the Malian social accounting matrix.

Nine global, bilateral and domestic trade policy reform scenarios are analyzed in the chapter. These nine scenarios are organized into four major groups based on the nature and source of the policy reforms. First, we compare two scenarios of incomplete reforms in the world commodity prices (FAPRI and OECD). Second, we examine two comparable scenarios of change in world commodity prices under the conditions of no and full implementation of WTO agricultural trade reforms (IFPRI-1 and IFPRI-2.). Third, we compare two scenarios of bilateral trade reforms (DFA and EEP), based on whether Malian exports would have preferential or non-preferential access to OECD markets. Finally, we examine three government policy scenarios, including banning cereal exports (BAN), effectively implementing a common external tariff regime (CET), and increasing public investments in key sectors.

The simulations are performed using IFPRI's standard CGE model, as discussed in Chapter IV. The analysis was based on an aggregated version of the Malian social accounting matrix presented in Chapter V. The Malian SAM was aggregated in order keep the analysis tractable, and to facilitate the generation of a feasible solution for the CGE model.

The results identify three interdependent channels through which price and policy scenarios would affect welfare and food consumption in Mali. These include changes in domestic prices, in factor incomes, and in the real exchange rates.

Price changes for both final and intermediate demand affect the real incomes of producers and consumers, often with opposite effects in urban and rural areas. For example, it was found that reduced world cereal prices in the two partial trade liberalization scenarios (FAPRI and OECD) would reduce domestic equilibrium prices, which in turn will mostly benefit urban households in Bamako and other urban zones. The same results are expected under full trade liberalization in the IFPRI-2 scenario. Regarding the IFPRI-1 status quo scenario (i.e. no further trade liberalization), however, commodity price effects appear to be dwarfed by the effects of exchange depreciation. The depreciation of the real exchange rate (RER) would weaken the purchasing power of imports, which in turn will lower consumption for net consumers (often urban households) while increasing incomes for net producers (often rural households). Except the EEP scenario, the RER would appreciate in all the other scenarios examined. In general, rural households would lose from RER appreciation, which would usually force a contraction in exports and depress the real producer revenues. A depreciation of the RER would have an opposite effect (e.g. of the IFPRI-1 scenario). In the EEP scenario,

however, the depreciation would stem from worsened conditions in the Malian export markets. This would slow the entire economy and reduce welfare across all households.

Changes in commodity prices also drive the welfare results in the three government policy scenarios. Banning cereals exports (BAN) would generate domestic surplus and lower cereals prices. Effectively implementing the CET regime would reduce average tariffs and reduce domestic prices. Investing in infrastructure would reduce production cost, which will also reduce domestic prices. In the BAN and CET scenarios, urban households would again benefit from reduced domestic prices, whereas rural households would lose. The cereal export ban could also have dynamic effects (not captured in this analysis) of undermining Mali's reputation in export markets as a reliable supplier, thereby hindering trade in future years. In the increased investments scenario, however, the gains a more evenly distributed between urban and rural households, because a reduction in production costs could increase both the producer and consumer surpluses.

Factor incomes would respond to changes in commodity prices. This response is commonly known as the Stolpler-Samuelson effects. In many cases, wage labor would gain in income, because it was assumed mobile across sectors (contrary to the composite production factors that were sector-specific). Factor mobility would permit a more efficient use of inter-sectoral arbitrage opportunities, hence an increase in its returns relative to the returns to fixed factors.[40] The Other Rural households share about one-quarter of wage labor incomes, and this proved very useful in compensating or even offsetting adverse shocks to producer prices observed under the price change scenarios.

[40] One should note that perfect mobility of labor is an extreme assumption as it assumes no private or social costs to intersectoral or rural-urban migration.

In many instances, welfare and food consumption would unambiguously improve in these households. At the same time, welfare loss and negative or ambiguous food consumption effects would be observed in the Rural Kayes-Sikasso and River households.

All these results vary with changes in model parameters and in macroeconomic closures, and are less stable than often reported in standard CGE analysis. The core qualitative results remain valid in terms of the channel through which global and domestic policy scenarios would affect welfare and food security in Mali. Because of the relative low quality of the Malian data, the magnitudes of the simulated effects need to be interpreted with caution. Except the EEP export regime, Mali is likely to gain from future reforms and productivity gains in world commodity markets. However, the gains would primarily be concentrated in Bamako and other urban zones (plus the Other Rural areas in many instances), whereas Rural Kayes-Sikasso and River households would shoulder most of the losses. Increased public investments would deliver the most Pareto-compatible welfare and food security results.

CHAPTER VII: SUMMARY, CONCLUSION AND RECOMMENDATIONS

> "...commodity policies are called a game in which politics overpowers economics and economists. In this characterization, anything that economists do, such as modeling consequence of alternative policies, is often thought to be for their own professional entertainment".
>
> John E. Lee, *Choices*, Fall 2002, p. 11.

7.1. The Research Question

This study has attempted to evaluate the potential impacts of WTO and West African agricultural trade reforms on welfare and food security in Mali. The WTO trade reforms involve a concerted effort among 145 nations toward increased liberalization of the world commodity markets through reductions in the level of trade-distorting supports to agriculture. West African trade reforms underscore the harmonization of agricultural trade policies among West African nations, with the aim of deepening the commercial integration in the region. These ongoing reforms are expected to change the level of welfare and food security in Mali and in other developing countries. But it is not clear a priori whether Mali would gain or lose from the anticipated increased liberalization of the World and West African agricultural markets. In addition, there are uncertainties regarding the extent to which WTO member countries would implement their trade reforms. These uncertainties have fueled speculations about the possible directions and magnitudes of changes in world commodity prices, and in the tariff protection regimes under which Mali will trade with its partners in West Africa and the rest of the world. This study has offered an approach to understand better the nature of the uncertainties by evaluating changes in welfare and food security in Mali under plausible scenarios of trade reforms.

The approach used in this study is based on a computable general equilibrium (CGE) analysis, and it consists of three key objectives. First, the study emphasizes the design of trade reform scenarios based on expected changes in world agricultural prices, in preferential trade opportunities for the Malian exports, and in government trade and fiscal policies. A second focus of the study is the construction of a social accounting matrix (SAM), which is the main database used in the Malian the CGE analysis. Finally, the study uses the SAM and the CGE model to simulate national and household-level welfare and food security impacts of trade and domestic policy reforms. Each of these three objectives is evaluated in sections 7.2, 7.3, and 7.4, respectively. Section 7.5 discusses the achievements and limitations of this study.

7.2. Trade Reform Scenarios

The first objective was to design trade reform scenarios, based on changes in world commodity prices, in the level of border protection applied to Malian exports, and in government trade and fiscal policies. There is an infinity of possible trade reform scenarios, which prompts the need to select a limited number of scenarios for tractable policy analysis. This study considers nine scenarios, each of which covering a specific aspect of global, bilateral or domestic policy reforms of interest.

Specifically, the study first compares two scenarios of change in world commodities prices that would result from a partial reform in world agricultural commodity markets (FAPRI and OECD).The magnitude and direction of change in the FAPRI and OECD scenarios depend on of change on a multitude of projection assumptions which differ in the two scenarios.

Second, the study also considers two comparable price change scenarios, based on the assumptions of no and full liberalization of the world commodity markets (IFPRI-1 and IFPRI-2). Contrary to the first price change scenarios where the underlying projection assumptions are different, only the assumed level of trade liberalization differs between the IFPRI-1 (status quo) and IFPRI-2 scenarios (full trade liberalization).

A third group of scenarios refers the two possible reforms in the bilateral trade opportunities in Mali. Such reforms would change the level of border protection (tariffs) facing key Malian exports to the rest of the world (ROW). Mali could face erosion in the preferential tariff rates that the country enjoys on its ROW exports, and this possibility is captured in the Effective Erosion of Preferences (EEP) scenario. Alternatively, Mali could obtain additional preferences in the form of Duty-Free Access (DFA) to exporting markets in the OECD countries. The DFA scenario is also considered in the analysis.

Finally, among the infinite policy actions the Government of Mali can take to manage its economy in rapidly changing world trade environment, this study emphasizes three scenarios. These include (i) a switch to a common external tariff regime (CET), (ii) an imposition of cereal export ban (BAN), and (iii) increased public investments for key sectors (GINV).

The rationale underlying each of these scenarios is discussed in detail in Chapter III, which deals exclusively with the design of trade reforms scenarios. The CGE simulation results in each of these scenarios are interpreted as the effects that the

policies and market conditions underlying these scenarios would have on the Malian economy, were these policies in place in 1997 (the base year used in the simulations).

7.3. Construction of a Detailed Social Accounting Matrix for Mali

Constructing a disaggregated social accounting matrix (SAM) for Mali is the second main objective of this study. To our best knowledge, this was the first matrix with such a level of detail in Mali. The matrix included 17 production sectors that produced 37 commodities, 25 of which were agricultural. In addition, there were nine production factors, five household types, and six different government policy instruments (taxes). The matrix also differentiated imports and exports based on their West African and ROW origins and destinations. The Malian SAM was built from very diverse and highly inconsistent data sources, and this created important imbalances between the demand (expenditures) and supply (incomes) accounts in the initial matrix. These initial imbalances were corrected using a procedure known as the cross-entropy (CE) SAM balancing method. The procedure is based on information theory and consists of finding a balanced matrix with the smallest deviation from the initial (unbalanced) matrix. The result of the CE procedure is a balanced social accounting matrix for Mali.

Although balanced, the matrix presented important structural differences with the initial matrix. This raises the question about whether the initial or the balanced SAM represents the "true", but unobserved, structure of the Malian economy. It is impossible to answer this question in light of the limited data that were available when the current SAM was built. Since then, however, the results of new household surveys and input-

output tables have been prepared, and their public release is imminent. These new (and certainly more consistent) data could reduce the observed disparities between the supply and demand sides of the economy. Improvements could also involve a definition of more homogenous production sectors, production factors, and household groups. The current matrix defines household groups based on their location. It also defined location-based production factors as a composite of classical production factors, such capital (including land) and labor. Thus, the returns to a composite factor represent aggregate returns to all of these factors. Besides, the localized nature of these factors makes them quasi-immobile in the CGE simulations. Such an assumption is reasonable, given structural rigidities in the Malian economy. Nonetheless, a definition of more conventional production factors can help sharpen the understanding of inter-sector shifts in factor allocations in response to reforms in world commodity markets.

7.4. A CGE Analysis of Welfare and Food Security Impacts of Trade Reforms in Mali

The central focus in this dissertation is the use of a computable general equilibrium model to simulate changes in welfare and food security under various trade reform scenarios. Welfare is measured by equivalent variation (EV), and food security is captured through the changes in food consumption at national and household levels, and in the capacity of the country to pay for its current food imports. While these indicators are not perfect measures of changes in welfare and food security, they are useful for approximating the effects of interest in this study.

The Malian computable general equilibrium model belongs to the class of the so-called neoclassical structuralist models. These models are based on the neoclassical general equilibrium of markets. They also include additional structural features, such as

home consumption of own productions. The Malian CGE model is essentially adapted from a standard neoclassical structuralist model developed by researchers at the International Food Policy Research Institute (IFPRI). Applying the standard CGE model the Malian data disaggregated social accounting generates an infeasible solution due to the presence of extremely small values in the matrix. Small entries pose serious convergence issues in nonlinear optimization models. In order to eliminate small entries, it was necessary to aggregate the 37 commodities into 20 commodity groups. The changes in the re-specified model have inevitably reduced the level of details initially contemplated. Nonetheless, the resulting analysis is still rich in details, allowing sectoral and household-level assessments of the impacts of global, bilateral and domestic trade policy reforms on welfare and food security in Mali.

The results indicate that under most of the scenarios, Mali will benefit from welfare gains and increased food consumption. As a country, Mali is likely to gain from expanded global (or North-South) trade, whether the expansion comes from partial (FAPRI and OECD) or full (IFPRI-2) liberalization of world commodity markets. Welfare would also increase if there were no further liberalization of world agricultural trade but productivity in the rest of the world continues to grow (IFPRI-1), or if the country secures an effective duty-free access for its exports to the world markets (DFA). The magnitude of welfare increases would vary from 1% (IFPRI-2) to 2.9% (OECD), and these differences are due to variations in the projected prices. Overall welfare would also increase under the three government policy scenarios (common external tariff, cereal export ban, and increased public investments in key sectors). The country's

welfare would decrease, however, if current trade preferences were eroded under the EEP trade regime.

The overall country effects hide important cross-household differences. Household effects are primarily determined by changes in domestic prices, which in turn affected factor incomes through the Stolper-Samuelson linkages. In general, reduced domestic prices would increase real urban incomes and decrease real incomes in rural areas. Reduced domestic prices would occur under partial (FAPRI, OECD) and full (IFPRI-2) liberalization of the world commodity markets. As net commodity purchasers, the two urban households (Bamako and Other Urban) as well as the Other Rural households (which has urban consumption pattern) would benefit from welfare increase whenever prices fell. Being net sellers of agricultural commodities, the remaining two rural households (Rural Kayes-Sikasso and River) would suffer more from the depressed real incomes associated with falls in domestic prices.

The status quo price change scenario (IFPRI-1) would have a mixed effect on domestic prices. Cereal prices would fall while livestock prices (only for "other livestock products") would increase, and the resulting effects would favor rural households, particularly those in the Kayes-Sikasso Region. Thus, the continuation of current world commercial policies would most likely benefit rural dwellers, with possibly net welfare losses in urban centers and in the Other Rural households.

In addition to changes in domestic prices, changes in factor incomes would also contribute to the observed changes in household welfare. The declines in domestic prices would generally be associated with higher returns to wage labor, which is has been specified as a mobile factor in the Malian CGE model. Reduced agricultural

productivity stemming from reduced commodity prices would force a reallocation of wage labor from less productive to more productive sectors, resulting in higher returns to this production factor. Since urban household own the quasi-totality of the wage labor factor, they would gain in welfare when the returns to wage labor increase in all but the IFPRI-1 and EEP scenarios. In the latter two scenarios, wage income would fall resulting in welfare losses in urban areas.

