Explaining the Evolution of Poverty: The Case of Mozambique

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We provide a comprehensive approach for analyzing the evolution of poverty using Mozambique as a case study. Bringing together data from disparate sources, we develop a novel "back-casting" framework that links a dynamic computable general equilibrium model to a micro-simulation poverty module. This framework provides a new approach to explaining and decomposing the evolution of poverty, as well as to examining rigorously the coherence between poverty, economic growth, and inequality outcomes. Finally, various simple but useful and rarely-applied approaches to considering regional changes in poverty rates are presented.

Key words: Economy-wide modeling, growth, inequality, measurement, poverty.

JEL codes: O10, O13, I32.

Measuring poverty remains a complex and contentious issue. This is particularly true in sub-Saharan Africa, where poverty rates are higher, information bases are typically weaker, and the underlying determinants of welfare are relatively volatile. Recent publications point to differing assessments regarding the overall trend in poverty reduction in the region. Based on different methods, both Sala-i-Martin and Pinkovskiy (2010) and Young (2011) conclude that poverty rates are falling rapidly throughout sub-Saharan Africa. In contrast, the World Bank – the official scorekeeper for the attainment of the Millennium Development Goal related to consumption poverty – reports much more modest declines (World Bank 2010).

There are two main elements to this debate. The first refers to the data used to make inferences about trends in well-being. Young (2011) raises doubts about the quality, reliability, and coverage of private consumption data of the type employed by the World Bank when measuring poverty at the household level. In particular, there may be large discrepancies between alternative measures of consumption growth (e.g. from supply tables in the national accounts) and those derived from expenditure surveys (see Ravallion 2003). This introduces the second issue – coherence. One challenge is to produce a measure of poverty for a given country at given points in time. Another task is for this to form part of a coherent interpretation of reality vis-à-vis the evolution of other indicators, including macroeconomic aggregates and external conditions such as inter-annual fluctuations in global commodity prices and weather patterns. Indeed, rigorous and established methods of poverty measurement are often not associated with corresponding analyses that formally situate and validate such measures in their wider macroeconomic context. This gap hinders identification of the underlying drivers of poverty trends and makes it difficult to disentangle the effects of public policy from those caused by external shocks and non-policy factors.

The present article illustrates an approach to filling this gap. As a starting point, we employ recently collected household data in Mozambique and examine the evolution of consumption poverty over the period 2002/03 to 2008/09. This period renders Mozambique of particular

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Amer. J. Agr. Econ. 94(4): 854–872; doi: 10.1093/ajae/aas022
Received Feb 2012; accepted Feb 2012; published online May 15, 2012

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interest due to major movements in international commodity prices. In addition, similar to other low-income African countries, Mozambique has recently experienced robust rates of gross domestic product (GDP) growth combined with emerging concerns about the extent to which this growth has been pro-poor. Thus, for the case of Mozambique, this study has three empirical analytical objectives: (i) to provide a comprehensive and robust analysis of the evolution of poverty; (ii) to cross-validate these trends based on external microeconomic and macroeconomic data; and (iii) to identify underlying drivers of poverty outcomes and their internal coherence in an economy-wide perspective.

In terms of methodology, the comprehensive nature of our analysis, which brings together data from disparate sources, is a key characteristic. In particular, we develop a novel "back-casting" approach that links a dynamic computable general equilibrium (CGE) model to a micro-simulation poverty module. This modeling framework provides a new approach for explaining and decomposing the evolution of poverty and for rigorously examining the coherence between poverty, economic growth, and inequality outcomes in the spirit of the triangle proposed by Bourguignon (2004). The framework builds on a growing body of literature that employs economy-wide models to track, and thus help explain and decompose, observed phenomena. Examples from this literature include Arndt, Robinson and Tarp (2002); Pauw and Thurlow (2011); and Dyer and Taylor (2011). Finally, because the dynamic CGE model is national in its scope, we cross-validate regional trends in poverty, including various simple but useful and rarely applied alternative poverty indicators (proxies).

We find that the national poverty rate in Mozambique stagnated between 2002/03 and 2008/09 at around 55% of the population rather than meeting the officially-stated goal of 45% by 2009. With respect to causal factors, our analysis points to (i) the macroeconomic drag imposed by nearly continuous fuel price increases from 2002 to 2008, combined with (ii) low productivity growth in agriculture, (iii) a weather shock, and (iv) high international food prices. Altogether, these four sets of factors essentially explain all of the stagnation in poverty rates at the national level. At the regional level, food scarcity, as measured by changes in relative prices, meals consumed per day, and the share of consumption devoted to food, is shown to be strongly related to measured poverty. Our analysis points to important consistency between consumption poverty rates, macroeconomic trends, and external market conditions. It also suggests that public policy should focus more on promoting growth in smallholder agricultural productivity in order to achieve stated poverty reduction goals.

The remainder of the paper is structured as follows. Section 2 reviews our approach to measuring consumption poverty, describes the data sources used, and presents the measured poverty trends. Section 3 introduces the potential drivers of poverty trends, with particular attention paid to the agricultural sector. Section 4 introduces the CGE model, while section 5 presents our model simulations and national-level results. Section 6 then investigates the consistency of changes in poverty rates at a regional level. The final section summarizes and concludes that the approaches employed could usefully be applied to other countries and/or regions.

Measuring Poverty Trends

Since obtaining the unwanted moniker of "poorest country in the world" in 1992, Mozambique has performed relatively well. Through at least 2003, growth was high and poverty reduction rapid. As a result of these achievements, Clément and Peiris (2008) labeled Mozambique an economic success story in sub-Saharan Africa. Based on available data, Arndt, Jones, and Tarp (2007) were similarly positive, though they warned of a "perplexing lack of attention to what appear to be priority needs" (p. 265) in the agricultural sector as well as inconsistent donor support to agriculture. More recent data makes it possible to consider in detail whether the positive trends exhibited from 1992–2003 continued through 2009.

Data Sources

The most recent information on consumption poverty in Mozambique comes from the 2008/09 household survey (IOF08) conducted by the Mozambican National Statistics Institute (INE). Below, results from this latest survey are compared to those obtained in two previous survey rounds (2002/03 and 1996/97, labeled IAF02 and IAF96, respectively). Although there are some small differences in the designs of the questionnaires, the three surveys are comparable as to their main

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objective, which is to measure consumption poverty at a given point in time. Like its predecessors, the 2008/09 survey contains detailed information on expenditure and consumption of food items. The IOF08 sample, at 10,832 households, is somewhat larger than earlier rounds (8,250 in IAF96 and 8,700 in IAF02). In all surveys, the sample is representative for the whole of Mozambique, as well as for the rural and urban zones, and each of the ten provinces plus Maputo City. In addition, IAF02 and IOF08 are both representative through time. For IOF08, data collection began in September 2008, lasted for one year, and was designed to be representative by quarter. DNEAP (2010) provides greater detail on the consumption data sets.

The results for consumption poverty are triangulated in this study using data from numerous sources. Data on the agricultural sector is particularly relevant. According to IOF08, 70% of individuals are located in rural areas, and virtually all of these (96%) are engaged in agriculture in some way. Poverty rates are typically higher in rural areas, meaning that approximately three out of four persons categorized as poor live in a rural zone. Additionally, the consumption of food items accounts for around two-thirds of the total consumption of poor households. These figures suggest there is likely to be a strong relationship between trends in agriculture and aggregate trends in poverty reduction. On this basis, the series of Agricultural Surveys (TIAs) (covering production and income) that were conducted in full or abridged form most years between 2002 and 2008 (the exception is 2004), provide an important complement to the household budget surveys. Kiregyera et al. (2008) provide a comprehensive evaluation of the TIA data sets.