Changes in the real exchange rate also appeared to be associated with the observed welfare changes. In general, urban welfare would increase when the exchange rate appreciates, and fall under a depreciation of the real exchange rates. Conversely, rural household would generally benefit from the depreciation (IFPRI-1). But an exception occurred under the EEP scenario in which real exchange rate depreciation could lead to reduced imports of intermediate inputs, and ultimately to generalized losses in welfare across all households. Rural households would lose from a currency appreciation, which could reduce exports and thereby producers' incomes.

Welfare results under the three government policies (implementing CET regime, banning cereal exports, and increasing public investments in key sectors) have the same characteristics as the results under the other scenarios. As before, these policies affect welfare through three interdependent effects on domestic prices, factor incomes, and real exchange rates. Overall welfare would increase under the CET and increased public investments scenarios, while remaining substantially unchanged when cereal exports are banned. Cereal export bans would raise domestic supply and reduce prices, which would have negative welfare impact in rural households and a positive impact in urban zones. The CET regime would reduce average tariffs, and thereby the domestic prices. The

increased public investments would also result in overall welfare gains in the country, with most of the gains concentrated in the Other Urban and Kayes-Sikasso households. In terms of welfare, this scenario will deliver a Pareto-compatible outcome in which no household would substantially lose from the positive investment shocks. These investments would help both producers and consumers through lower intermediate and final demand prices. Underlying the investment result is the assumption that the distribution of aggregate public investments mirrors the pattern in the base year, and is relatively well spread out across households. In practice, however, public investments are made at the margin, and they tend to be sector and location-specific. Thus, the expected Pareto-compatible effects of increased public investments will most likely weaken, if the increases were to be allocated at the margin, instead of the current across-the-board allocation.

In most cases, food security effects will follow closely the welfare impacts. Food consumption would unambiguously increase under expanded liberalization of world commodity markets (particularly the FAPRI scenario). Conversely, erosion in tariff preferences would unambiguously reduce food consumption across all households in Mali. The ratio of current food imports to total exports revenues did not present any systematic relationship with the level of food consumption in Mali.

All these results are obtained under the assumption Mali would not benefit from the worldwide productivity gain, which would drive reduction in world commodity prices. An alternative scenario is to investigate the case when also benefit from productivity gains, concurrently with the rest of the world. This scenario was investigated and the results indicate that increased productivity in Mali would reduce, or

even reverse, losses incurred in rural areas. This is mainly because a gain in productivity in Mali would increase the competitiveness of domestic production, limiting the negative effects on increased imports on domestic production.

An important conclusion from the results is that the South-South liberalization (the CET regime) would result in 3% overall welfare increase, and a similar magnitude of gains is expected under the North-South partial liberalization scenarios (FAPRI and OECD). So, from the perspective of the country as a whole, there is as much gain to be expected from effective implementation of the CET regime in West Africa, as there are gains from increased liberalization in the rest of the world. This confirms the common belief that poor countries would benefit from own trade liberalization. However, most of the expected gains would go to urban households, who would benefit from important falls in final demand prices, real exchange rate appreciation and increased returns to their endowment.

This unequal distribution of the potential gains (which would favor urban dwellers) could encourage lobbying for and against the maintenance and an effective implementation of trade reforms. As indicated in the quote at the beginning of this chapter (Lee, 2002), it is these sorts of conflictual interests that empower politics to overpower economics and economists, when it comes to the making of agricultural commodity policies.

7.5. Achievements and Limitations of the Dissertation

One of the limitations of this study is that some of the quantitative results appear to be less stable than standard results in computable general equilibrium analysis. The Malian CGE model was moderately sensitive to parameter values and to some

macroeconomic closures regarding the foreign market and the savings-investment accounts. This moderate sensitivity of the CGE results may be due to the relatively limited quality of the Malian social accounting matrix. Despite this sensitivity of quantitative estimates, qualitative results can be viewed as robust, particularly in terms of how the fundamentals (movements in commodity prices, in factor incomes, and in the real exchange rates) would affect welfare and food security in Mali. Because the magnitude of the simulated effects is less stable, caution is needed when using the quantitative results for policy applications.

Despite the various limitations outlined throughout the study, we can say that the key objectives of the study have been met in their essence. Yet, this study may be improved in many respects. First, we indicated earlier that there is a tremendous room for improving the quality of data used in this study, once recent micro and macroeconomic survey results are made available. The quality of the social accounting matrix is crucial to the quality of the CGE results, and it important that a representative matrix for the country be put together for Mali. This is best done by a team of sectoral experts using the best available information from national and multilateral institutions. We have also identified serious imbalances in the supply and demand sides of the economy. Creating a balanced social accounting matrix by a team of experts would be one of the best ways to reconcile production and consumption data in Mali. It could also permit more specific distinction of household groups and production factors in the economy. The SAM could finally be used for a wide range of policy analyses, and would be great addition to the economic analysis toolkit for the country.

Second, there is also a room to modify the standard analytical model to reflect more closely a more empirically-based specification of the production technology and consumer preferences in Mali. The current generic LES demand and CES/Leontief technologies could eventually be replaced with evidence-based specification of consumer preferences and production technologies that are more representative of the Malian economy. An example of such evidence is Camara's (2004) characterization of consumer demand in Bamako within the Almost Ideal Demand System (AIDS) framework.

Third, the Malian model is static, but results suggest that there could be several adjustment and readjustment processes at work between the base year and the counterfactual general equilibria of the economy. For example, changes in investment demand has both contemporaneous and future effects, but the lack of dynamics in a standard CGE model would fail to capture future effects if investments are endogenously determined. A dynamic model would, therefore, be useful for a richer understanding of the adjustment path the economy will follow in response to policy shocks.

Fourth, it is clear that CGE models represent a useful framework to understand the impacts of alternative trade and government policies. Yet, smaller models that trace the impacts of specific policy changes at sector or even at commodity (*filière*) levels are necessary to complement CGE-based results. Diagana et al. (1999) is an example of such an alternative analysis, applied to the impacts of the devaluation of the CFA franc on the agricultural sector in West Africa.

Fifth, the analysis is limited to the inter-household effects of policy changes. There are ample evidence, however, that policy changes has both inter- and intra-household effects. There is an emerging literature on micro-simulations that permit analyses of both effects within general equilibrium models. Such analyses are based on actual households, as opposed to standard analyses that rely on representative households. The expenditures and incomes of real households are directly obtained from household surveys, and the social accounting matrix in micro-simulation analyses contains as many households as there are in the surveys. Micro-simulation analyses are possible if there are reliable income and expenditure data on each real household. Currently in Mali, only the 1994 survey meets this criterion. Unfortunately, the survey is of limited value for current policy analyses because several structural changes took place in Mali since the survey was conducted immediately after the 1994 devaluation of the CFA franc. A combined income-expenditure survey would be required for reliable micro-simulation analyses in Mali.

Finally, a general message from this study is that in a world where agricultural productivity is growing faster than in Mali, urban consumers benefit from freer trade regimes that allow them to access that increased productivity. Rural farmers with immobile resources, producing import substitutes, generally lose. The losses are mitigated, or even reversed, if the Malian agricultural sector becomes equally productive as in the rest of the world, because domestic productions are able to compete more effectively against imports.

APPENDICES

Appendix 4.1: Mathematical Model: Sets, Parameters, Variables and Equations[41]

SETS

$a \in A$	Activities
$a \in ACES(\subset A)$	Activities with CES function at the top of the technology nest
$c \in C$	Commodities
$c \in CD(\subset C)$	Commodities with domestic sales of domestic output
$c \in CDN(\subset C)$	Commodities not in CD
$c \in CE(\subset C)$	Exported commodities
$c \in CEN(\subset C)$	Commodities not in CE
$c \in CM(\subset C)$	Imported commodities
$c \in CMN(\subset C)$	Commodities not in CM
$c \in CT(\subset C)$	Transactions service commodities
$c \in CX(\subset C)$	Commodities with domestic production
$f \in F$	Factors
$i \in INS$	Institution (domestic and rest of the world)
$i \in INSD(\subset INS)$	Domestic institutions
$i \in INSDNG(\subset INSD)$	Domestic non-government institutions
$h \in H(\subset INSDNG)$	Households

PARAMETERS

Latin letters

$cwts_c$	Weight of commodity *c* in the *CPI*
$dwts_c$	Weight of commodity *c* in the production price index
$ica_{c,a}$	Quantity of *c* as intermediary input per unit of activity *a*
$icd_{c,c'}$	Quantity of commodity *c* as trade input per unit of *c'* produced and sold domestically
$ice_{c,c'}$	Quantity of commodity *c* as trade input per exported unit of *c'*
$icm_{c,c'}$	Quantity of commodity *c* as trade input per imported unit of *c'*
$Inta_a$	Quantity of aggregate intermediate input per activity unit
iva_a	Quantity of value-added per activity unit
$\overline{mps_i}$	Base saving rate for domestic institution *i*
$mps01_c$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates
pwe_c	Export price (foreign currency)
pwm_c	Import price (foreign currency)
$qdst_c$	Quantity of stock change
$\overline{qg_c}$	Base-year quantity of government demand

[41] This Appendix substantially uses materials from Lofgreen, Harris and Robinson (2002).

$\overline{qinv_c}$	Base-year quantity of private investment demand
$shif_{i,f}$	Share of the domestic institution i in income of factor f
$shif_{i,i'}$	Share of net income of i' to i ($i' \in INSDNG'; i \in INSDNG$)
ta_a	Tax rate for activity a
te_c	Export tax rate
tf_f	Direct tax rate for factor f
$\overline{tins_i}$	Exogenous direct tax rate for domestic institution i
$tins01_i$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates
tm_c	West African import tariff rate
tq_c	Rate of sales tax
$trnsfr_{i,f}$	Transfer from factor f to institution i
tva_a	Rate of value-added tax for activity a

Greek letters

α_a^a	Efficiency parameter in the CES activity function
α_a^{va}	Efficiency parameter in the CES value-added function
α_a^{ac}	Shift parameter for the domestic commodity aggregation function
α_a^q	CES function shift parameter (imports and domestic sales)
α_a^t	CET shift function parameter (exports and domestic sales)
$\beta_{a,c,h}^h$	Marginal share of consumption spending on home commodity c from activity a for household h
$\beta_{a,h}^m$	Marginal share of consumption spending on marketed commodity c for household h
δ_a^a	CES activity share parameter
$\delta_{a,c}^{ac}$	Share parameter of domestic commodity aggregation function
δ_c^q	CES function share parameter (imports and domestic sales)
δ_c^t	CET function share parameter (exports and domestic sales)
$\delta_{f,a}^{va}$	CES value-added function share parameter for factor f in activity a
$\gamma_{c,h}^m$	Subsistence consumption of marketed commodity c for household h
$\gamma_{a,c,h}^h$	Subsistence consumption of home commodity c from activity a for household h
$\theta_{a.c}$	Yield of output c per unit of activity a
ρ_a^a	CES production function exponent
ρ_a^{va}	CES value-added function exponent

EXOGENOUS VARIABLES

$\overline{CPI}$	Consumer price index
$\overline{DTINS}$	Change in domestic institution tax share (= 0 for base; exogenous variable)
$\overline{FSAV}$	Foreign saving (foreign currency)
$\overline{GADJ}$	Government consumption adjustment factor
$\overline{IADJ}$	Investment adjustment factor
$\overline{MPSADJ}$	Saving rate scaling factor (= 0 for base)
$\overline{QFS_f}$	Quantity supplied of factor
$\overline{TINSADJ}$	Direct tax scaling factor (= 0 for base; exogenous variable)
$\overline{WDFDIST_{f,a}}$	Wage distortion factor for factor *f* in activity *a*

ENDOGENOUS VARIABLES

$DMPS$	Change in domestic institution saving rates (= 0 for base; exogenous variable)
DPI	Producer price index for domestically marketed output
EG	Government expenditures
EH_h	Consumption spending for household
EXR	Exchange rate (local currency per unit of foreign currency)
$GOVSHR$	Government consumption share in nominal absorption
$GSAV$	Government savings
$INVSHR$	Investment share in nominal absorption
MPS_i	Marginal propensity to save for domestic non-government institution (exogenous variable)
PA_a	Activity price (unit gross revenue)
PDD_c	Demand price for commodity produced and sold domestically
PDS_c	Supply price for commodity produced and sold domestically
PE_c	Export price (domestic currency)
$PINTA_a$	Aggregate intermediary input price for activity *a*
PM_c	Import price (domestic currency)
PQ_c	Composite commodity price
PVA_a	Value-added price (factor income per unit of activity)
PX_c	Aggregate producer price for a commodity
$PXAC_{a,c}$	Producer price for commodity *c* for activity *a*
QA_a	Quantity (level) of activity
QD_c	Quantity sold domestically of output
QE_c	Quantity of exports
$QF_{f,a}$	Quantity demanded of factor *f* from activity *a*
QG_c	Government consumption demand for commodity
$QHA_{a,c,h}$	Quantity of household home consumption of commodity *c* from activity *a* for household *h*

QE_c	Quantity of exports
$QF_{f,a}$	Quantity demanded of factor f from activity a
QG_c	Government consumption demand for commodity
$QHA_{a,c,h}$	Quantity of household home consumption of commodity c from activity a for household h
$QINTA_a$	Quantity of aggregate intermediary input
$QINT_{c,a}$	Quantity of commodity c as intermediary input to activity a
$QINV_c$	Quantity of investment demand for commodity
QM_c	Quantity of imports
QQ_c	Quantity of goods supplied to domestic market (composite supply)
QT_c	Quantity of commodity demanded as trade input
QVA_a	Quantity of (aggregate) value-added
QX_c	Aggregate marketed quantity of domestic output of commodity
$QXAC_{a,c}$	Quantity of market output of commodity c from activity a
$TABS$	Total nominal absorption
$TINS_i$	Direct tax rate for institution i ($i \in INSDNG$)
$TRII_{i,i'}$	Transfer from institution i' to i (both in the set $INSDG$)
WF_f	Average factor price f
YF_f	Income of factor f
YG	Government revenue
YI_i	Income of domestic non-government institution
$YIF_{i,f}$	Income to domestic institution i from factor f

EQUATIONS

1. Price Block

Import price:
$$PM_c = pwm_c.(1+tm_c).EXR + \sum_{c' \in CT} PQ_{c'}.icm_{c'c} \qquad c \in CM \qquad (4.1)$$

Export price:
$$PE_c = pwe_c.(1-te_c).EXR - \sum_{c' \in CT} PQ_{c'}.ice_{c'c} \qquad c \in CE \qquad (4.2)$$

Demand price of nontraded goods:
$$PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'}.icd_{c'c} \qquad c \in CD \qquad (4.3)$$

Absorption
$$PQ_c.(1-tq_c).QQ_c = PDD_c.QD_c + PM_c.QM_c \qquad c \in (CD \cup CM) \qquad (4.4)$$

Market output value
$$PX_c.QX_c = PDS_c.QD_c + PE_c.QE_c \qquad c \in CX \qquad (4.5)$$

Activity price
$$PA_a = \sum_{c \in C} PXAC_{ac}.\theta_{ac} \qquad a \in A \qquad (4.6)$$

Aggregate intermediate input price
$$PINTA_a = \sum_{c \in C} PQ.ica_{ac} \qquad a \in A \qquad (4.7)$$

Activity revenue and cost
$$PA_a.(1-ta_a).QA_a = PVA_a.QVA_a + PINTA_a.QINTA_a \qquad a \in A \qquad (4.8)$$

Consumer price index
$$\overline{CPI} = \sum_{c \in C} PQ_c.cwts_c \qquad (4.9)$$

Producer price index for nontraded market output
$$DPI = \sum_{c \in C} PDS_c.dwts_c \qquad (4.10)$$

2. Production and Trade Blocks

CES technology: Activity prod. Function
$$QA_a = \alpha_a^a.\left(\delta_a^a.QVA_a^{-\rho_a^a} + (1-\delta_a^a).QINTA_a^{-\rho_a^a}\right)^{-\frac{1}{\rho_a^a}} \qquad a \in ACES \qquad (4.11)$$

CES tech.: value-added intermediate input quantity ratio
$$\frac{QVA_a}{QINTA_a} = \left(\frac{QINTA_a}{PVA_a}.\frac{\delta_a^a}{1-\delta_a^a}\right)^{\frac{1}{1+\delta_a^a}} \qquad a \in ACES \qquad (4.12)$$

Value-added and factor demands
$$QVA_a = \alpha_a^{va}.\left(\sum_{f \in F} \delta_{fa}^{va}.QF_{fa}^{-\rho_a^{va}}\right)^{\frac{1}{\rho_a^{va}}} \qquad a \in A \qquad (4.13)$$

Factor demand
$$WF_f.\overline{WFDIST}_{fa} = PVA_a.(1-tva_a).\left(\sum_{f \in F'} \delta_{fa}^{va}.QF_{fa}^{-\rho_a^{va}}\right)^{-1}.\delta_{fa}^{va}.QF_{fa}^{-\rho_a^{va}-1} \qquad a \in A,\ f \in F \qquad (4.14)$$

Leontief tech.: demand for aggregate value-added	$QVA_a = iva_a.QA_a$	$a \in ALEO$	(4.15)
Leontief tech.: demand for aggregate intermediate input	$QINTA_a = inta_a.QA_a$	$a \in ALEO$	(4.16)
Disaggregated intermediate input demand	$QINT_{ca} = ica_{ca}.QINTA_a$	$a \in A$ $c \in C$	(4.17)
Commodity production and allocation	$QXAC_{ac} + \sum_{h \in H} QHA_{ach} = \theta_{ac}.QA_a$	$a \in A$ $c \in CX$	(4.18)
Output aggregation function	$QX_c = \alpha_c^{ac}.\left(\sum_{a \in A} \delta_{ac}^{ac}.QXAC_{ac}^{-\rho_c^{ac}}\right)^{-\frac{1}{\rho_c^{ac}-1}}$	$c \in CX$	(4.19)
First-order condition for output aggregation function	$PXAC_{ac} = PX_c.QX_c\left(\sum_{a \in A'} \delta_{ac}^{ac}.QXAC_{ac}^{-\rho_c^{ac}}\right)^{-1}.$ $\delta_{ac}^{ac}.QXAC_{ac}^{-\rho_c^{ac}-1}$	$a \in A$ $c \in CX$	(4.20)
Output transformation (CET) function	$QX_c = \alpha_c^t.\left(\delta_c^t.QE_c^{\rho_c^t} + (1-\delta_c^t).QD_c^{\rho_c^t}\right)^{\frac{1}{\rho_c^t}}$	$c \in$ $(CE \cap CD)$	(4.21)
Export-domestic supply ratio	$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PDS_c}.\frac{1-\delta_c^t}{1-\delta_c^t}\right)^{\frac{1}{\delta_c^t-1}}$	$c \in$ $(CE \cap CD)$	(4.22)
Output transformation for non exported commodities	$QX_c = QD_c + QE_c$	$c \in$ $(CD \cap CEN)$ $\cup$ $(CE \cup CDN)$	(4.23)
Composite supply (Armington) function	$QQ_c = \alpha_c^q.\left(\delta_c^q.QM_c^{-\rho_c^q} + (1-\delta_c^q).QD_c^{-\rho_c^q}\right)^{-\frac{1}{\rho_c^q}}$	$c \in$ $(CM \cap CD)$	(4.24)
Import-domestic demand ratio	$\frac{QM_c}{QD_c} = \left(\frac{PDD_c}{PM_c}.\frac{\delta_c^q}{1-\delta_c^q}\right)^{\frac{1}{1+\delta_c^t}}$	$c \in$ $(CM \cap CD)$	(4.25)
Demand for transaction services	$QT_c = \sum_{c' \in C'} icm_{cc'}.QM_{c'} + ice_{cc'}QE_{c'} + icd_{cc'}QD_{c'}$	$c \in CT$	(4.27)

3. Institution Block

Factor income

$$YF_f + \sum_{a \in A} WF_f.\overline{WFDIST}_{fa}.QF_{fa} \qquad f \in F \qquad (4.28)$$

Institutional factor income

$$YIF_{if} = shif_{if}\left((1-tf_f).YF_f - trnsf_{rowf}.EXR\right) \qquad i \in INSD,\ f \in F \qquad (4.29)$$

Income of domestic non-government institutions

$$YI_i = \sum_{f \in F} YIF_{if} + \sum_{i' \in INSDNG'} TRII_{ii'} + trnsf_{igov}.\overline{CPI} + trnsf_{irow}.EXR \qquad i \in INSDNG \qquad (4.30)$$

Intra-institutional transfers

$$TRII_{ii'} = shii_{ii'}.(1-MPS_{i'}).(1-TNIS_{i'}).YI_{i'} \qquad i \in INSDNG,\ i' \in INSDNG' \qquad (4.31)$$

Household consumption expenditure

$$EH_h = \left(1 - \sum_{i \in INSDNG} shii_{ih}\right).(1-MPS_h).(1-TNIS_h).YI_h \qquad h \in H \qquad (4.32)$$

Household consumption demand and marketed commodity

$$PQ_c.QH_{c,h} = PQ_c.\gamma^m_{c,h} + \beta^m_{c,h}.\left(EH_h - \sum_{c' \in C} PQ_{c'}.\gamma^m_{c',h} - \sum_{a \in A}\sum_{c' \in C} PXAC_{a,c'}.\gamma^h_{a,c',h}\right) \qquad c \in C,\ h \in H \qquad (4.33)$$

HH consumption demand for home consumption

$$PXAC_{a,c}.QHA_{a,c,h} = PXAC_{a,c}.\gamma^h_{a,c,h} + \beta^h_{a,c,h}.\left(EH_h - \sum_{c' \in C} PQ_{c'}.\gamma^m_{c',h} - \sum_{a \in A}\sum_{c' \in C} PXAC_{a,c'}.\gamma^h_{a,c',h}\right) \qquad a \in A,\ c \in C,\ h \in H \qquad (4.34)$$

Investment demand

$$QINV_c = \overline{IADJ}.\overline{qinv_c} \qquad c \in CINV \qquad (4.35)$$

Government consumption demand

$$QG_c = \overline{GADJ}.\overline{qg_c} \qquad c \in C \qquad (4.36)$$

Government revenue

$$\begin{aligned} YG = {} & Q \sum_{i \in INSDNG} TINS_i.YI_i \\ & + \sum_{f \in F} tf_f.YF_f + \sum_{a \in A} tva_a.PVA_a.QVA_a \\ & + \sum_{a \in A} ta_a.PA_a.QA_a + \sum_{c \in CM} tm_c.pwm_c.QM_c.EXR \\ & + \sum_{c \in CE} te_c.pwe_c.QE_c.EXR + \sum_{c \in C} tq_c.PQ_c.QQ_c \\ & + \sum_{f \in F} YIF_{gov,f} + trnsfr_{gov,row}.EXR \end{aligned} \qquad (4.37)$$

Government expenditure

$$EG = \sum_{c \in C} PQ_c.QG_c + \sum_{i \in INSDNG} trnsfr_{i,gov}.\overline{CPI} \qquad (4.38)$$

4. System Constraint Block

Factor market

$$\sum_{a \in A} QF_{f,a} = \overline{QFS_f} \qquad f \in F \qquad (4.39)$$

Composite commodity market

$$QQ_c = \sum_{a \in A} QINT_{c,a} + \sum_{h \in H} QH_{c,h} + QG_c + QINV_c + qdst_c + QY_c \qquad c \in C \qquad (4.40)$$

Current account balance for rest of the world (in foreign currency)

$$\sum_{c \in CM} pwm_c.QM_c + \sum_{f \in F} trnsfr_{row,f} = \sum_{c \in CE} pwe_c.QE_c + \sum_{i \in INSD} trnsfr_{i,row} + \overline{FSAV} \qquad (4.41)$$

Government balance

$$YG = EG + GSAV \qquad (4.42)$$

Direct institutional tax rate

$$TINS_i = \overline{tins_i}.(1 + \overline{TINSADJ}.tins01_i) + \overline{DTINS}.tins01_i) \qquad i \in INDSNG \qquad (4.43)$$

Institutional saving rate

$$MPS_i = \overline{mps_i}.(1 + \overline{MPSADJ}.mps01_i) + \overline{DMPS}.mps01_i) \qquad i \in INDSNG \qquad (4.44)$$

Saving-investment balance

$$\sum_{i \in INSDNG} MPS_i.(1 - TINS_i).YI_i + GSAV + EXR.\overline{FSAV} = \sum_{c \in C} (PQ_c.QINV_c + \sum_{c \in C} PQ_c.qdst_c) \qquad (4.45)$$

Total absorption

$$TABS = \sum_{h \in H} \sum_{c \in C} PQ_c.QH_{c.h} + \sum_{a \in A} \sum_{h \in H} \sum_{c \in C} PXAC_{a,c}.QHA_{a,c.h} + \sum_{c \in C} PQ_c.QG_c + \sum_{c \in C} PQ_c.QINV_c + \sum_{c \in C} PQ_c.qdst_c \qquad (4.46)$$

Ratio of investment to absorption

$$INVSHR.TABS = \sum_{c \in C} PQ_c.QINV_c + \sum_{c \in C} PQ_c.qdst_c \qquad (4.47)$$

Ratio of government consumption to absorption

$$GOVSHR.TABS = \sum_{c \in C} PQ_c.QG_c \qquad (4.48)$$

Appendix 5.1: Justification of Entries in the Malian Macrosam

There are 34 nonzero entries in the Malian macrosam, as presented in Table 5.2. This Appendix documents the sources and the rationale of each of these entries. Throughout this section, a cell is referred as [Row, Column] where the first element refers to the row, and the second to the column. All figures are expressed in million CFAF francs (CFAF).

Both the **729,045** million CFAF attributed to intermediate inputs [Commodities, Activities] and the **1,310,343** million of value added at factor cost [Factors, Activities] were taken directly from the national accounts published by DNSI. The sum of these two values is the gross output, evaluated to be 2,039,388 million.

Along the row, activities received income from marketed output [Activity, Commodities] and from home-consumed output [Activities, Households]. The input-output (I-O) table indicated that households' home consumption [Activities, Households] in 1997 was **320,311** million, whereas the private final consumption [Commodities, Households] was **663,356** million, and the final consumption of the government [Commodities, Government] was **221,563** million. The value of the marketed output [Activities, Commodities] was **1,719,077** million, the difference between the gross output and the home-consumed output.

Regarding the marketing margins [Commodities, Commodities], the auxiliary DNSI accounts suggest that they represented about 12% of the total private consumption, which would be 118,040 million. For the macrosam, we have retained a more precise estimate of the aggregate marketing margins, evaluated to **126,500** million based on detailed estimates discussed later in Appendix 5.2.

The Malian total exports [Commodities, ROW] in 1997 were valued to **361,610** million CFAF, while imports [ROW, Commodities] run at **486,200** in the same year. These figures were taken directly from DNSI national accounts, which also valued the1997 changes in stocks [Commodities, Stock Change] to be -22,789. It is straightforward to verify that this figure is the sum of the variation in the stocks of cotton (-28,514) and livestock (5,755). A careful analysis of the I-O table revealed, however, changes in the stocks of other commodities in 1997. These include gold (-30), food crops (8,426), other manufacturing goods (5,533), water, electricity and energy (3,200) and other trading services (16,800). Changes in stocks for traded services refer to equipments specific to the delivery of these services. It is unclear why these latter variations in stocks were not included in the DNSI official figures on stock variation, which was set to -22,789 million. Given that the I-O table was one of our main data source used in building the SAM, we have treated the official figures as inaccurate. We have, therefore, used all the details provided in the I-O table, and this changed the total variations in stocks to **11,170** million CFAF.