Methods for Determining Consumption Poverty

The methods employed to measure consumption poverty are those employed by Arndt and Simler (2010), who build upon the work of Ravallion (1994; 1998), Ravallion and Bidani (1994), and Tarp et al. (2002b). In brief, per capita consumption for each household in the survey is estimated using information on purchases, own consumption and receipts-in-kind. In order to take into account geographic differences in costs of living and consumption patterns, Mozambique is divided into 13 relatively homogeneous spatial domains. Within each domain, a poverty line is estimated, which contains two components: the food poverty line and the non-food poverty line. The food poverty line is obtained by deriving a bundle of food products that: (i) reflects the consumption patterns of poor households within the spatial domain; (ii) provides sufficient calories (approximately 2,150 with the actual calorie target depending on the demographic composition of the domain); and (iii) passes a series of spatial and temporal revealed preference conditions that ensure comparability in the quality of the bundle across space and time.[1] Prices paid by the poor for the elements of the bundles are then calculated, and the food poverty line is simply the cost of the bundle.

Because it is much more difficult to define and price a reasonable bundle of non-food items consumed by the poor, an indirect method is used to calculate the non-food poverty line. Worldwide, poor people allocate a considerable share of their total consumption to non-food items. Thus, average non-food consumption is calculated for households whose total per capita consumption is “close” to the food poverty line. This expenditure is viewed as a minimum budgetary allocation required to meet basic non-food needs and is defined as the non-food poverty line. The total poverty line is obtained as the sum of the food poverty line and the non-food poverty line. Further details on the approach can be found in DNEAP (2010).

Consumption Poverty Rates

Using the approaches outlined above, the data from the IOF08 household survey indicates that the consumption poverty rate remained essentially static between 2002/03 and 2008/09. As shown in table 1, the national headcount ratio was 54.7% according to IOF08. In comparison, in the first comparable survey conducted in 1996/97, the headcount ratio was 69.4%. Poverty thus decreased by 14.7 percentage points over the twelve-year period from 1996/97. The increase of 0.6 percentage points observed since 2002/03 is not statistically significant using the approach suggested by Simler and Arndt (2007). Thus, the rates obtained from IAF02 and IOF08 are appropriately viewed as being roughly equivalent.

[1] This ensures that the 2008/09 bundle of domain A is not manifestly of higher quality than the 2008/09 bundle of domain B, and vice versa, and that the 2002/03 bundle of domain A is not manifestly of higher quality than the 2008/09 bundle of domain A, and vice versa.

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Table 1. Estimated Consumption Poverty Rates

	2002/03		2008/09		Absolute difference	Confidence interval
	Headcount	SE	Headcount	SE		
National	54.1	1.7	54.7	1.8	0.6	±4.9
Urban	51.5	2.6	49.6	2.2	−1.9	±6.6
Rural	55.3	2.1	56.9	2.3	1.6	±6.1
North	55.3	3.2	46.5	3.2	−8.8	±8.8*
Central	45.5	2.8	59.7	2.9	14.2	±7.9*
South	66.5	1.7	56.9	2.9	−9.6	±6.6*
Niassa	52.1	5.5	31.9	4.8	−20.2	±14.3*
Cabo Delgado	63.2	3.7	37.4	5.2	−25.8	±12.5*
Nampula	52.6	4.8	54.7	3.8	2.1	±12.0
Zambezia	44.6	5.0	70.5	4.2	25.9	±12.8*
Tete	59.8	4.2	42.0	4.6	−17.8	±12.3*
Manica	43.6	4.1	55.1	5.6	11.5	±13.6
Sofala	36.1	3.5	58.0	4.9	21.9	±11.9*
Inhambane	80.7	2.4	57.9	4.5	−22.8	±10.0*
Gaza	60.1	3.5	62.5	4.2	2.4	±10.8
Maputo Province	69.3	3.0	67.5	3.8	−1.8	±9.6
Maputo City	53.6	3.2	36.2	3.3	−17.4	±9.0*

Note: Author's estimates based on IOF08 and IAF02. A * in the final column indicates a statistically significant difference in the poverty rate between 2002/03 and 2008/09. The confidence interval is the confidence interval for the difference. The standard error (SE) of the difference in poverty rates is the square root of the sum of the squares of the standard errors in 2002/03 and 2008/09. Because the distribution of the poverty rate is unknown, confidence intervals are defined as plus or minus twice the standard error. Confidence intervals on the levels can be obtained via simple calculation.

Both rural and urban areas contributed to poverty reduction from 1996/97 to 2008/09. From 2002/03 to 2008/09, however, data show a moderate increase in rural poverty (from 55.3% to 56.9%) and a moderate reduction in urban poverty (from 51.5% to 49.6%). Neither of these changes is statistically significant. As expected, a greater variation in changes in poverty rates is seen when we look at a more geographically disaggregated level. The stagnation in national and rural/urban poverty rates masks a genuine variation at lower levels of aggregation. Changes in poverty rates at the regional level (North, Center, South) are all statistically significant, as are seven of the 11 provincial measures (including Maputo City). Nevertheless, the lack of precision in the provincial poverty measures and differences through time, reflected in wide confidence intervals, is also noticeable.

We now proceed to explain and decompose these observations, focusing first on coherence at the national level, and subsequently on analysis at more disaggregated levels.

Potential Drivers of Poverty Stagnation

A number of factors help explain the stagnation in poverty trends. They include agricultural performance, weather patterns, and fluctuations in global food and fuel prices. Since agriculture is an important activity in Mozambique, especially for poorer households, we start by reviewing this sector's recent performance before turning to changes in nonagricultural and external conditions. In a subsequent section, the factors considered in this section are incorporated into the dynamic CGE model and micro-simulation module.

Agricultural Performance

Tables 2 and 3 summarize key trends in agriculture based on the Ministry of Agriculture TIA series. Four main findings are highlighted below. First, beginning with table 2, the TIAs confirm the continued importance of agriculture for households' well-being. From 2002 to 2008, the number of small- and medium-sized farms grew by 19%, which is consistent with population growth; and the area under cultivation increased by 34%. Importantly, the vast majority of farms are small – the average size is around 1.5 hectares, with many farms operating on one hectare or less.

Second, indicators concerning access to and use of productivity-enhancing inputs, such as pesticides and fertilizers, show a negative trend. From 2002 to 2008, the share of farming households receiving extension information appears to have declined from 13.5% to 8.3%. Similarly, the use of pesticides fell from 6.8% to 3.8%. Even ignoring these trends, the absolute levels

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Table 2. Agriculture and Agricultural Technology

	2002	2003	2005	2006	2007	2008	Change, 2008–2002 (%)
Cultivated area (1,000 hectares)	4,185	4,535	5,552	5,612	5,672	5,602	33.9
Number of small and medium sized farms (1,000)	3,127	3,210	3,333	3,396	3,619	3,725	19.1
Average farm size (hectares)	1.3	1.4	1.7	1.7	1.6	1.5	12.4
Average household size (persons)	5.0	5.0	5.3	5.1	4.9	5.1	2.0
Rural population (millions of people) [adjusted]	12.4	12.7	14.0	13.7	14.0	15.1	21.5
Household heads with Grade 4 education (%)	31.1	32.9	36.4	36.2	36.6	42.3	36.0
Receipt of extension information (% farms)	13.5	13.3	14.8	12.0	10.1	8.3	−38.5
Use of chemical fertilizer (% farms)	3.8	2.6	3.9	4.7	4.1	4.1	7.9
Use of pesticides (% farms)	6.8	5.3	5.6	5.5	4.2	3.8	−44.1
Use of irrigation (% farms)	10.9	6.1	6.0	8.4	9.9	8.8	−19.3
Receipt of credit (% farms)	–	2.9	3.5	2.9	4.7	2.6	−10.3

Note: Author's estimates from TIA databases.