Commodities also received payments from private and public investments. These payments were entered in cells [Commodities, Capital Investment] and

[Commodities, Government Investment], respectively. The main DNSI accounts only provided the value of the total investment, known as the *Formation Brute Capital Fixe* (FBCF). This value was 348,093 million CFAF. This figure is very close to the 347,300 million allocated to FBCF in the BCEAO database. BCEAO figures also indicated that the public sector accounts for 31.9% of the total investment, while private investment makes up the difference. Thus, we used the ratio 31.9:68.1 to distribute the total investment to the public and private sectors, which receive **110,893** and **237,200**, respectively.

The *Tableau Economique Integré* (TEI), which is an unpublished source from DNSI, indicates that factor return to households made about 80% of value added. This was equivalent to **1,048,874** million CFAF, entered in cell [Households, Factors]. The total factor income and tax to government amounted to 88,555 million according to TEI figures (factor taxes alone were 10,305 million). This amount was adjusted by government service of foreign debt, evaluated to 13,000 million according the IMF sources. Thus, the entry to [Government recurrent, factor] was **75,555** million CFAF. Total factor payments to the rest of the world in cell [Rest of the world, Factors] were **43,687** million, based on the TEI figures. The last entry in the factor column, that is the factor return to enterprises, was obtained as a residual so that the total payments to factors (domestic and foreign) balanced with factor income to domestic and foreign institutions. The residual was entered in cell [Enterprises, Factors] and amounted to **153,924** million CFAF. The 1997 TEI also indicates that factor payments from abroad were **11,097** million [Factors, Rest of the world].

The entry for indirect fiscal revenue to the government recurrent account in cell [Government Recurrent, Commodities] was **149,700**. Direct fiscal receipts, or institutional payments to the government recurrent account, came from households and enterprises. These payments amounted to 46,600 in 1997, according to BCEAO records. Households paid about 9% of this amount (4,208), whereas enterprises paid the rest (42,392). The ratio 9:91 came from the preliminary TEI, which indicated that enterprises paid 35,000 (91%) out of the total 38,474 that governments received as direct fiscal income. In the macrosam, one should note that the entry of households' payments to the government included not only taxes, but also social security payments. The TEI evaluated these latter payments to 24,642 in 1997. Thus, the entry to [Government Recurrent, Household] was **28,850** (4,208 + 24,642) and this for [Government Recurrent, Enterprises] was, as indicated earlier, **42,392**.

Regarding savings, the preliminary TEI showed a total saving of 299,263 million CFAF distributed between households (19%), enterprises (42%) and government (39%). According to the DNSI national accounts, total savings in 1997 were 314,552. We distributed this latter figure to households, enterprises and government, using the ratio 0.19:0.42:0.39, respectively. Thus, saving entries were **130,619** for [Capital Investment, Enterprises], **60,467** for [Capital Investment, Households] and **123,466** for [Capital Investment, Government Recurrent]. Foreign savings in cell [Capital Investment, ROW] were **24,634**, taken directly from the DNSI national accounts.

With regard to transfers between Mali and the rest of the world, the TEI sources indicated that the country received total current transfers of 158,091 million from abroad. This was shared, mainly between the government recurrent account which received **99,306** in [Government recurrent, ROW], and households, which received **58,785** in [Households, ROW]. Transfers from ROW to enterprises were **5,509** million, also taken from the 1997 TEI. On the other hand, the 1997 national accounts revealed that current transfers to the ROW amounted to 51,351 million, of which **12,024** may be attributed to households [ROW, Households], according the 1997 TEI. The difference, **39,327** million, was paid by the government recurrent account [ROW, Government recurrent]. Also, the national accounts indicated that enterprises transferred **13,800** million to ROW, as indicated in cell [ROW, Enterprises]. One may notice that all ROW transfers to governments are paid to the recurrent account, though some of these transfers may be for investment purposes. We have adopted the standard treatment of these transfers, which are first cashed in the government current account, which transfer them to the capital investment account, which in turn allocates them to the government investment account.

There are two remaining entries that are unexplained entries to the macrosam. First, the **58** million CFAF to [Households, Enterprises] represent enterprises' dividend payment to households. This figure was taken directly from the preliminary TEI. Second, households also received a transfer of **28,489** million from government recurrent account in cell [Households, Government Recurrent]. The 1997 preliminary TEI provided these two figures.

All the 34 nonzero entries in the macrosam will be disaggregated in order to fill in the relevant cells of the microsam , which is discussed below in Appendix 5.2.

Appendix 5.2: Justification of Entries to the Malian Microsam

The microsam has 83 accounts, as mentioned earlier. Entries to the microsam were obtained by disaggragating the 34 nonzero entries of the macrosam. This section discusses the disaggreation procedure and the main sources of the data needed to carry out this procedure.

Intermediate inputs

Intermediate inputs were differentiated by their domestic and import origins in the base I-O table. The structure of the microsam does not allow for such differentiation, so these intermediate consumptions were aggregated.

One of the main characteristics (and perhaps limitations) to the entries of intermediate input uses relate to the distribution of a single intermediate consumption value to many commodities, in situations where one activity produces several commodities. In most cases, it was not possible to access information on the share of each commodity in the total consumption of intermediate inputs by activities. We used activity volume or value to prorate the use of these inputs, guided by common sense or additional insights into the production processes. For example, the activity "food production, excluding rice" (AFOOD) consumes 4,525 million CFAF worth of food products as intermediate inputs. This intermediate consumption is primarily made of seeds, which were evaluated to be between 2% (maize and roots) and 3% (millet, sorghum, fonio, and beans) of the value of the outputs. "Other crops" intermediate consumption is determined as residual. These rates come from unpublished DNSI sources.

Other activities, such as "agro-industry and beverages" (AAIDT), "trade" (ATRAD) and "nontraded services" (ANTSE) also used food products as intermediary inputs. Most of the agro-industry activities are informal food processing at home, such as home brewery. The 1997 agricultural survey evaluated the rate of home food processing to be 1.37% for millet, 1.13% for sorghum, 0.36% for maize, 0.13% for fonio and 1.25% for beans. Each rate was applied to the output values of the corresponding commodity. The resulting total (1,349) was adjusted to reflect the initial entry of 352, using the proportionality rule.

The activity "trade" (ATRAD) also used food products (from activity AFOOD) as intermediate inputs. We used the commercialization rate of these products to distribute the 122 million CFAF of intermediate input consumption (from the I-O table) to the seven food commodities. Similarly, the production of nontraded services, mainly by public administration and nonprofit organizations, used food crops as intermediate inputs. Again, we assumed that uses are proportional to the value of the activities, thus distributing the 1,532 million of that consumption to the seven food products. Products from the industrial cropping activity (groundnuts, tobacco and wheat), and the use of these products as intermediate inputs are disaggregated in the microsam following the same assumptions used for the food cropping activity. For example, seeds represented 2% of groundnuts, 3% of tobacco and 3% of wheat. Home processing rate

were 3.3% on groundnuts and 27.1% for tobacco, while commercialization rates were 20.2% and 25.6%, respectively for groundnuts and tobacco. Most processing activities, however, are based on oil making (groundnut, so we allocate most to groundnut). Regarding the processing of animal products by the agro-industrial activity (AAIDT), payments to commodities were limited three commodities (hides and skins, cattle, and sheep and goats), again using the proportionality rule. The activity "production of other manufacturing goods" (AOMGG) used four commodities: firewood (CFWOO), furniture wood (CWOOD), gathering products (CGATH) and gold (CPGLD), proportional to their values, whereas the activity "buildings and public works" (ABBTP) used only furniture wood (CWOOD).

Production factors

The Malian microsam has nine production factors. The factors were identified mainly based on the results of the EMCES 94, which described households in terms of activity intensity in each factor category. The EMCES 94 was carried out between March and July 1994, and the published results were based on data from 9,800 households, sampled across the entire country. The survey, though comprehensive in many regards, had nevertheless a limited focus in terms of cropping activities, if compared to the yearly permanent agricultural survey, the *Enquête Agricole Permanente* (EAP). The EMCES 1994 covered specifically the main traditional cereals (sorghum and millet) and more input-intensive cereals (maize and rice), as well as export and agro-industrial crops (cotton and groundnuts). The survey put less emphasis on horticultural crops, such as fruits and vegetables, though these crops represent strategic activities of women and urban farmers. Despite these limitations, experts at DNSI argue that the main crops surveyed are representative of the agricultural activities undertaken by a "large majority of rural households" (Toure, 1995; p. 7).

We have distinguished three location-based farming factors (Kayes-Sikasso, River, and Other rural), and Table E.1 (Table 5.9 in the main text) provides further details on the composition of these regions. This table is based on Charmes (1994). Table E.1 indicates, for example, that the Kayes-Sikasso composite farming factor includes farming factors from Sikasso Region (excluding the Dioila Circle) and from Kayes Region (excluding Noiro Circle), on so on. Touré (1995; p. 17) shows the shares of households in each socioeconomic group that are involved in the main agricultural activities. The sum of these should normally sum up to 100, but in many cases (sorghum, maize and rice), it was slightly less than 100, and we corrected the inconsistency through proportional readjustment of these shares.

Regarding nonagricultural activities, their importance was determined based on their relative contributions to household incomes. A nonagricultural enterprise was defined as a "production unit having as main function the production of goods and services in sectors other than agriculture, livestock keeping, fishery and forestry" (Toure, 1995; p. 8).

Payments of the "other manufacturing goods" activity (AOMGG) to all factors, except capital, were obtained from the cost share of these factors in the total value added

of the activities. Similarly, the return to food and industrial cropping activities was shared between five "composite" factors: Kayes-Sikasso Farming, River Farming, Other Rural Farming, Rural Composite and Urban Composite. The returns were computed as weighted averages, using cost shares as weights. The EMCES 94 supplied these cost shares, which we discuss later in this Appendix.

Table E.1: Description of locations" used to define composite production factors

Locations	Composition
Kayes-Sikasso	Sikasso Region (plus Dioila Circle) Kayes Region (minus Nioro Circle)
River	Koulikoro Region (minus Dioila and Nara Circles) Segou Region (minus Niono Circle) Mopti Region (minus Bandiagara, Koro, Bankass, Douentza Circles)
Other	Tombouctou Region Gao Region (plus Nioro, Niono, Bandiagara, Koro, Bankass, Douentza Circles)

Source: Based on Charmes (1994; p. 19)

Payments to capital were assumed to correspond to activities for which the I-O table indicated that investments have been made. Three activities received almost the totality of investment expenditures in 1997. These include "building and public work" (ABBTP) with 61.7%, "other manufacturing goods" (AOMGG) with 25.7%, and "livestock and fishery" (ALIFI) with 8.6%. The activities "trade" (ATRAD) with 2.3%, "transport and telecommunication" (ATTEL) with 0.2% and "non-traded services" (ANTSE) with 1.6%, made up the rest of investments. Thus, return to capital is restricted to these six activities. Assuming factor price equalization across sectors, the return to capital was considered to be proportional to the value of investments. Returns to two activities, "building and public work" (ABBTP) and "other manufacturing goods" (AOMGG) which also take place in the informal sector, are adjusted by the share of modern sector in these activities. Making the adjustment resulted in a more even distribution of the returns to formal capital across the six activities, as shown in Table E.2 below.

Table E.2: Initial and Adjusted Shares of Activities in Total Investment

Activities	Share of total investment in the 1997 I-O table (in percent)	Adjusted shares based on the proportion of modern activities (in percent)
ALIFI	8.6	18.7
AOMGG	25.7	27.4
ABBTP	61.7	45.1
ATRAD	2.3	5.0
ATTEL	0.2	0.4
ABTSE	1.6	3.4
Total	100.0	100.0

Source: Based on the 1997 I-O table and other data from DNSI.

The value added of the "livestock and fishery" (ALIFI) activity is distributed to capital and the location-based composite factors. Payments to composite factors are

proportional to the intensity of livestock activities in the five agricultural composite "factor" categories.

The value-added from activity "forestry and gathering" was distributed between the three main farming factors ("Kayes-Sikasso", "River" and "Other Farming"), proportional to the intensity of the forestry and gathering activity in these localities. The intensity is based on the survey of rural labor presented in Doumbia and Kamate (1997; p.8), in which the figures were presented by administrative regions. We used Charmes' (1994; p. 19) mapping of administrative regions into the location-based composite factors (Table E.1). It was not possible to obtain figures that were disaggregated to the level of administrative circles, implying that our distribution was solely based on aggregate regional figures. As a consequence, it is possible that payments of the activity "forestry and gathering location" to the composite factor "River" (include three administrative regions minus seven circles) was overestimated, whereas the payments to "Other Farming" composite factor (which include two regions plus six circles) was underestimated.

In order to distribute the value-added of the agro-industrial activity (AAIDT), we used the fact that the modern sector represented about 94% of value added of that activity, according to DNSI auxiliary figures. We assumed that this figure can be considered as the payment for wage labor. Thus, the remaining 6% was distributed to the composite factors, proportional to the manufacturing intensities in each of the five locations. A similar procedure was use to distribute the value added of the "textile" activity to the wage labor factor (67%, corresponding to the share of the modern sector according to DNSI figures), and to other location-based composite factors which shared the remaining 33% proportionally to their cotton production intensity.

All factor payments of the "banking and insurance" activity (ABISE) went to wage labor.

Home consumption

Home consumption was observed with six activities. Except the activity "Other nontraded services", all the activities where home consumption was observed were related to agriculture, again defined broadly to include, in addition to cropping activities, fishery, livestock keeping, forestry and gathering. Home consumption was proportionally distributed to different household groups, based the intensity of these activities. Given home consumption, marketed outputs in the sub-matrix [Activities, Commodities] are obtained for each commodity as the difference between total output and home consumed output. The DNSI sources provided the rates of home consumption of each commodity considered in the microsam.

Final household consumption

Households' final consumptions were obtained by combining the information in the I-O table, the EBC 89, EMCES 94 and WAEMU 99.

EMCES 94 evaluated total household expenditures to 648,529 million CFAF, which is very close to the 663,356 million CFAF indicated in the I-O table as final household consumption. However, the structure of the expenditures by main commodity groups was drastically different in these two sources (Table E.3). One of the sources of the differences is that, while consumption of the commodity "trade" was directly incorporated to the final consumption values in the EMCES 94, it was separated in the I-O table and amounted to more that 19% of the total final consumption. However, differences persisted, even when the consumption of the "trade" is distributed proportionally across the remaining commodities groups. The most striking differences include: (i) underestimation of the consumption of food items, particularly of the products from food and rice cropping activities; and (ii) overestimation of final consumption of commodities such as agro-industrial products (CAIDT) and other manufacturing goods (COMGG). There is no easy way to reconcile these drastic differences, so we will use to the EMCES 1994 structure of household's expenditures, instead of the one in the I-O table, as the latter is based on the much older EBC 89 survey. It is plausible to assume that the structure of final household consumption has changed since the devaluation of the currency in 1994.

The EMCES 94 survey itself was carried out in the second quarter (March to July 1994) following the devaluation, making the results very susceptible of "picking up" extra short-term effects that are likely to inflate the budget shares for food consumption. Thus, while EMCES 94 evaluated the budget share of food at 62% in Bamako, WAEMU consumption surveys indicated this share to be 50% in 1999 (AFRISTAT, 2001; p. 271)[42]. The 1999 figures are likely to reflect more accurately the situation prevailed in 1997, the year to which the Malian SAM was calibrated. It was not possible to do similar comparisons for the remaining four location-based household types. For these latter households, the most recent budget shares were the ones documented in the EMCES 1994 survey. The final structure of households' expenditure retained in this study was a compromise between the EMCES 94 structure and the most recent budget share information for Bamako.

For Bamako, we used a simple average of the two sources (1994 and 1999), in order to minimize the short-term devaluation effects that inflated the 1994 figures, particularly regarding the budget share of food consumption. For the other four household groups, we have taken the percentage change in the average figures with respect to the 1994 figures to reflect aggregate relative price effects that affected not only Bamako dwellers, but also residents in the remaining part of the country. Thus, these percentage changes were applied to each broad consumption categories to obtain the budget share of that category. Further disaggregation of the category budget shares into commodity shares was done while retaining the intra-category structure of the 1994 data.

In some limited cases, expenditure shares were taken from the EBC 89, which provided very detailed information on commodity budget shares. Thus, detailed budget

[42] The figures, published in AFRISTAT (2001; p. 271), represent the weight of food production in the price WAEMU index. This weight was 5,001 on a scale of 10,000.

shares for beans, groundnuts and forestry products were taken from EBC 89. These budget shares were applied to total consumptions in each location-based household group to obtain the corresponding final consumptions. Among the three forestry/gathering products (firewood, furniture wood and gathering products) the EBC 89 figures left the furniture wood and gathering products aggregated. We therefore used the shares of these two products in the total output (of the forestry/gathering activities) and adjusted them to be consistent with the budget shares of firewood for the five household groups.

Final consumption of the commodity "hides and skins" (CSKIN) was determined in the same manner with regards to the livestock production activity, particularly outputs of cattle, and sheep and goats. Budget share of "other meat" (besides beef and meat from sheep and goats) from EBC 89 was distributed to two commodities: "pork" (CPORC) and "camels and donkeys" (CDKCM), proportional to output value, again using the relative importance of these commodities in the total output of livestock activity.

The budget share of agro-industrial products (CAIDT) was determined as residual, so that the constraint on the share of food in total expenditure is satisfied. The expenditure share of "other food items" (COTHE) was primarily based on the shares allocated to fruits and vegetables.

The I-O table showed that the final private consumption of "building and public works" (CBBTP) was relatively small, if compared to the investment expenditures on that commodity. EMCES 94 indicated budget share of lodging rent in total expenditures in the five household groups, and these shares are used as proxy for final consumption of BTP.

Budget shares for final consumption of "other traded services" (COTSE) were mainly made of education and health services, excluding medicines and school materials, which were treated as other manufactured goods.

Table E.3: Comparison of budget shares of main expenditure items in Bamako in 1994 and 1999

Expenditure Items	EMCES 1994	WAEMU 1999	Average of the two sources	Percent change w.r.t. 1994
Education	0.80	1.65	1.23	53.1
Health	2.40	2.30	2.35	-2.1
Clothing	4.70	5.29	5.00	6.3
Lodging	10.10	18.71	14.41	42.6
Transports and Communication	16.80	11.88	14.34	-14.6
Food	62.00	50.01	56.01	-9.7
Others Expenses	3.20	10.16	6.68	108.8
Total	100.00	100.00	100.00	0.0

Source: Based on EMCES (1994) and AFRISTAT (2001)

Other traded services (mainly health and education) made up about 3.8% of household expenditures, based on the 1999 figures. We assumed that this figure is slightly lower in rural areas, about 3%. Similarly "bank and insurance services" (CBISE), besides regular insurance services on transport equipment, were assumed to be confined to urban areas, and to represent about 0.3% of total expenditures, as suggested by the Bamako consumption survey. Final consumption of "trade" (CTRAD) was directly incorporated to each commodity, so that "trade" can be better viewed as intermediate input. Budget shares for "other manufacturing goods" (COMGG) are obtained as residuals over total budget shares, including an average of 3% for intra-household transfers.

Using the information above, it is possible to obtain the structure of consumption for the five household types. The total final consumption obtained amounted to 637,498 million CFAF, which is slightly less than the I-O and the unbalanced macrosam's final consumption entry of 663,356 million CFAF.

Trade

Data on cereal trade is highly inconsistent. For example, while the I-O table showed no trade in cereals, other DNSI tables evaluated cereal exports at over four billion CFAF. Parallel studies, such as Diakité and Samaké (2002), evaluated the same exports at nearly 1.4 billions. The high disparity in the data may be attributed to the importance of informal cereals trade between Mali and its neighbors, most of which is occurring through very porous borders. For the purpose of this SAM, we will consider that Diakité and Samaké's figures, which are based on the survey of informal cereal trade, are closest to what is really happening in Mali. Furthermore, they constitute a middle ground between DNSI's zero and four billion extreme figures. Diakité and Samaké's figures have the additional advantage that they show the structure (in volume) of these cereal exports, dominated at more than 80% by millet exports. We converted the volume-based structure into a value-based one, using domestic consumer valuation of each of the cereals studied by Diakité and Samaké. This reduced slightly the share of millet in total cereal exports to 78.6%.

DNSI external trade data showed milk and eggs imports of about 9,233 million CFAF, 98.4% of which can be attributed to milk and milk products, according to the FAO statistical database. A similar procedure (i.e., total value from DNSI external trade source and distribution from FAO database) was applied to cereals imports, which were evaluated to nearly 8,821 million CFAF shared between rice (49.9%), wheat (48.9) and maize (1.2%). Also nearly 2,083 million CFAF worth of exports of oilseeds and beans were shared between groundnuts (91.4%) and beans (8.6%), a ratio suggested by the 1997 FAO trade data for Mali. About 45 million CFAF of beans were imported, a figure taken directly from DNSI trade database.

Imports and exports of the aggregate commodities were taken directly from the I-O table. The West African regional and non-regional distribution is based on the 2001 detailed analysis of the origins of imports and the destinations of exports. Also rice imports, evaluated at 8,683 million CFAF were taken directly from the I-O table. DNSI

estimated tobacco imports at 4,283 million CFAF, and this was used directly in the microsam. Tobacco exports were negligible.

The DNSI trade database indicates imports of fruits and vegetable at 1363 million CFAF. FAO trade data suggests that roots and tubers made about 14% of that figure in 1997. Furthermore, 94% of these imports were tropical roots and tubers such as yams, and cassava, as well as other starchy staples such as plantains. These imports were attributed to the West African region.

Imports of wheat were obtained as the residual over the 10,542 million CFAF imports of the three commodities produced by the nonfood industrial cropping activities, as indicated in the I-O table. Thus, wheat imports were 6,259 million CFAF.

About 52% of exports of "other food products" (COTHE), mainly composed of fruits and vegetables (mangoes, green beans, potatoes and onions), went to three regional countries (Côte d'Ivoire, Burkina Faso and Senegal). The remaining 48% went to Europe (Diakite and Samake, 2002). Besides, DNSI trade data suggested that three-quarters of imports of fruits and vegetables (COTHE) came from within the region.

Fish exports are dominated by dried fish, which were exported mainly to regional markets. Fish imports are assumed to be equally shared between fresh and dried/smoked fish, mainly of regional origin.

Imports of furniture wood and firewood were assumed to be essentially regional and made of furniture woods. Data were taken from the DNSI trade database. Exports were also assumed to be essentially made of furniture woods, distributed roughly in equal proportion to the West African and non-West Africa regions.

Exports of cotton, gold and groundnuts were essentially non-regional, whereas exports of most commodities were dominantly oriented towards regional markets. A small share of the hides and skins produced may have been traded internationally, particularly in the Middle East (Metzel et al., 1997). We assumed this share to be roughly 10% of the value of exports.

Though we have used the best available information to allocate exports and imports of most commodities by the destination and origin, we were not able to do for all commodities. For all the remaining commodities not discussed above, we have used the overall share of regional exports and imports as a proxy.

Imports of combustibles, main component of the "electricity, water and energy" commodity (CEWEN), were essentially of a regional origin (about 98% according to DNSI trade statistics).

Regional imports of textiles represents about a third (30%) of total textile and apparel imports, and these of agro-industrial products (CAIDT) represented about 57% (DNSI trade statistics). Also, about 3.9% of "transport and telecommunication"

(CTTEL) imports were from regional origin, so were nearly 9.4% of "other manufacturing goods" (COMGG) imports (DNSI trade statistics).

Regional exports represented about 12.9% of the total Malian exports in 1997. Imports of regional origin were much higher, about 41.4% of the total imports in 1997 (BCEAO, 2001). The export figure is certainly an underestimation, because it did not appear to have accounted for unrecorded cereal exports between Mali and its neighbors. These exports are obtained from parallel sources (as discussed above) and are included in the SAM.

The I-O table estimated "trade" exports to11,590 million CFAF. Following the format adopted in this SAM, these exports will be treated as marketing margins on exported commodities, and these margins are paid by exports to the marketing margin accounts.

Based on the entries discussed above, all exports added up to 341,177 million CFAF, which is slightly less than entry in the unbalanced SAM, 361,610 million. The balanced macrosam show a total export of 371,967 million CFAF, and the initial entries were adjusted upwards to reflect the macro aggregate. A similar adjustment was required for imports, which totaled 490,589 million CFAF whereas the entry in the unbalanced macrosam was 486,200. Total imports in the balanced macrosam amounted to 472,226 million CFAF.

Marketing margins

Most of the information on marketing margins on domestic sales and imports (as percentage of marketed output) was provided in the DNSI's I-O document. Exports are dominated by livestock, cotton and gold, and the marketing margins on these commodities were taken from other sources. For example, Diakite and Samake (2002) evaluated the marketing margin of livestock exports to be about 12% of the export values.

Marketing margins on exports were assumed to be at least equal to domestic marketing margins, which were used as lower bound. Where there is no information, we used a generic margin 12%, which is the average marketing margins used in the DNSI auxiliary accounts.

Applying the respective margin coefficients to each commodity resulted in a total marketing margin that was slightly greater than the 126,500 million CFAF that were entered in the unbalanced macrosam (Table 5.2). The difference was corrected through a proportional readjustment of the calculated margin for domestically sold, imported and exported commodities. In addition total marketing margins on exports were constrained to equal 11,590 million, which is the I-O table's valuation of these margins in 1997.

Variation in Stocks

The variations in stocks were evaluated in the I-O table to -22,789 million. This figure corresponded to the sum of the variation in the stock of cotton (-28,514) and livestock (5,755). The same I-O table showed a negative change in stocks of gold and minerals (-30), as well positive changes in stock of food crops (8,426), other manufacturing goods (5,533), water, electricity and energy (3,200) and other trading services (16,800). As mentioned earlier, changes in stocks for traded services refer to equipments specific to the delivery of these services. It is unclear why these latter variations in stocks were on included in the DNSI "official" data on stock variation, which was the -22,789. Given that the I-O table was one of our main data source for building the SAM, we've treated the official figure as inaccurate, and we used the provided details, which changed the total variations to a positive 11,170 million CFAF in 1997. The change in livestock stocks was assumed to be divided between sheep and goats and cattle, in proportion of their output. The same proportionality condition was used to distribute the change in stocks of food commodities to the five home-grown cereals included in the microsam (i.e., millet, sorghum, rice, maize and fonio).

FBCF: Public and Private Investment

As explained earlier, the I-O table retained six investment items: (i) livestock, (ii) other manufacturing goods, (iii) building and public works, (iv) trade, (v) transport and telecommunication and (vi) nontraded services. Total investment was evaluated to 348,093 million, of which 31.8% was public (110,893). The public investment expenditures from the I-O tables were drastically different from the investment expenditures published by the IMF (2002), which estimated them to 196,200 million CFAF in 1997. The difference may be explained by the fact that IMF (2002) treated expenditures on agricultural research and extension, and other public services as investments, whereas the I-O table treated them as current expenditures that corresponded to final consumption of nontrated services. We retained the I-O table's treatment, and used the IMF (2002) figures to allocate the 110,893 million FCFA to the six commodities that have received public investment.

Total investments on "other manufacturing goods" (COMMG) were 89,449 million CFAF in 1997. We allocated 42,100 million CFAF to the public sector, which roughly corresponded to government's investments in the secondary sector, as indicated in IMF (2002). The residual was allocated to the saving-investment account.

Government investments in "buildings and public works" (CBBTP) were obtained so that the total government investments equal the 110,893 million CFAF. The difference between the total and government's investments in CBBTP went to the saving-investment account. Investments in livestock went to cattle, sheep-goats and the group of camels and donkeys, proportional to their values.