Table 3. Production Trends for Food Crops

	2002	2003	2005	2006	2007	2008	Change, 2008–2002 (%)	CV
(A) Production per person (kilograms)								
Maize	90.0	92.9	67.3	101.7	80.7	80.7	−10.3	14.0
Rice	7.5	9.2	4.6	7.1	7.3	5.8	−22.7	22.7
Sorghum and millet	12.2	16.7	9.3	16.3	13.7	9.4	−23.0	25.0
Groundnut	10.0	8.2	6.8	7.0	8.6	7.6	−24.0	14.7
Legumes	6.9	8.4	6.1	9.7	9.5	8.4	21.7	17.4
Cassava	278.2	376.1	341.7	399.5	353.0	269.4	−3.2	15.6
Sweet potato	36.8	48.0	36.4	49.4	61.4	40.5	10.1	21.1
(B) Aggregate measures (using calories)								
Total production index	100.0	124.2	111.3	140.9	128.6	113.8	13.8	12.1
Productivity (kcal/ha)	2,307	2,643	1,935	2,424	2,189	1,961	−15.0	12.2
Productivity index	100.0	114.6	83.9	105.1	94.9	85.0	−15.0	12.2
Calories per person/day	2,135	2,583	2,103	2,717	2,422	2,000	−6.3	12.5

Note: Author's estimates from TIA databases. CV is coefficient of variation.

of these indicators are very low and illustrate that the vast majority of farming households continue to use almost no modern inputs or irrigation technologies to support production.

Third, turning to table 3, agricultural production shows only weak aggregate growth. When adjusted to take into account either the expansion of cultivated area or population growth, the conclusion is that agricultural productivity in the smallholder sector has remained stagnant over time. Panel A shows that, with population growth, per capita production (using rural population) of nearly all the principal staple crops was lower in 2008 compared to 2002. Panel B provides the aggregated figures for production of principal food crops, calculated using caloric values of the individual crops as weights. These caloric values remain constant over time and can be used to derive a total production index. When calculated on a per capita basis, the total calorie-value of agricultural production has been at best stagnant, and possibly falling. For example, total calorie availability per person per day was 2,000 calories in 2008 compared to 2,135 in 2002 (based on national agricultural production alone). This means that if the total volume of production of these principal crops were distributed equally across all rural households, it would not be sufficient to meet the calorie needs defined by the food baskets. These declines in per capita food production are highly consistent with the national picture of stagnant rural poverty over the same period.

The final point from table 3 is one of production volatility. The last column reports the coefficient of variation, which is the standard deviation of the annual row values divided by their mean. It indicates the expected change per year as a percentage of the average value.

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For individual crops, the level of volatility appears large on this measure (panel A). This is repeated with the aggregate production indices in panel B, where total production and total calorie-availability (per person per day) can be expected to vary by 12% from one year to the next. Production volatility is likely to be much larger at the regional level given that differential regional performances are expected to offset each other to some extent. Large variability in agricultural production is indicative of a high level of vulnerability of rural populations, a point which supports evidence from table 2 concerning limited access to modern technologies, especially irrigation. More broadly, the evidence of production volatility supports some of the large regional changes in poverty rates observed in table 1.

Overall, domestic production strongly outweighs trade in food products. In 2003, imports accounted for only slightly more than 10% of total food supply, while exports accounted for a mere 4% of use. Nevertheless, trade could play an important equilibrating role if demand outstrips supply. Not surprisingly, food imports rose alongside the lack of growth in domestic food production. Real food imports grew by 122% between 2002 and 2008 according to national accounts data (National Institute of Statistics 2010b). The share of food in total imports rose from 9–14% over the same period.[2] Food exports also grew by about 110% over the same period though from a much smaller base. Growth in exports of a few food products (horticulture, cashews, fresh fruit, wood, sugar, and spirits) accounted for all of the growth in food product exports over the period. Total export volumes for all other food/agricultural products actually declined slightly.[3]

Thus, one potential explanation for poverty rate stagnation is weak growth in agricultural productivity, combined with region-specific weather shocks to agricultural production in 2008, as these factors led to a decline in per capita production of food crops between 2002 and 2008.

External Conditions

At the same time that agricultural production was stagnating, substantial changes were taking place in international commodity markets. World food prices spiked significantly in real terms, with the peak attained in mid-2008. During the IOF survey period, world food prices declined significantly below their peak levels of mid-2008 but were still well above levels registered in 2002 and 2003.[4] In addition, real fuel prices rose almost continuously from 2002 to a peak in mid-2008 that was nearly five times the average level observed in 2002/03. Like food, oil prices declined in the second half of 2008 but remained at levels well above those observed in 2002/03. Hence, the observed decline in per capita production of food crops in 2008 occurred essentially simultaneously with a very strong spike in international food prices. Increases in fuel prices raised the costs of delivering food to Mozambique (even after the international food price had been paid), distributing imports within the country, and distributing whatever surplus domestic production that might have existed.

Labor Force

The share of children enrolled in school in Mozambique increased markedly in all provinces between 2002 and 2008, and the efficiency with which students move through the education system also improved rapidly. These changes have two effects. First, because children are a large share of the population (the 7–17 age group represents more than one-quarter of the population), a more pronounced tendency to remain in school has labor market effects. In particular, using data from IAF02 and IOF08, the supply of unskilled labor has been declining since 2002/03 at a rate of slightly less than 2.5% per year.[5] Second, the profile of those who are working is rapidly becoming more skilled, albeit from a low base. The stock of semi-skilled labor more than doubled, while the stock of skilled labor came close to doubling. However, even though the skilled labor stock is growing rapidly, the net effect of the tendency to remain in school over the period 2002/03 to 2008/09 was a relatively slow rate of growth in the total labor force. According to the IOF/IAF surveys, the labor force as a whole grew at about 0.4% per annum.

[2] Food aid is typically monetized at prevailing market prices and is counted simply as an import.

[3] All figures obtained from national accounts data.

[4] For example, the International Monetary Fund's food commodity price index registered a level during the IOF survey period that was 53% in nominal terms (or about 40% in real USD terms) above the level observed during the IAF survey period (July 2002 to June 2003).

[5] Unskilled labor is defined as those without a complete primary school education; semi-skilled labor refers to those who completed primary school but did not complete secondary school; skilled labor refers to those who completed secondary school or better.

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Macroeconomic Analysis

While all of the factors described above are likely to influence poverty in the Mozambican context, it is not clear which drivers are the most important. To consider and contrast their economic implications, we use a dynamic economy-wide model of Mozambique, which is linked to a poverty module. Using the model as a simulation laboratory, we are able to estimate the strength of various factors in determining the national poverty rate, as well as poverty rates by urban and rural zone. This modeling is also useful as a validation exercise at the national level. In particular, the model can help determine whether the observed evolution of poverty from 2002/03 to 2008/09 can be plausibly reconciled with observed rates of economic growth and trends in inequality measures.

Model Description

Dynamic CGE models are often applied to issues of trade strategy, income distribution, and structural change in developing countries, as they have features that make them suitable for such analyses. First, they simulate the functioning of a market economy, including markets for labor, capital and commodities, and provide a useful perspective on how changes in economic conditions are mediated through prices and markets. Second, they ensure that all economy-wide constraints are respected. This is critical discipline when substantial shocks are imposed. Shocks such as rises in world fuel prices have macroeconomic consequences in terms of, for example, the supply and demand for foreign currency. CGE models track the balance of payments and require that a sufficient quantity of foreign currency be available to finance imports. Finally, CGE models contain detailed sector breakdowns and provide a "simulation laboratory" for quantitatively examining how various impact channels influence the performance and structure of the examined economy.