Savings

Household savings were assumed to be proportional to their income. All foreign savings were attributed to rest of the world (ROROW).

Distributed profits
Transfers by enterprises to households were marginal (58 million CFAF) and was assumed to go to Bamako households.

Taxes
Tax receipts on international trade were 112,500 million CFAF in 1997. This figure is consistent across sources (DNSI and IMF). About 34,200 were attributed to value-added tax (VAT) on imports, another 29,200 were allocated to special duties on petroleum products, and 2,100 were allocated to duties on gold exports (IMF, 2002). The remaining 47,000 million CFAF were attributed to tariff receipts on imported commodities. The total indirect tax revenue was 149,700 million. The difference between this total and tariff receipts on international trade (that is, 37,200) represented essentially the VAT on domestic production. IMF (2002) estimates of VAT collected on domestic productions was lower, about 26,500 million CFAF. We maintained the 37,200 million CFAF, which is consistent with the overall indirect tariff receipts of 149,700, as indicated in the BCEAO publication (BCEAO, 2001).

The normal value-added tax (VAT) rate in 1997 was 15% and the reduced rate was 10%. The reduced rates applied to agricultural equipment and inputs, medical and school supplies and chemicals. Exports are exempted, but a special export tax of 3% was applied to gold exports (IMF 1998; 1999; 2002). We used these rates for each the 37 commodities in the microsam, but the resulting value-added tax receipts on domestic productions were much higher than the 26,500 million CFAF suggested by IMF (2002), let alone the 37,200 million FCFA retained in this study. One of the reasons for this overestimate was that only 41% of the production of goods and services was classified "modern", that is, the taxable base of the economy. We therefore used the share of "modern" production in total production to adjust for the VAT receipts, constraining to total to be consistent with the 37,200 million CFAF mentioned above. A similar procedure was used on the value added tax receipts from imports, evaluated to 34,200 million CFAF in 1997. The difference here was that there was no need to adjust the receipts by the taxable shares of production branches, as all qualified imports were automatically subject to VAT on the ports of entries. The total value added tax receipts on products and services were the sum of the receipts on domestic sales and imports.

Petroleum products (an essential component of commodity CEWEN) paid 29,200 million CFAF in special duties that included both import tariffs and the value-added tax. We treated the special tax as part of the "Other Taxes on Products". The 2,100 million CFAF export duties on gold exports were also treated under other taxes.

Factor taxes amounted to 10,305 million CFAF. Firms (including public firms) paid 8,211 million CFAF and households paid the difference (2,094 million CFAF). Households' factor tax payments were allocated to the factor called "independent entrepreneurship" and enterprise payments were assumed to be taxes on capital. The TEI also showed a production subsidy of 13,097 million CFAF in 1997, but this does not appear in any the other sources, such as BCEAO (2001) and IMF (2002). We, therefore, did not consider this subsidy in the microsam. Considering such a subsidy

would have resulted in a negative net factor tax, which would imply a net effective subsidization of production factors. These subsidies are likely to come in the form of tax breaks of production inputs and equipments, and this was accounted for to a large extent in the relatively lower tariffs and taxes collected on these products.

Households paid a direct tax of 28,850 million CFAF (income tax and social security payments), distributed to the five households using the shares of wage income. They also received a government transfer of 28,489 million CFAF. This income was distributed to household using their shares in total wage income as weights.

Tariffs

According to the 1997 I-O table, average tariffs on "other manufacturing goods" (COMGG) were about 6.9%. The government perceived a total import tax (VAT + duties) of 5,533 million CFAF on a subset of COMGG imports that was valued at 80,149 million CFAF. Assuming the average rate applied to all COMGG imports, the total duties collected on this commodity would be about 28,735 million CFAF, 30% of which are tariff revenues.

Nearly 66% of agro-industrial (CAIDT) imports are made of sugar. The tariff rate on sugar was about 70% in 1997 (55% for variable tax on imports and about 15% normal custom and fiscal duties), while average duties on the remaining components of the CAIDT composite commodities were 15% on average. Thus a weighted average tariff rate on CAIDT was 51.3%.

Diakité and Samaké (2002) evaluated the import tariff on rice in 1997 at 36%. The same rate was applied to other imported products that were also produced domestically. An average rate of 15% was applied on all remaining commodities and the total tariff receipt was constrained to sum up to 47,000 million, as discussed earlier.

Transfers

There was no basis for distributing income transfers from or to abroad by the five household groups. We arbitrarily assign initial distribution of these transfers, which were confined to urban households. (Though some rural households may have transfer with the rest of the world, it is assumed that the transfers are made or received in via urban service centers). Bamako dwellers receive and send three-quarter of these transfers whereas other urban dwellers transact in the remaining quarter. Also unknown is the share of West Africa is these transfers. We again arbitrarily assign initial values, sharing the both the incoming and outgoing transfers equally between the two foreign accounts: West Africa and the rest of the world without West Africa. Necessary readjustments were left to the cross-entropy SAM balancing process.

Appendix 5.3: Ratio of Expenditures to Incomes in the Unbalanced Microsam

Account Name	Account Description	Ratio expenditures to incomes
AFOOD	Food production, excluding rice production	1.00
ARICE	Rice production	1.00
AINAG	Industrial agriculture, excluding cotton production	1.00
ACOTT	Cotton production	1.00
ALIFI	Livestock keeping and fishery	1.00
AFOGA	Forestry and Gathering	1.00
AMINI	Mining	1.00
AAIDT	Agro-industry, beverage & tobacco	1.00
ATEXT	Textile production	1.00
AOMGG	Production of other manufacturing goods	1.00
AEWEN	Production of electricity, water and energy	1.00
ABBTP	Construction and public works	1.00
ATRAD	Trade	1.00
ATTEL	Transport and telecommunication	1.00
AOTSE	Other traded services	1.00
ABISE	Bank and insurance services	1.01
ANTSE	Nontraded services	1.00
CMILL	Millet	0.14
CSORG	Sorghum	0.21
CMAIZ	Maize	0.28
CFONI	Fonio	0.17
CROOT	Root crops (potatoes, yam, cassava)	0.23
CBEAN	Beans	2.11
COTHE	Other crops	1.03
CRICE	Rice	0.50
CGNUT	Groundnuts	2.74
CTOBA	Tobacco	0.57
CWHEA	Cotton	1.20
CCOTT	Wheat	0.90
CCATT	Cattle	0.86
CSHGT	Sheep and Goats	0.60
CPORC	Pork	0.60
CDKCM	Donkeys and Camels	0.35
CPOUL	Poultry	0.33
CEGGS	Eggs	6.65
CMILK	Milk	1.14
CSKIN	Hide & Skins	0.39
CFFIS	Firewood	0.70
CSFIS	Furniture wood	2.83
CFWOO	Hunting/Gathering products	8.37
CWOOD	Fresh fish	0.58
CGATH	Smoked fish	7.68
CPGLD	Gold	0.93
CAIDT	Agro-industry and beverages	2.39
CTEXT	Textile products	1.34
COMGG	Other manufacturing goods	1.08
CEWEN	Electricity, water and energy	1.25

Appendix 5.3: Ratio of Expenditures to Incomes in the Unbalanced Microsam (continued)

Account Name	Account Description	Ratio expenditures to incomes
CBBTP	Construction and public works	1.06
CTRAD	Trade services	1.02
CTTEL	Transport and telecommunication services	1.14
COTSE	Other traded services	0.80
CBISE	Bank and insurance services	1.23
CNTSE	Nontraded services	1.09
MMDOM	Marketing margins on domestic sales	1.00
MMIMP	Marketing margins on imports	1.00
MMEXP	Marketing margins on exports	1.00
FCAPI	Capital	1.27
FWLAB	Wage labor	0.95
FIENT	Independent entrepreneurship	1.01
FTRAD	Composite factor for trading services	0.96
FOUAC	Composite factor for other urban activities	0.98
FFCKS	Composite farming factor in Rural Kayes-Sikasso	0.96
FFCRV	Composite farming factor in Rural River Region	0.96
FFOTH	Composite farming factor in other rural	0.96
FORAC	Composite factor for other rural activities	0.98
HBMKO	Bamako residents	1.44
HOURB	Residents in other urban zones	1.24
HRUKS	Residents in Rural Kayes-Sikasso Region	0.84
HRURV	Residents in Rural River Region	0.87
HORUR	Residents in other rural zones	1.17
ENTRE	Formal enterprises	1.00
GRVAT	Value-added taxes for government recurrent account	1.00
GRTAR	Tariff incomes for government recurrent account	1.00
GROTP	Other taxes on products	1.00
GRFAC	Factor taxes for government recurrent account	1.00
GRDTA	Direct tax on institutions	1.00
GROTH	Other taxes for government recurrent account	1.00
GRECU	Government recurrent account	1.00
GINVE	Government investment account	1.00
SINVE	Saving investment account	1.00
WESTA	West Africa	0.53
ROROW	Rest of the world, excluding West Africa	1.14
STCHG	Change in stock	1.00

Source: SAM

Appendix 5.4: A 1997 Balanced Social Accounting Matrix for Mali (Million CFAF francs)

	AFOOD	ARICE	AINAG	ACOTT	ALIFI	AFOGA	AMINI	AAIDT	ATEXT	AOMGG	AEWEN	ABBTP	ATRAD	ATTEL	AOTSE	ABISE
AFOOD																
ARICE																
AINAG																
ACOTT																
ALIFI																
AFOGA																
AMINI																
AAIDT																
ATEXT																
AOMGG																
AEWEN																
ABBTP																
ATRAD																
ATTEL																
AOTSE																
ABISE																
ANTSE																
CMILL	1256							38								
CSORG	847							20								
CMAIZ	194							4								
CFONI	124															
CROOT																
CBEAN	44															
COTHE	972															
CRICE		7107														
CGNUT			496					7038					147			
CTOBA			5					46								
CWHEA			70													
CCOTT				1944	81			1545	2785							
CCATT					4138			276								
CSHGT					752			192								
CPORC																
CDKCM					210											
CPOUL					346											
CEGGS					1057											
CMILK					2076											
CSKIN					87			7								
CFFIS					1015											
CSFIS					713											
CFWOO								131		1272						
CWOOD										280		11282				
CGATH										2290						
CPGLD										387						

Appendix 5.4: A 1997 Balanced Social Accounting Matrix for Mali (Continued)

	AFOOD	ARICE	AINAG	ACOTT	ALIFI	AFOGA	AMINI	AAIDT	ATEXT	AOMGG	AEWEN	ABBTP	ATRAD	ATTEL	AOTSE	ABISE
CAIDT		655						9686					614			
CTEXT	77		154						5546				1791			
COMGG	1693	7194	2135	13466	3301	3317	23466	6605	2043	35226	2653	80739	8609	18577		749
CEWEN	506	1718	181	1856	3619		5257	1570	2436	5043	3614	7517	5956	14294	8174	435
CBBTP				82	1414		2194	476	127	139	381			3682	1234	382
CTRAD	1258	3944	732	4068	3814	917	12565	7347	3279	11776	3271	28093	9836	23408	2975	673
CTTEL	1169	2316	524	882	137	45	611	1465	303	2220	651	8822	9094	2609	3948	1148
COTSE				3289	1061		1317	3698	1670	8720	1489	12428	11505	9572	55	2583
CBISE				1285				1269	290	705	413	4734	3966	12428	42	9069
CNTSE																
MMDOM																
MMIMP																
MMEXP																
FCAPI					23169					21112		34835	37182	3203		
FWLAB								45270	7351	101	21770	1459	10971	3522	4217	5398
FIENT								2652		489		13154	12890	19812	13973	
FTRAD													27933		1021	
FOUAC	5021	1111	339		3912					208		2949	9308	17773	14232	
FFCKS	66142	13795	8405	67887	2197	7579	72032		2258	295		6165	51343	2763	12703	
FFCRV	55578	11416	4288	16726	69049	37331			598	1890		7998	36149	7579	12703	
FFOTH	32944	11892	2393	1848	59735	32311			86	4537		1634	9358	8840	6377	
FORAC	23703	8562	2108	12473	1312				463	2016		8423	33006	6235	15243	
HBMKO																
HOURB																
HRUSW																
HRURV																
HORUR																
ENTRE																
GRVAT																
GRTAR																
GROTP																
GRFAC																
GRDTA																
GROTH																
GRECU																
GINVE																
SINVE																
WESTA																
ROROW																
STCHG																
TOTAL	191528	69709	21829	125806	183194	81500	117442	89334	29234	98706	34241	230233	279658	154297	96896	20436

Appendix 5.4: A 1997 Balanced Social Accounting Matrix for Mali (Continued)

	ANTSE	CMILL	CSORG	CMAIZ	CFONI	CROOT	CBEAN	COTHE	CRICE	CGNUT	CTOBA	CWHEA	CCOTT	CCATT	CSHGT	CPORC
AFOOD		33592	25318	8023	1161	1347	249	32339								
ARICE									17348							
AINAG										8593	751	1311				
ACOTT													125806			
ALIFI														51962	26702	150
AFOGA																
AMINI																
AAIDT																
ATEXT																
AOMGG																
AEWEN																
ABBTP																
ATRAD																
ATTEL																
AOTSE																
ABISE																
ANTSE																
CMILL	191															
CSORG	141															
CMAIZ	86															
CFONI																
CROOT																
CBEAN																
COTHE	416															
CRICE	161															
CGNUT																
CTOBA																
CWHEA																
CCOTT																
CCATT	138															
CSHGT	85															
CPORC																
CDKCM																
CPOUL																
CEGGS																
CMILK																
CSKIN																
CFFIS																
CSFIS																
CFWOO																
CWOOD																
CGATH																
CPGLD																

Appendix 5.4: A 1997 Balanced Social Accounting Matrix for Mali (Continued)