In CGE models, economic decision-making is the outcome of decentralized optimization by producers and consumers within a coherent economy-wide framework. A variety of substitution mechanisms occur in response to variations in relative prices including substitution between labor types, capital and labor, imports and domestic goods, and exports and domestic sales. The Mozambique CGE model follows in the tradition of Dervis, De Melo and Robinson (1982), and its detailed specification is provided in Diao and Thurlow (2012). The Mozambique model contains 56 activities/commodities, including 24 agricultural and 7 food-processing sectors. Five factors of production are identified: unskilled, semi-skilled and skilled labor, agricultural land, and capital. Additionally, imports, exports, and domestic supplies require margin services in order to move from source of supply to point of demand. Provision of margin services is an activity in the model that buys trade and transport as intermediates. This detail captures Mozambique's macroeconomic structure quite well and in turn influences model results appropriately.

Economic development and poverty reduction is in many ways about the accumulation of factors of production such as physical capital, human capital, and technology. These factors, combined with the necessary institutional frameworks to make them productive, determine the material well-being of both households and countries. The dynamic CGE model captures these accumulation processes. For the purposes of this analysis, labor and land growth rates were exogenously imposed. Capital is accumulated by the conversion of savings into investment, with the destination of investment determined by relative rates of profitability across sectors. The model is also well-suited to considering the domestic implications of changes in international prices. World prices for imports and exports are exogenous to the model but can be changed in order to consider how the economy reacts to changes in the terms of trade.

The model is calibrated to a social accounting matrix (SAM) (McCool, Thurlow and Arndt 2009), which provides a complete snapshot of the Mozambican macro-economy in 2003.[6] This database contains the income and expenditure patterns of 10 household groups (i.e. aggregations of households in IAF02). Representative households are separated into rural and urban areas and national income quintiles. A poverty module, based on the IAF02 data, permits one to consider how changes in economic conditions translate into changes in poverty rates. The top-down poverty module functions by taking changes in commodity prices and factor returns from the CGE

[6] The SAM uses technical coefficients from a 1995 input-output table. IAF02 was used to disaggregate households in the SAM, since this was the closest survey to the 2003 benchmark year. IAF02 was also the key data source for the 2003 rebasing of national accounts, on which the SAM is also based.

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model, as reflected in each representative household's consumption changes. These real changes at the commodity level are imposed proportionally on the consumption levels of corresponding households in IAF02. Thus, for each simulation, a new household-specific level of per capita expenditure is estimated, which serves as a welfare measure in standard poverty analysis. A more detailed specification of the poverty module is provided in the appendix.

Scenarios

This section describes the various scenarios employed to consider the evolution of poverty. We present six successive scenarios: 2003 Baseline, Education, Agriculture, Food, Fuel, and Weather. The scenarios are cumulative with each new scenario adding a particular set of changes to the earlier one. The 2003 Baseline presents a projection of economic growth and poverty rates in 2008/09 using assumptions that would have reasonably pertained had the projection been made in early 2004. This is an admittedly ad hoc way to generate a counterfactual. At the same time, actual poverty performance differed significantly from the targeted level of 45%. As some of the present authors were engaged in the process of setting the 45% level, we are able to communicate some of the thinking that underpinned the choice of that level. The Baseline then allows us to consider why actual poverty performance differed from the targeted level.

Subsequent scenarios progressively add differences to this baseline, with all previously imposed differences maintained. Thus, the Food scenario contains the new differences from the Baseline that comprise the Food scenario, as well as the differences imposed in the Education and Agriculture scenarios. The final scenario, Weather, represents the total cumulative effect of all changes from the Baseline. It also represents our best attempt to track the evolution of the Mozambican economy from 2003 to 2009. In the following subsections, we present the shocks from each scenario.

2003 Baseline

In the 2003 Baseline scenario, the model is run from 2003 to 2009. The following assumptions related to factor accumulation, technical change, and world prices are imposed on the growth process.

- *Factors*: Skilled, semi-skilled, and unskilled labor stocks are projected to grow at rates of 3.5, 2.75, and 2.25% per annum, respectively. These rates are basically consistent with a population growth of about 2.5%, while recognizing that efforts in education are generating faster growth in the stock of skilled labor.
- *Technology*: Agricultural productivity improves at a relatively rapid rate of approximately 6% per year for food crops. This advance is obtained by a combination of Hicks-neutral (about five percentage points) and land augmenting technical change (about one percentage point).
- *World prices*: Prices for all imports and exports are assumed to remain constant at the levels observed in 2002/03 (IMF 2011).

These three sets of assumptions are the most important for this analysis because they are changed in the five later scenarios. All other assumptions remain constant across the scenarios.

Differences between scenarios are of interest because they provide insight into the principal factors that explain the observed outcomes. For example, what is the difference between the 2003 Baseline scenario presented here and the Weather scenario that contains all differences from the 2003 Baseline? Or what are the implications of reduced agricultural productivity growth from 2002/03 to 2008/09 for poverty rates? For the purposes of analyzing differences across scenarios, the assumptions that remain constant are typically of lesser importance and typically have relatively minor implications for the differences across scenarios.

Nevertheless, we are also interested in the capacity of the model to track the observed evolution of the Mozambican economy, including changes in the structure of value added, the components of GDP, and the evolution of poverty. For this purpose, essentially all modeling choices are relevant. The most important choices are presented here. In all scenarios, the following closure rules apply. A balanced closure is applied to the macroeconomic aggregates. Specifically, consumption (C), government (G), and investment (I) remain at constant shares of total nominal absorption (defined as C + I + G). Tax rates are fixed and the government deficit is variable. Saving rates of institutions (households and enterprises) adjust proportionately to equate savings with investment each year. Labor is fully employed and mobile across all activities. The stock of

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capital is modeled in the putty-clay tradition, meaning that allocated capital is sector-specific (i.e. immobile) but new investment can be directed to any sector. This new investment is allocated based on factor returns from the previous year. The stock of arable land, cleared and ready for planting, grows at 5% per annum, which is consistent with the figures presented in table 2.

The exchange rate is flexible and adjusts to equilibrate the supply and demand for foreign currency. Hicks-neutral productivity growth for cash crops is set at 3.5% per year. Non-agricultural productivity growth varies by sector and is chosen to reflect the sectoral growth rates recorded by national accounts between 2003 and 2008. For agriculture, because planting occurs in period t and harvest occurs in period t + 1, land allocation decisions are made based on the world prices that prevailed in period t. Similarly, farmers are not able to anticipate droughts.

Education

The actual decline in the supply of unskilled labor since 2002/03 referred to above contrasts with the baseline assumption of growth in the unskilled stock of labor at a rate of 2.25% per year. Moreover, compared with the rates of growth assumed in the baseline scenario, growth in the stocks of semi-skilled and skilled labor has in reality been more rapid. Similarly, the 0.4% per annum growth of the labor force as a whole is significantly less than the rate of population growth and the assumed rate of growth of the labor force in the baseline scenario (both of which are approximately 2.5% per annum).

Agriculture and Weather

Agriculture and Weather are the third and sixth scenarios, respectively, and are principally derived from tables 2 and 3. As shown in table 3, there is very little evidence of technical advance. In the Agriculture scenario, we reduce the rate of underlying technical advance for food crops to zero by eliminating both Hicks-neutral and factor-specific (land) technical advance. Separately, the production of food crops was highly variable over the 2002–08 period (see table 3). This volatility is taken to be due principally to weather. In the Weather scenario, we introduce weather shocks that reduce or increase per capita food production in accordance with TIA data. TIA data are not available for 2004 and 2009. For the years where data are lacking, no weather shock is applied.[7]

Food and Fuel Prices

These two scenarios (the fourth and fifth, respectively) draw on figure 1, which provides indices of real international prices for selected import commodities. Real values are calculated by deflating prices by the U.S. GDP deflator. As can be seen in the figure, prices for crucial imports rise dramatically. In the Food and Fuel scenarios, import and export prices for food and fuel commodities, with a published international price, are changed in line with changes in world markets. This is done for each year from 2004–2009. To separate the effects, only food prices are changed in the Food scenario. Changes in fuel prices are added in the Fuel scenario.

Modeling Results

Table 4 illustrates the growth in the components of GDP from both a production and an expenditure perspective by sector between 2003 and 2009 as (i) published in national accounts, and (ii) projected by the dynamic CGE model for the final cumulative scenario, Weather. This last scenario is designed to be the one that most closely simulates the actual evolution of the Mozambican economy. The table also shows the shares of each sector in value added, as well as expenditure shares in 2003. Sectors are divided between the broad categories of agriculture, industry, and services.

We note that, for industry and services, actual growth in value added is reasonably close to the growth in value added projected by the CGE model; however, for reasons discussed in more detail below, the projected rate of growth of agriculture is substantially lower than the rate estimated by national accounts. Overall, GDP growth differs between the estimations of national accounts (7.6% per annum) and the projections of the model (6.7% per annum). Approximately 90% of the difference in the overall GDP growth rate is due to the difference in the growth rate of agriculture – particularly food crops – which represented

[7] No weather shocks are applied in 2007 either due to lower confidence in the data.

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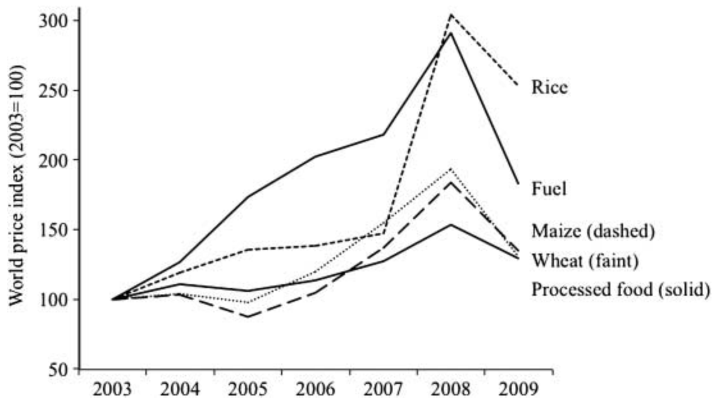

Figure 1. International commodity price indices

Note: IMF (2011) and Council of Economic Advisors (2010).

Table 4. Growth of GDP Components in National Accounts and Model, 2003–2009

		Change, 2003-2009 (%)	
	Share, 2003 (%)	National accounts	CGE model
Gross domestic product	100.0	7.6	6.7
Production optic			
Agriculture	25.9	7.9	3.9
Industry	23.1	6.3	7.8
Services	50.9	8.3	7.5
Expenditure optic			
Consumption	88.7	5.9	4.5
Investment	22.5	4.5	5.8
Government	12.8	7.7	8.5
Exports	26.3	11.0	10.2
Imports	−50.2	4.7	5.2

Note: Authors' calculation and national accounts.

more than two-thirds of the agricultural value added in 2003.

Since 1996, two sources of information on agricultural production have been maintained in Mozambique. The first relies principally on the Early Warning System, while the second relies on the TIA survey. As emphasized in Kiregyera et al. (2008), these two sources of information provide very different perspectives on the evolution of the agricultural sector over the past eight years. Kiregyera et al. also make clear that the TIA provides a more reliable source of information. Recently, these and other observations led the government to switch the principal official source of information on agriculture to the TIA. The switch leads to a very considerable revision of the performance of the agricultural sector both in terms of levels and trends.[8] Overall, the Early Warning System data indicate both larger production levels and more rapid growth in agriculture than TIA.

While the Statistical Yearbook (National Institute of Statistics 2010a) has switched from the Early Warning System to TIA as the principal (but not only) source of information on agricultural production levels, the same is not true of national accounts, which, through 2009,

[8] For example, the 2005 Statistical Yearbook estimates that 1.38 million metric tons of maize were produced in 2005. This figure came from the Early Warning System. The 2008 Statistical Yearbook indicates that only 0.94 million metric tons of maize were produced in 2005. This figure came from TIA. In other words, relative to TIA, the Early Warning System overestimated maize production in 2005 by nearly 50%.

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Table 5. Actual and Projected Poverty Rates

	National		Rural		Urban	
	Actual	Model	Actual	Model	Actual	Model
Aggregate	54.7	54.2	56.6	55.3	49.6	51.8
Semester 1	57.3	57.0	60.1	57.3	50.5	56.1
Semester 2	52.3	51.5	53.8	53.3	48.6	47.5

Note: Authors' estimates.

still reflect agricultural production levels as provided by the Early Warning System. As a result, the growth rate of the agricultural sector, as estimated by national accounts, is overstated. The final column of table 4 shows the estimated growth rate of agriculture using data from TIA as inputs into the CGE model (as per the Weather scenario). The growth rate of agriculture in this scenario is considerably slower (3.9% per annum versus 7.9%). This decline in the growth rate of agriculture reduces overall GDP growth by approximately one percentage point per annum over the period 2003 to 2009.

Even with this correction to the estimated overall GDP growth rate, per capita GDP is still estimated to have grown by about 4.2% per annum (6.7% GDP growth rate minus about 2.5% annual population growth rate) from 2003 to 2009. Table 4 illustrates that the rate of private consumption growth is lower than GDP growth in both the model and in the national accounts. Real consumption is growing in the model at about 4.5% per annum in total, or about 2% per annum per capita.

This value, approximately 2% per annum per capita, represents our current best estimate of real private consumption growth. Can this real growth in personal consumption be reconciled with stagnation in consumption poverty rates?

Table 5 illustrates that it can. The table compares poverty rates derived from IOF08 with projected poverty rates using the CGE model. Before comparing the rates, it is helpful to note that the CGE model is annual while the IOF survey spans 2008 and 2009. To deal with this issue, we assume that the first semester of IOF results correspond to model year 2008 while the second semester of IOF results corresponds to model year 2009. When comparing the full IOF database with the model results, we take the simple average of results from 2008 and 2009.

Model results are strikingly close to estimates from IOF08. At the national level and for the full survey period, the IOF survey estimates that 54.7% of the population consumes below the poverty line. The corresponding model estimate is 54.2%. Model results are also very close to IOF estimated rates in rural zones for both the full survey period and by semester. The only rates that do not lie very close to one another between the model projection and IOF08 are the first semester in urban zones. The difference between these two rates is a bit less than six percentage points.[9] Overall, the IOF08 results appear to be very consistent with the evolution of macroeconomic variables.

A significant advantage of CGE models is that they allow the analyst to decompose complex phenomena, such as the evolution of poverty rates through time, in order to provide insights about the driving forces behind results. So far, we have considered only results from the final scenario, Weather, which includes all of the effects discussed in the preceding subsection. Figure 2 shows the evolution of poverty rates through time for each of the scenarios: 2003 Baseline, Education, Agriculture, Food, Fuel, and Weather. Recall that the scenarios are cumulative. Hence, the Agriculture scenario differs from the 2003 Baseline both in terms of rates of productivity growth in agriculture and the rate of growth of the labor force by skill class.

A number of useful observations emerge from figure 2. First, the goal of reducing the poverty rate to 45% by 2009 appears to have been a reasonable one.[10] As discussed above, the 2003 Baseline scenario provides a projection of poverty rates based on information available in 2004. In this scenario, the labor force grows at plausible rates, agricultural productivity growth is relatively rapid, world prices are held constant, and no weather events occur. Under this scenario, a poverty rate of 45.2% is attained in 2009. This is essentially the

[9] The lower rates observed in IOF08 in urban zones in the first semester compared to the model may reflect an ability on the part of urban consumers to smooth consumption.