	ANTSE	CMILL	CSORG	CMAIZ	CFONI	CROOT	CBEAN	COTHE	CRICE	CGNUT	CTOBA	CWHEA	CCOTT	CCATT	CSHGT	CPORC
AFOOD																697
ARICE																456
AINAG																35294
ACOTT																25491
ALIFI																6705
AFOGA																29072
AMINI																23664
AAIDT																10148
ATEXT																
AOMGG																
AEWEN	12270	8407	4198	1045	875	90	8526	3795	4809				4287	2071	87	
ABBTP			90		145	11	672	5820		1751	1920					
ATRAD	2230	27	1241			75	1035	9	1304				1033	1358		
ATTEL																67743
AOTSE																5586
ABISE																4599
ANTSE																4059
CMILL																3687
CSORG																640
CMAIZ																3402
CFONI																4124
CROOT																3917
CBEAN																
COTHE																
CRICE																
CGNUT																
CTOBA																
CWHEA																
CCOTT	3013	1604	287	29	83	9	1597	2182	247	537	556		4682	1465	4	
CCATT			45					8804			880					
CSHGT																
CPORC																
CDKCM																
CPOUL																
CEGGS																
CMILK																
CSKIN																
CFFIS			22		486	5	1485			176						
CSFIS			253		30	27	513	16517		5359	5445					
CFWOO																
CWOOD	51106	35355	14159	2235	2966	466	46168	54475	14954	8574	10113	125806	61964	31596	241	230501
CGATH																
CPGLD																

Appendix 5.4: A 1997 Balanced Social Accounting Matrix for Mali (Continued)

	CDKCM	CPOUL	CEGGS	CMILK	CSKIN	CFFIS	CSFIS	CFWOO	CWOOD	CGATH	CPGLD	CAIDT	CTEXT	COMGG	CEWEN	CBBTP
AFOOD																
ARICE																
AINAG																
ACOTT																
ALIFI	5886	3940	1502	3563	1455	19397	5657									
AFOGA								5032	5035	7567						
AMINI											117442					
AAIDT												89334				
ATEXT													29234			
AOMGG														98706		
AEWEN															34241	
ABBTP																230233
ATRAD																
ATTEL																
AOTSE																
ABISE																
ANTSE																
CMILL																
CSORG																
CMAIZ																
CFONI																
CROOT																
CBEAN																
COTHE																
CRICE																
CGNUT																
CTOBA																
CWHEA																
CCOTT																
CCATT																
CSHGT																
CPORC																
CDKCM																
CPOUL																
CEGGS																
CMILK																
CSKIN																
CFFIS																
CSFIS																
CFWOO																
CWOOD																
CGATH																
CPGLD																

Appendix 5.4: A 1997 Balanced Social Accounting Matrix for Mali (Continued)

	CDKCM	CPOUL	CEGGS	CMILK	CSKIN	CFFIS	CSFIS	CFWOO	CWOOD	CGATH	CPGLD	CAIDT	CTEXT	COMGG	CEWEN	CBBTP
CAIDT																
CTEXT																
COMGG																
CEWEN																
CBBTP																
CTRAD																
CTTEL																
COTSE																
CBISE																
CNTSE																
MMDOM	3803	593	263	2272	230	4635	2549	857				422	1082			
MMIMP			10	2776		610	133		1315			2054	7880	25050	864	
MMEXP	569	842			2168	7	178						35			
FCAPI																
FWLAB																
FIENT																
FTRAD																
FOUAC																
FFCKS																
FFCRV																
FFOTH																
FORAC																
HBMKO																
HOURB																
HRUSW																
HRURV																
HORUR																
ENTRE																
GRVAT	188	107	48	987	81	814	210	134	545	229		1631	4008	14827	1497	2306
GRTAR			13	1530		167	67		668			6167		12231	3853	28
GROTP											6511				25093	
GRFAC																
GRDTA																
GROTH																
GRECU																
GINVE																
SINVE																
WESTA			85	263		1191	409		4052			19702	7418	19046	57634	
ROROW				8636								2512	12210	250052	289	
STCHG																
TOTAL	10446	5482	1921	20028	3934	26821	9202	6023	11614	7796	123953	121823	61868	419912	123471	232567

Appendix 5.4: A 1997 Balanced Social Accounting Matrix for Mali (Continued)

	CTRAD	CTTEL	COTSE	CBISE	CNTSE	MMDOM	MMIMP	MMEXP	FCAPI	FWLAB	FIENT	FTRAD	FOUAC	FFCSW	FFCRV	FFOTH
AFOOD																
ARICE																
AINAG																
ACOTT																
ALIFI																
AFOGA																
AMINI																
AAIDT																
ATEXT																
AOMGG																
AEWEN																
ABBTP																
ATRAD	279658															
ATTEL		154297														
AOTSE			85855													
ABISE				20436												
ANTSE					230501											
CMILL																
CSORG																
CMAIZ																
CFONI																
CROOT																
CBEAN																
COTHE																
CRICE																
CGNUT																
CTOBA																
CWHEA																
CCOTT																
CCATT																
CSHGT																
CPORC																
CDKCM																
CPOUL																
CEGGS																
CMILK																
CSKIN																
CFFIS																
CSFIS																
CFWOO																
CWOOD																
CGATH																
CPGLD																

Appendix 5.4: A 1997 Balanced Social Accounting Matrix for Mali (Continued)

	CTRAD	CTTEL	COTSE	CBISE	CNTSE	MMDOM	MMIMP	MMEXP	FCAPI	FWLAB	FIENT	FTRAD	FOUAC	FFCSW	FFCRV	FFOTH
CAIDT																
CTEXT																
COMGG																
CEWEN																
CBBTP																
CTRAD						67165	51101	12113								
CTTEL																
COTSE																
CBISE																
CNTSE																
MMDOM																
MMIMP																
MMEXP																
FCAPI																
FWLAB																
FIENT																
FTRAD																
FOUAC																
FFCKS																
FFCRV																
FFOTH																
FORAC																
HBMKO										40302	11448	10523				
HOURB										24518	9047	10917	39295			
HRUSW										2212	1010	1759		314205		
HRURV										9729	10290	6091			264707	
HORUR										25684	4802	3722				176078
ENTRE									77232		25519		19244			
GRVAT		1651	19193	1914	5425											
GRTAR		3489	7802	1712												
GROTP																
GRFAC									4851		5454					
GRDTA																
GROTH									65155							
GRECU																
GINVE																
SINVE																
WESTA		175		5566												
ROROW		9896		5148					44994	3200						
STCHG																
TOTAL	279658	169509	112850	34777	235926	67165	51101	12113	192232	105645	67570	33012	58539	314205	264707	176078

Appendix 5.4: A 1997 Balanced Social Accounting Matrix for Mali (Continued)

	FORAC	HBMKO	HOURB	HRUSW	HRURV	HORUR	ENTRE	GRVAT	GRTAR	GROTP	GRFAC	GRDTA	GROTH	GRECU	GINVE	SINVE
AFOOD		326	461	47628	40021	1063										
ARICE		77	838	15460	12120	23866										
AINAG		33	119	5724	2733	2563										
ACOTT																
ALIFI		112	959		32954	28955										
AFOGA				6451	30278	27137										
AMINI																
AAIDT																
ATEXT																
AOMGG																
AEWEN																
ABBTP																
ATRAD																
ATTEL																
AOTSE		186	357	3015	2801	4683										
ABISE																
ANTSE																
CMILL		3049	2682	7703	16578	15951										
CSORG		2508	2242	10068	8774	8885										
CMAIZ		791	700	4238	3678	3624										
CFONI		92	82	662	454	600										
CROOT		1348	510		769	338										
CBEAN			4	37												
COTHE		4646	4136	15207	10703	7441										
CRICE		8466	7398	10672	9238	8684										
CGNUT		30	22	591	792											
CTOBA		726	826	3753	1809	1409										
CWHEA		2212	703	3532	1494	2102										
CCOTT																
CCATT		4719	4266	9172	2851	1930										12108
CSHGT		1478	1344	9033	452	555										3776
CPORC		36	31	174												
CDKCM		1244	1181	4457	1398	1085										744
CPOUL		431	411	2284	717	471										
CEGGS		211	109	395		148										
CMILK		2324	1149	4866	5311	4301										
CSKIN		135	127													
CFFIS		1864	2387	7799	8365	5377										
CSFIS		558	587	990	1049	372										
CFWOO		166	117	2059	1926	352										
CWOOD		29	23													
CGATH		197	103	2681	1963	562										
CPGLD																

Appendix 5.4: A 1997 Balanced Social Accounting Matrix for Mali (Continued)

	FORAC	HBMKO	HOURB	HRUSW	HRURV	HORUR	ENTRE	GRVAT	GRTAR	GROTP	GRFAC	GRDTA	GROTH	GRECU	GINVE	SINVE
CAIDT		14423	11713	41017	24823	18195										
CTEXT		4962	5266	18010	15001	10604										
COMGG		8180	8165	35423	22663	12585									36958	45339
CEWEN		2485	6286	9158	8544	5772										
CBBTP		4018	2006	454	821	288									62677	145486
CTRAD																2253
CTTEL		18114	10948	20035	20342	3176									572	
COTSE		3580	3163	8343	5992	4068										
CBISE		424	150													
CNTSE														219883	16043	
MMDOM																
MMIMP																
MMEXP																
FCAPI																
FWLAB																
FIENT																
FTRAD																
FOUAC																
FFCKS																
FFCRV																
FFOTH																
FORAC																
HBMKO							24							2953		
HOURB														4596		
HRUSW	16697															
HRURV	38446															
HORUR	16300															
ENTRE	46019															
GRVAT																
GRTAR																
GROTP																
GRFAC																
GRDTA		9234	6958	425	8714	3518	39205									
GROTH																
GRECU								72092	47456	31604	10305	68055	65155			
GINVE																116251
SINVE		7506	11894	24364	23134	15923	121466							127103		
WESTA																
ROROW		18776	3003				12774							49653		
STCHG																5433
TOTAL	117462	129695	103430	335883	329263	226587	173469	72092	47456	31604	10305	68055	65155	404188	116251	331389

Appendix 5.4: A 1997 Balanced Social Accounting Matrix for Mali (Continued)

	WESTA	ROROW	STCHG	TOTAL
AFOOD				191528
ARICE				69709
AINAG				21829
ACOTT				125806
ALIFI				183194
AFOGA				81500
AMINI				117442
AAIDT				89334
ATEXT				29234
AOMGG				98706
AEWEN				34241
ABBTP				230233
ATRAD				279658
ATTEL				154297
AOTSE				96896
ABISE				20436
ANTSE				230501
CMILL	1149		2509	51106
CSORG	32		1839	35355
CMAIZ	232		611	14159
CFONI			220	2235
CROOT				2966
CBEAN	381			466
COTHE	2647			46168
CRICE	58		2690	54475
CGNUT		5838		14954
CTOBA				8574
CWHEA				10113
CCOTT		153721	-34270	125806
CCATT	18851		3516	61964
CSHGT	11493		2436	31596
CPORC				241
CDKCM	126			10446
CPOUL	821			5482
CEGGS				1921
CMILK				20028
CSKIN	3579			3934
CFFIS	14			26821
CSFIS	4933			9202
CFWOO				6023
CWOOD				11614
CGATH				7796

	WESTA	ROROW	STCHG	TOTAL
CAIDT				121823
CTEXT				61868
COMGG			5533	419912
CEWEN			3561	123471
CBBTP				232567
CTRAD				279658
CTTEL	36715			169509
COTSE	1902	1468	16800	112850
CBISE				34777
CNTSE				235926
MMDOM				67165
MMIMP				51101
MMEXP				12113
FCAPI		4989		192232
FWLAB				105645
FIENT				67570
FTRAD				33012
FOUAC				58539
FFCKS				314205
FFCRV				264707
FFOTH				176078
FORAC				117462
HBMKO	19726	44719		129695
HOURB	15057			103430
HRUSW				335883
HRURV				329263
HORUR				226587
ENTRE		5455		173469
GRVAT				72092
GRTAR				47456
GROTP				31604
GRFAC				10305
GRDTA				68055
GROTH				65155
GRECU		109521		404188
GINVE				116251
SINVE				331389
WESTA				117716
ROROW				449288
STCHG				5433
TOTAL	117716	449288	5433	

Appendix 6.1: Base Production and Trade Elasticities

Activities	SAM Account and production elasticities		Commodities	SAM Account & CES and CET elasticities	
Food production excluding rice	AFOOD	0.45	Coarse grains	CCORS	1.50
			Other food	COFOO	1.50
Rice production	ARICE	0.45	Rice	CRICE	1.50
Industrial ag excluding cotton	AINAG	0.45	Other industrial. ag products	CINAG	1.50
Cotton production	ACOTT	0.45	Cotton	CCOTT	1.50
Livestock keeping and fishery	ALIFI	0.45	Cattle and sheep and goats	CCASG	1.50
			Other livestock	COLIV	1.50
			Fish	CFISH	1.50
Forestry and Gathering	AFOGA	0.45	Forestry & gathering products	CFOGA	1.50
Mining	AMINI	0.60	Mining products	CPGLD	1.50
Agro-industry	AAIDT	1.50	Agro-industry and beverages	CAIDT	2.00
Textile production	ATEXT	1.50	Textile products	CTEXT	2.00
Production, other manufactures	AOMGG	1.50	Other manufacturing goods	COMGG	2.00
Production, elec. water & energy	AEWEN	1.50	Electricity water and energy	CEWEN	2.00
Construction and public works	ABBTP	0.95	Construction & public works	CBBTP	1.50
Trade	ATRAD	2.00	Trade	CTRAD	1.50
Transport & telecom	ATTEL	2.00	Transport & telecom.	CTTEL	1.50
Other traded services	AOTSE	2.00	Other traded services	COTSE	2.00
Bank and insurance services	ABISE	2.00	Bank and insurance services	CBISE	2.00
Nontraded services	ANTSE	2.00	Nontraded services	CNTSE	2.00

Source: Adapted from Decaluwé, Dissou and Robichaud (2000), p. 9.