[10] The target was established without the benefit of formal CGE modeling.

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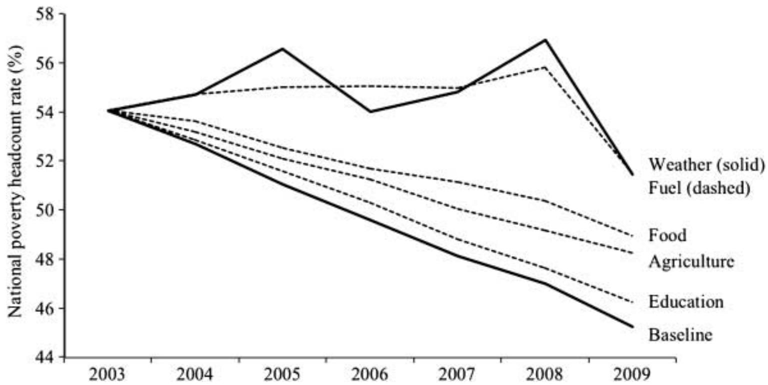

Figure 2. Evolution of poverty rates in model scenarios

Note: Effects are cumulative across scenarios: Agriculture includes effects of Education, Food includes effects of Agriculture, and so on until Weather, which is the final composite scenario.

same as the level targeted by government and external partners.

When the principal differences between the 2003 Baseline scenario and the actual evolution of key external variables are applied to the model, the estimated poverty rate increases in every case. The Education scenario illustrates that, from 2003 to 2009, the contraction in the growth of the labor force due to increased school enrolments increases poverty. Over time, the more rapid growth in skilled and semi-skilled labor that this expansion in enrolments implies is expected to reduce poverty. However, in the near term, education is an investment that implies a small contraction in consumption (and hence a slight increase in poverty).

The principal impacts on poverty derive from: (i) the combination of low productivity growth in agriculture, particularly food crops, substantial increases in world food prices, and a weather shock in 2008; and (ii) the nearly continuous increase in fuel prices from 2003 to 2009. When at their peak in 2008, fuel prices contributed most to the increases in poverty above the 2003 Baseline scenario. In 2009, with the decline in fuel prices but relative firmness of food prices, the combination of low agricultural productivity growth and food price increases contributed most to the increase in poverty.[11]

The strength of the fuel price effect merits further mention. This effect is consistent with earlier analysis (Arndt et al. 2008; 2005). Net imports of fuel and derived products represent a substantial share of total imports–about 18% in 2003. Because fuel use is difficult to economize on, particularly over relatively short time periods, fuel price increases imply a need to either increase exports or reduce imports for any given level of foreign exchange availability from external sources. This terms of trade loss amounts to a reduction in the quantity of goods available to the economy.

Earlier analysis by Arndt et al. (2008) illustrates that policy choices have some impact on poverty. For example, fuel subsidies can reduce the poverty impact of fuel shocks. However, fuel subsidies only partially offset the impact and come at the cost of reducing investment (and increasing future poverty rates, assuming the investment is effective). In addition, fuel subsidies increase the burden of macroeconomic adjustment; they imply (by definition) lower fuel prices and hence greater fuel consumption. This means that exports must increase more or imports of other items must decline by more than in the no-subsidy case. For these reasons, Mozambican authorities

[11] As with all dynamic CGE models, ours is path dependent; and so the order of the simulations will affect comparative results between intermediate scenarios. For example, the incremental change caused by the Weather scenario differs when run before or after the Agriculture scenario, since the latter reduces the size of the agricultural sector (i.e. the part of the economy most affected by weather conditions). That being said, these differences caused by sequencing are usually quite small leaving qualitative conclusions intact. This is the case for our analysis, where the increase in poverty in the Fuel and Agriculture scenarios are much larger than for other scenarios. Moreover, the final combined scenario (in our case, Weather) produces the same outcome regardless of the order of its component simulations. Thus, while some caution is needed when attributing absolute contributions to component factors, our overall conclusions on the major factors contributing to the stagnation in poverty rates are robust.

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have largely, though not completely, allowed international fuel prices to pass through to higher domestic fuel prices. In the model simulations, the international fuel price increases are assumed to be passed through to the economy.

Changes in fuel prices influence relative prices throughout the economy. In Mozambique, the existence of large differences between farm-gate agricultural prices and consumer prices is well established. Transport costs, of which fuel is a substantial component, account for a large share of this difference. Other things being equal, higher fuel prices simultaneously lower farm-gate prices and increase consumer prices because they expand the marketing wedge between producers and consumers (Tarp et al. 2002a). The costs of distributing imported products, especially food, which is bulky and relatively low value, increases. Finally, direct transport costs, which are often particularly important for urban residents, tend to rise.

To complete this section, we consider the links between consumption growth, poverty, and inequality set forth by Bourguignon (2004). In the model, consumption is growing and poverty is essentially unchanged (up in 2008 and down in 2009). Therefore, one expects inequality to rise, though not dramatically, as the rate of consumption growth is not particularly rapid. This is indeed the case in the model. The Gini coefficient, derived from micro-simulation results for 2008 and 2009, rises to about 43.4, or about two points higher than the estimate from 2002-03. In contrast, the point estimate for inequality from the IOF08 survey points to no change relative to 2002/03. Nevertheless, the change in the Gini coefficient estimated by the model falls well within the estimated confidence interval for the change in the Gini coefficient from 2002/03 to 2008/09.[12] We conclude that cross referencing with other sources and approaches points to an increase in inequality of about two points.

[12] In calculating the Gini coefficient from the survey data, real consumption is determined using the poverty lines. Evidence from the consumer price index points to an increase in the price of basic goods, particularly basic foods consumed by the poor, relative to manufactures, services, and processed foods, which comprise a large share of consumption of upper income Mozambicans. Preliminary analysis indicates that accounting for these differential price trends across income classes, which the combined CGE and poverty module framework does implicitly, results in increases in measured inequality.

Regional Poverty Rates

While stagnation in poverty rates at the national level is confirmed by our macroeconomic analysis, table 1 indicates substantial regional variation in poverty reduction measures. This section considers whether these regional variations are consistent with other sources of data. The first subsection uses agricultural price data as a cross reference on the household survey. This is a strong form of cross–checking, as the price data and the household survey data were collected separately. In addition, we consider the internal consistency of the household survey using food-based poverty indicators.

Agricultural Price Data

An important source of information concerning trends in Mozambican prices is contained in the Agricultural Markets Information System (SIMA). The SIMA data provide price information for a range of core agricultural products in 25 urban markets (cities and towns) covering all provinces. It has a much wider geographical coverage than the price database used for constructing the consumer price index (CPI), which is restricted to the three principal urban centers. While the spatial coverage is better, the SIMA data cover a relatively small number of agricultural goods. Nevertheless, these products tend to be important elements in the consumption baskets of poor people.

Table 6 compares provincial measures of price inflation constructed from the SIMA series with survey-based measures of food price inflation (the ratio of the food poverty lines in the first column). Two price series are calculated from the SIMA, from which inflation is then derived. The first is based on a simple average of prices across all relevant SIMA products for each of the 12-month periods covered by the IAF02 (July 2002 to June 2003) and IOF08 (September 2008 to August 2009). The ratio of these two averages measures cumulative food price inflation between the two periods. The second SIMA price series is a weighted measure, where the weights are estimated so as to correspond to the weights of the same items in the food poverty baskets estimated from IAF02.

The poverty line-based price indices and the SIMA-derived price indices are not perfect comparators. Discrepancies exist due to the more restricted number of products in the SIMA dataset as well as differences

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Table 6. Comparison of Market Information System (SIMA) and Survey-based Measures of Food Price Trends

	Food poverty line ratio	SIMA price ratios		Ratio difference	
		Un-weighted	Weighted	Un-weighted	Weighted
Niassa	1.98	1.98	1.85	0.00	−0.13
Cabo Delgado	1.98	1.77	2.00	−0.20	0.02
Nampula	2.29	2.11	2.24	−0.18	−0.04
Zambezia	2.68	2.15	3.05	−0.54	0.36
Tete	2.69	2.14	2.37	−0.56	−0.32
Manica	2.54	2.26	2.63	−0.29	0.09
Sofala	2.52	2.14	2.70	−0.38	0.18
Inhambane	2.37	2.06	2.23	−0.31	−0.13
Gaza	2.37	2.05	2.05	−0.32	−0.32
Maputo City	1.97	2.05	2.03	0.09	0.07
Overall	2.35	2.08	2.34	−0.27	0.00

Note: Authors' estimates using IOF, IAF and SIMA databases. Given that SIMA prices are calculated as 12-month averages (corresponding to the full periods of the household surveys), the food poverty lines do not include a temporal price adjustment; the final two columns provide the percentage difference between the survey-based inflation estimate (the food poverty line ratio) and the weighted and un-weighted inflation estimates from the SIMA database. Maputo province is excluded as it is not covered by the SIMA series; overall prices are calculated as weighted averages, with weights based on corresponding survey-based provincial population shares (also excluding Maputo province).

in geographical coverage. Nevertheless, the trends in the SIMA-derived measures of inflation are highly consistent with those derived from the household surveys. At the national level, the SIMA dataset suggests that cumulative food price inflation was in the order of 134% between 2002/03 and 2008/09 (weighted price series). This is almost exactly the same as that estimated from the household survey data. At the provincial level the trends are also very consistent–for example, the correlation between these sets of provincial inflation measures is 0.82.

Continuing with the SIMA price series, table 7 presents the distribution of prices across provinces in IAF02 and IOF08 relative to the national average. A score above (below) one indicates a price premium (discount) relative to the national average for a province during a given period. Of particular interest are changes in relative prices over time. Using the preferred weighted price series, one notes a fall in the relative price premium of the Northern and Southern provinces (e.g. Niassa from 1.50 to 1.19) and a rise in the relative prices of Central provinces (e.g. Zambézia from 0.68 to 0.88). This is indicative of more acute price increases in the Central provinces relative to the rest of the country.

A strong relationship exists between these changes in relative prices and changes in the survey-based poverty headcount rates. The correlation coefficient between these two series (shown in the final row of the table) is 0.825 for the weighted SIMA price series and 0.654 for the un-weighted series. The largest changes (positive and negative) in poverty rates correspond to the largest changes in relative prices. In the case of the two northernmost provinces, a slower rate of price increase (from a higher base) has been associated with substantial poverty reduction. In contrast, many of the central provinces have seen the most rapid rate of price increases (from a lower base), and an increase in the poverty headcount. These relative price trends very likely reflect shifts in supply conditions by province. Relatively more rapid growth in supply is expected to induce a decline in relative prices.

As a final analysis, we use the weighted SIMA calculated rates of growth in prices depicted in table 6 to inflate the 2002/03 poverty lines to 2008/09 values. We then recalculate poverty rates in 2008/09. On this basis, figure 3 provides a scatter plot of the actual and predicted poverty levels for 2008/09 as well as the changes relative to 2002/03. The results are very consistent. The correlation between the two sets of poverty levels is 0.912, and 0.907 between the two sets of poverty changes. Furthermore, the standard deviation of the changes in poverty across the 13 spatial domains is 17.3 for the SIMA predictions compared with 14.2 in IOF.

Food-based Poverty Indicators

We consider two additional indicators of well-being in 2002/03 and 2008/09, both of which are food-based. They are: (i) the average daily

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Table 7. Comparison of Market Information System (SIMA) Relative Prices and Poverty Headcount Changes (2002/03 versus 2008/09)

	Headcount change IOF-IAF	SIMA relative prices (un-weighted)			SIMA relative prices (weighted)		
		2002/03	2008/09	Change (%)	2002/03	2008/09	Change (%)
Niassa	−20.16	1.20	1.15	−4.82	1.50	1.19	−21.17
Cabo Delgado	−25.80	1.14	0.97	−14.75	1.22	1.04	−14.80
Nampula	2.08	0.94	0.95	1.31	0.95	0.91	−4.30
Zambezia	25.94	0.90	0.93	3.35	0.68	0.88	30.07
Tete	−17.77	1.01	1.04	2.91	1.05	1.07	1.20
Manica	11.49	0.98	1.06	8.60	1.01	1.13	12.23
Sofala	21.93	1.01	1.05	3.11	0.93	1.07	15.25
Inhambane	−22.75	1.07	1.06	−0.88	1.13	1.08	−4.67
Gaza	2.38	1.08	1.06	−1.40	1.19	1.04	−12.35
Maputo City	−17.45	0.98	0.96	−1.25	1.10	0.96	−13.24
Overall	0.97	1	1	0	1	1	0
Correlation with headcount change	1.000			0.654			0.825

Note: Authors' estimates using IOF08, IAF02 and SIMA databases. The overall change in the headcount of IOF-IAF differs from table 1 because Maputo Province is not included here.

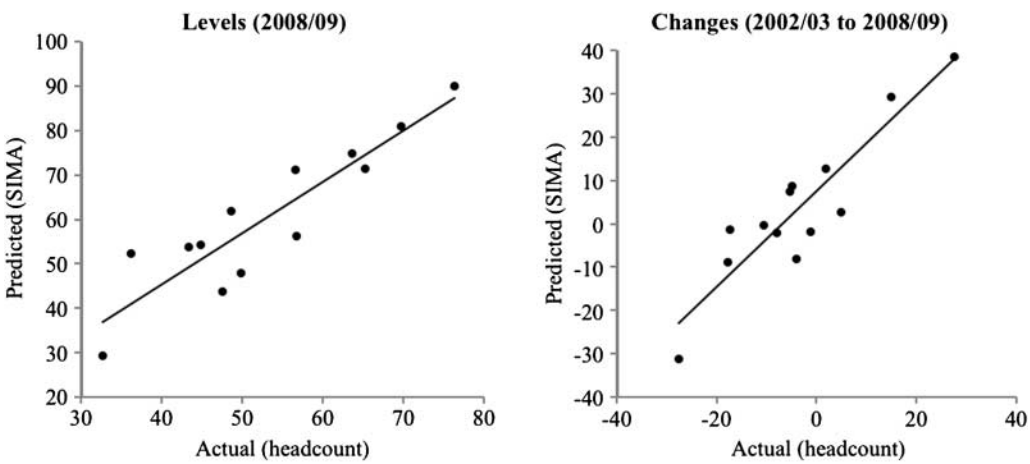

Figure 3. Poverty rate levels and changes using actual results and predicted IAF poverty lines inflated using SIMA price indices by spatial domain

Note: IOF poverty changes are depicted on the horizontal axis while IAF/SIMA changes are depicted on the vertical axis.

number of meals per person; and (ii) the share of food in total consumption, where households with a food share higher than a predetermined threshold are classified as poor. Data for these alternative measures are presented in table 8. The last two rows of the table provide the correlation between changes in monetary poverty at the regional level (not shown in the table) and changes in the corresponding alternative measure.