Appendix 6.2: Base and Calibrated Data for Selected Indicators

Items	Base Year Data	Calibrated Data	Percent change from base
Total absorption	1421.0	1466.4	3.2
Total investment	209.7	209.7	0.0
Public expenditure	219.9	248.6	13.1
Total exports	467.5	467.4	0.0
Total imports	534.6	554.9	3.8
GDP, market price	1461.7	1401.4	-4.1
GDP, factor price	1343.5	1272.4	-5.3
Net indirect tax	118.2	129.0	9.1
Private consumption, including:	991.4	1056.8	6.6
Bamako	119.8	139.5	16.4
Other urban	84.5	93.1	10.2
Rural S-K	300.2	321.5	7.1
Rural River	287.0	273.9	-4.6
Other rural	199.9	228.7	14.4
Total factor income, including:	991.4	1056.7	6.6
Capital	187.2	175.7	-6.1
Wage labor	175.6	188.3	7.2
Composite independent entrepreneurship	54.6	50.7	-7.1
Composite trading services	15.0	13.2	-12.0
Composite other urban activities	52.5	48.1	-8.5
Composite farming , Rural S-K	320.2	310.6	-3.0
Composite farming, Rural River	264.7	232.2	-12.3
Composite farming , Other Rural	182.1	173.7	-4.6
Composite other rural activities	91.5	80.0	-12.6

Source: Author

Appendix 6.3: Final and Intermediate Demand Prices Under Price and Market Access Scenarios (% change from base)

Items	BASE	FAPRI	IFPRI1	IFPRI2	OECD	DFA	EEP
Commodities		Consumer Prices (Percent change from base)					
Coarse grains	0.7	-6.7	-2.0	-8.9	-0.1	-1.7	4.3
Other food	0.9	-12.6	-10.2	-3.1	-6.8	-9.1	5.1
Rice	0.9	-3.0	0.1	-2.0	-3.0	-1.6	3.9
Other industrial. ag products	2.1	-10.4	-13.2	3.9	-8.7	-12.5	18.3
Cattle and sheep and goats	1.0	-11.5	-19.6	-2.6	-38.9	-9.8	4.2
Other livestock	2.4	-25.5	9.8	-12.0	0.9	-2.5	-21.9
Fish	1.4	26.3	-1.7	11.5	-17.0	-36.0	-5.8
Forestry & gathering products	0.8	0.9	2.2	0.0	-1.2	-2.8	-2.5
Agro-industry and beverages	1.9	20.5	-40.8	3.0	12.4	16.1	-15.6
Textile products	1.9	8.5	75.9	13.6	20.6	-2.8	-35.7
Other manufacturing goods	1.2	-4.0	11.3	-13.9	-1.8	-4.2	6.2
Electricity water and energy	1.0	35.3	13.8	52.3	37.1	67.2	33.2
Construction & public works	0.6	1.4	11.2	0.7	1.2	0.8	9.8
Trade	0.4	2.5	11.0	2.3	1.8	1.9	11.7
Transport & telecom.	0.9	3.4	23.6	16.2	0.6	-8.7	7.7
Other traded services	0.3	29.5	41.6	42.8	9.7	31.7	71.5
Bank and insurance services	0.5	4.9	15.5	8.2	2.6	3.8	16.2
Nontraded services	1.0	0.9	-0.6	3.7	1.2	0.7	-4.9
Activities		Price of Aggregate Intermediate Inputs					
Food production, excl. rice	0.9	-1.2	8.2	0.9	0.7	-1.3	7.3
Rice production	1.1	-3.6	2.9	-1.6	-2.0	0.9	7.4
Industrial ag, excluding cotton	1.1	0.1	11.4	0.8	1.0	-1.2	7.7
Cotton production	1.0	2.1	11.9	1.5	1.8	2.2	11.7
Livestock keeping and fishery	1.1	-1.6	3.9	1.4	-6.2	-1.3	4.7
Forestry and gathering	1.1	-0.4	10.0	-2.8	0.4	-0.7	8.1
Mining	0.9	1.6	10.6	0.5	2.0	2.3	10.0
Agro-industry and beverages	1.2	3.7	-7.7	0.3	3.3	5.4	3.6
Textile production	1.0	5.5	28.7	7.8	8.5	3.4	-1.9
Other manufacturing goods	1.0	2.0	11.5	1.4	1.7	2.1	11.1
Electricity, water and energy	0.8	5.9	12.8	8.1	5.3	8.3	14.6
Construction and public works	1.0	1.4	11.2	0.7	1.2	0.8	9.8
Trade	0.8	5.8	16.9	9.5	4.1	4.3	13.3
Transport and telecom.	0.8	4.6	12.7	5.9	3.8	5.9	14.0
Other traded services	0.9	7.8	14.1	13.6	7.5	9.6	13.2
Bank and insurance services	0.8	4.9	15.5	8.2	2.6	3.8	16.2
Nontraded services	0.9	4.0	13.2	6.5	3.4	3.6	11.5

Source: Author

Appendix 6.4: Summary Macroeconomic Indicators

Macro Indicators	BASE	FAPRI	IFPRI1	IFPRI2	OECD	DFA	EEP
Total real absorption	1443.2	2.3	2.0	0.9	2.4	1.2	-2.3
GDP, Market Price	1401.4	1.4	1.9	0.1	2.2	1.1	-1.6
GDP, Factor Cost	1272.4	1.8	1.0	1.3	0.7	0.1	-2.3
Total real household consumption	1056.8	3.2	2.7	1.3	3.3	1.7	-3.1
Total real exports	479.9	-0.2	0.3	-2.9	2.7	2.4	-0.1
Total real imports	567.0	3.1	0.8	0.2	3.1	2.7	-2.7
Real exchange rate	114.8	-5.4	8.9	-3.6	-3.1	-2.0	12.2
Nominal exchange rate	129.8	0.4	9.3	0.2	0.9	0.2	8.2
Export price index (FCU)—(1)	100.0	-	-	-	-	0.7	-3.1
Import price index (FCU)—(2)	100.0	-2.2	-0.5	-2.0	-0.5	-	-
World (tradables) price index	100.0	-1.2	-0.3	-1.1	-0.3	0.3	-1.4
Domestic (non-tradables) price index	100.0	4.8	0.1	2.9	3.8	2.6	-4.9
Terms of trade =(1)/(2)	100.0	2.2	0.5	2	0.5	0.7	-3.1

Source: Author

Appendix 6.5: Imports (Percent change from base)

Imported Commodities	BASE	FAPRI	IFPRI1	IFPRI2	OECD	DFA	EEP
Coarse grains	0.1	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Other food	2.0	-20.9	-30.4	-5.0	-11.8	-13.7	-1.0
Rice	8.6	-	-	-	-	-	-
Other industrial. ag products	20.5	-17.1	-33.2	8.6	-15.8	-22.7	19.5
Other livestock	19.4	-24.8	2.1	-9.1	-0.9	-2.4	-28.7
Fish	2.2	32.3	-12.0	14.3	-24.1	-50.7	-15.7
Forestry & gathering products	2.1	-	-	-	-	-	-
Agro-industry and beverages	39.9	46.3	-38.8	26.3	14.7	12.5	-18.1
Textile products	39.7	6.3	46.1	10.3	15.3	-2.6	-34.3
Other manufacturing goods	355.6	-3.5	1.4	-11.4	-2.1	-3.6	-1.6
Electricity water and energy	61.9	27.0	3.3	39.8	27.8	50.6	18.1
Transport & telecom.	8.3	4.5	19.2	23.3	-0.5	-13.4	-0.7
Bank and insurance services	6.6	3.6	4.5	6.3	1.3	2.8	5.9
Total	**566.9**	**3.1**	**0.8**	**0.2**	**3.1**	**2.7**	**-2.7**

Source: Author

Appendix 6.6: Disaggregated Real Household Consumption (Percent change from base)

	BASE	FAPRI	IFPRI1	IFPRI2	OECD	DFA	EEP
Bamako	139.5	12.2	-3.5	4.0	12.5	10.6	-8.2
Other urban	93.1	10.3	-0.7	6.3	10.3	7.3	-6.0
Rural S-K	321.5	0.0	10.2	-0.1	2.2	-0.5	0.1
Rural River	273.9	0.0	1.5	-0.2	-1.2	-1.5	-2.2
Other rural	228.7	3.2	-1.1	1.4	1.7	0.7	-4.6
TOTAL	**1056.8**	**3.2**	**2.7**	**1.3**	**3.3**	**1.7**	**-3.1**

Source: Author

Appendix 6.7: Implementation of the CET Scenario

Commodity	Calibrated import tariffs	CET Tariffs	Percent change	Share of ROW imports	Changes to import prices
Coarse grains	16.4	8.0	-51.2	92.1	-1.9
Rice	53.3	8.7	-83.7	100.0	-23.6
Other industrial. ag products	8.0	5.0	-37.5	98.4	2.5
Other livestock	17.2	4.8	-72.1	96.1	-5.2
Fish	14.6	10.1	-30.8	0.0	-6.8
Forestry & gathering product	16.5	10.1	-38.8	0.0	-8.6
Agro-industry and beverages	27.8	14.7	-47.1	11.3	-16.0
Other manufacturing goods	4.5	12.0	166.7	92.9	12.3
Electricity water and energy	6.7	8.7	29.9	0.5	-1.5
Transport & telecom	34.6	8.5	-75.4	98.3	-15.4

Source: Based on Chapter III and the calibrated CGE model database

Notes: The table shows the calibrated import tariffs from the CGE model, the CET rates from Chapter III (aggregated to account for commodity aggregation), the percentage change from the calibrated to the CET rates, the share of the rest of the world in total imports, and the transmitted changes in equilibrium import prices. The effective CET rates applied in the CET scenario are weighted by share of ROW in total imports. Commodities such as fish and forestry and gathering products are 100% source from within West Africa (ROW's import share is zero), so that the effective CET rates on these commodities are zero for these commodities.

Appendix 6.8: Real Imports (Percent change from base)

Imported Commodities	BASE	CET	BANS	GINV
Coarse grains	0.1	-0.2	-0.2	-0.2
Other food	2.0	-16.9	-7.8	-17.2
Rice	8.6	-	-	-
Other industrial. ag products	20.5	-11.4	-7.1	22.2
Other livestock	19.4	-31.4	-28.8	-26.3
Fish	2.2	-17.8	-14.3	-17.5
Forestry & gathering products	2.1	-	-	-
Agro-industry and beverages	39.9	39.7	16.8	8.1
Textile products	39.7	-22.8	0.0	-5.2
Other manufacturing goods	355.6	3.8	-2.6	8.5
Electricity water and energy	61.9	15.9	17.6	-51.4
Transport & telecom.	8.3	-8.2	-0.5	8.5
Bank and insurance services	6.6	4.2	5.0	3.5
Total	**566.9**	**3.6**	**0.2**	**-0.2**

Source: Author

Appendix 6.9: Real Exports (Percent change from base)

Exported Commodities	BASE	CET	BAN	GINV
Coarse grains	0.7	0.0	-100.0	0.0
Other food	6.1	14.3	8.3	8.9
Rice	0.1	-3.8	-100.0	1.0
Other industrial. ag products	6.3	10.9	6.1	-13.2
Cotton	163.3	-	-	-
Cattle and sheep and goats	51.9	13.1	6.5	9.9
Other livestock	2.4	85.1	59.6	53.4
Fish	6.8	29.4	15.4	18.3
Mining products	152.5	-	-	-
Transport & telecom.	68.6	14.5	0.3	-5.1
Other traded services	21.2	-8.3	-27.0	-22.1
Total	**479.9**	**4.3**	**0.3**	**-0.2**

Source: Author

Appendix 6.10: Final and Intermediate Demand Prices (Percents change from base)

Item	BASE	CET	BAN	GINV
Commodities	Consumer Prices (Percent change from base)			
Coarse grains	0.7	-0.3	-3.3	1.8
Other food	0.9	-6.4	-7.1	-8.6
Rice	0.9	-3.4	-3.0	1.0
Other industrial. ag products	2.1	-3.7	-5.8	15.0
Cattle and sheep and goats	1.0	-16.2	-11.1	-15.5
Other livestock	2.4	-30.7	-27.8	-23.6
Fish	1.4	-15.0	-12.0	-11.9
Forestry & gathering products	0.8	-2.3	-4.0	0.2
Agro-industry and beverages	1.9	27.6	19.8	11.7
Textile products	1.9	-15.8	-1.1	-5.2
Other manufacturing goods	1.2	17.7	-4.5	12.2
Electricity water and energy	1.0	18.4	20.8	-58.9
Construction & public works	0.6	9.9	-0.1	3.3
Trade	0.4	7.9	0.4	1.0
Transport & telecom.	0.9	-10.9	-1.7	7.2
Other traded services	0.3	21.1	48.4	42.0
Bank and insurance services	0.5	2.1	4.9	5.9
Nontraded services	1.0	-5.4	1.2	-1.4
Activities	Price of Aggregate Intermediate Inputs			
Food production, excl. rice	0.9	2.7	-2.0	0.1
Rice production	1.1	0.9	-0.4	1.4
Industrial ag, excluding cotton	1.1	7.4	-1.6	3.0
Cotton production	1.0	11.4	1.1	3.3
Livestock keeping and fishery	1.1	-4.4	-5.8	-9.5
Forestry and gathering	1.1	12.9	-1.9	3.8
Mining	0.9	11.5	-0.3	0.6
Agro-industry and beverages	1.2	10.0	6.4	6.2
Textile production	1.0	3.0	1.6	-2.6
Other manufacturing goods	1.0	10.9	0.9	3.1
Electricity, water and energy	0.8	8.0	3.7	-4.6
Construction and public works	1.0	9.9	-0.1	3.3
Trade	0.8	4.8	4.8	3.3
Transport and telecom.	0.8	8.1	3.1	-0.7
Other traded services	0.9	0.8	3.0	-11.7
Bank and insurance services	0.8	2.1	4.9	5.9
Nontraded services	0.9	5.9	1.6	-0.9

Source: Author

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