With respect to the change in the reported average number of meals consumed per capita between the two surveys, it is important to highlight that the number of meals per day is a separate question posed to the household head in the QUIBB (Core Welfare Indicators Survey) section of the IOF/IAF questionnaires. It is not obtained from the commodity-by-commodity consumption information used to estimate the consumption aggregate, and in

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Table 8. Food-based Indicators of Poverty and Wellbeing

	Number of meals			"Food share" poverty (%-point)		
	2002/03	2008/09	Change (%)	2002/03	2008/09	Change
Niassa and Cabo Delgado (rural)	2.05	2.28	11.3	60.4	57.5	−2.9
Niassa and Cabo Delgado (urban)	2.31	2.29	−0.9	53.9	52.0	−1.9
Nampula (rural)	2.24	2.16	−3.6	57.8	62.3	4.5
Nampula (urban)	2.24	2.29	1.9	44.9	57.2	12.3
Sofala and Zambezia (rural)	2.47	2.28	−7.7	42.1	59.5	17.5
Sofala and Zambezia (urban)	2.59	2.41	−6.7	41.7	46.7	5.0
Manica and Tete (rural)	2.41	2.30	−4.8	51.6	45.6	−6.0
Manica and Tete (urban)	2.60	2.53	−2.8	54.1	58.0	3.9
Gaza and Inhambane (rural)	2.04	2.11	3.7	73.1	72.0	−1.2
Gaza and Inhambane (urban)	2.44	2.31	−5.2	62.7	66.6	3.9
Maputo Province (rural)	2.31	2.42	4.6	81.2	81.2	0.0
Maputo Province (urban)	2.38	2.46	3.5	61.8	75.3	13.5
Maputo City	2.45	2.47	1.0	53.6	64.4	10.8
National	2.33	2.29	−1.6	54.1	59.5	5.3
Correl. with headcount (all)			−0.597	1.000	0.516	0.579
Correl. with headcount (ex. Maputo)			−0.602	1.000	0.600	0.709

Note: Authors' estimates using IOF08 and IAF02 databases. Food share poverty is calibrated to replicate IAF02 results based on food shares, these are held fixed and applied to IOF08 survey data (see text for further details).

that sense is an independent indicator of the short-term consumption level. The changes in the number of meals declared per day exhibits a negative correlation of −0.60 with the change in poverty. Hence, provinces with increases (decreases) in poverty are those provinces with fewer (more) meals consumed per day. For example, rural Niassa and Cabo Delgado record an 11.3% increase in the average number of meals consumed and a 27.7 percentage point fall in headcount poverty. In contrast, rural Sofala and Zambézia record a large increase in headcount poverty, which corresponds to a fall in the average of the declared number of meals consumed.

Second, following from Engel's Law, the share of food in household consumption is a useful proxy for well-being. Thus, a decline in the food share over time is likely to be indicative of improvements in living standards. This insight informs the "food share" poverty measure shown in the table. Specifically, for each spatial domain, we find the food share threshold that replicates the 2002/03 poverty rates. These thresholds are held fixed and then applied to the food shares observed in the 2008/09 survey. Households with food shares above this threshold (in either round) are deemed to be poor. Once again, the correlation between changes in this measure and the headcount poverty rate are good, at 0.58 (or 0.71 excluding Maputo City), confirming the broad pattern of changes in monetary poverty over time.

Conclusions

In this article we outlined a mixed-method approach to cross-validating poverty and other indicators. The approach cross references an array of survey-based data and other measurements. We also develop a novel backcasting technique using a dynamic CGE model linked to a micro-simulation poverty module that rigorously explores coherence between poverty outcomes and national accounts data. This modeling framework also permits a direct evaluation of the poverty-growth-inequality triangle of Bourguignon (2004) and a decomposition of the drivers of poverty trends to ascertain the relative importance of different factors behind the evolution of poverty incidence.

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Taking Mozambique as a case study, we conclude that the incidence of consumption-based poverty stagnated from 2002/03 to 2008/09. Regional analysis of price data and food-based poverty indicators confirms differential regional trends. Trends were positive from 2002/03 to 2008/09 in Northern Mozambique, which registered important advances in combating poverty; the same goes for the Southern region, albeit to a slightly lesser extent. In contrast, Central Mozambique saw increases in consumption poverty.

Three sets of reasons were identified as the main factors behind the disappointing performance in the consumption-based measure of poverty. These are:

- Very slow or zero growth rates in agricultural productivity, reflected in weak growth in food crop production;
- Weather shocks that impacted the harvest of 2008, particularly in the Central provinces; and
- Declining terms of trade due to large increases in international food and fuel prices. Fuel prices, in particular, rose substantially from 2002/03 to 2008/09.

Overall, the methods employed illustrate considerable coherence across disparate sources of information, which substantially enhances confidence in the fundamental conclusion of stagnation in poverty rates. Application of these approaches to other country or regional contexts appears to be merited. For example, disaggregated regional or rural economy-wide models, as in Dyer and Taylor (2011), usefully provide a finer resolution view of the poverty picture and could provide an enhanced perspective on the drivers of poverty outcomes.

With respect to Mozambique, an important policy message to draw from this analysis is that a principal missing element in the current development process–as elsewhere in sub-Saharan Africa–is sustained productivity growth in smallholder family agriculture. Getting agriculture moving is a serious challenge in the struggle against poverty. Without stimulating the agricultural sector, particularly but not exclusively the family sector, widespread poverty among large numbers of food-producing small and medium-sized farmers is simply unlikely to go away in the foreseeable future. This is especially so given the vulnerable nature of sub-Saharan African economies, where, as shown in this study, exogenous shocks can have substantial real impacts on the livelihoods of the poorest. While African countries exert little influence on external conditions, domestic policies can address the need for stimulating the agricultural sector head-on.

Acknowledgements

Numerous individuals and institutions helped to make this article possible. We would like to specifically acknowledge the National Directorate of Studies and Policy Analysis (DNEAP) and the National Institute of Statistics (INE) in Mozambique. Financial support from the development cooperation agencies of Denmark and Switzerland (DANIDA and SECO) is gratefully acknowledged. All errors and omissions are the responsibility of the authors.

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Appendix: Poverty Module

A Linear Expenditure System (LES) in the CGE model determines consumption demand C in time period t for each good i and representative household h:

$$\text{(A.1)}\quad P_{it}\cdot C_{iht} = P_{it}\cdot\gamma_{ih} + \beta_{ih}\cdot\left(Y_{ht} - \sum_{i}{}' P'_{it}\cdot\gamma'_{ih}\right)$$

where γ is a minimum subsistence level, β is the marginal budget share, P is the price of each good, and Y is disposable household income (i.e. after taxes and savings).

IAF02 contains detailed expenditure information for surveyed households, some of which is lost when aggregating into representative

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household groups. We therefore link each household in the CGE model to its corresponding constituent households from IAF02. Changes in consumption quantities in the model are then passed down to the survey, as shown below:

$$\text{(A.2)} \quad H_{ist} = H_{ist-1} \cdot \frac{C_{iht}}{C_{iht-1}} \quad \text{where } f : s \rightarrow h$$

where H is the quantity of good i consumed by household s in period t. The function f maps IAF02 households to aggregate household groups in the CGE model, whose consumption is represented by C. Annual consumption changes in the model cause proportional changes for corresponding survey households. However, differences in the consumption patterns of detailed survey households means that changes in total consumption levels will vary, as shown below:

$$\text{(A.3)} \quad T_{st} = \sum_i (H_{ist} \cdot p_{is})$$

where T is total consumption of survey household s, and p is the price of good i reported by household s. We fix p at base-year levels such that T measures real consumption changes. As in standard poverty measurement, T is compared to a base-year poverty line to determine whether survey household s is classified as "poor" within each time period. This poverty module is considered "top-down" since we do not impose consistency in absolute consumption changes between the CGE model and the micro-simulation module. For a more detailed description of the micro-simulation module, see Diao and Thurlow (2012).

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