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# Higher fuel and food prices: impacts and responses for Mozambique

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**Abstract**

Rising world prices for fuel and food represent a negative terms-of-trade shock for Mozambique. The impacts of these price rises are analyzed using various approaches. Detailed price data show that the world price increases are being transmitted to domestic prices. Short-run net benefit ratio analysis indicates that urban households and households in the southern region are more vulnerable to food price increases. Rural households, particularly in the North and Center, often benefit from being in a net seller position. Longer-term analysis using a computable general equilibrium (CGE) model of Mozambique indicates that the fuel price shock dominates rising food prices from both macroeconomic and poverty perspectives. Again, negative impacts are larger in urban areas. The importance of agricultural production response in general and export response in particular is highlighted. Policy analysis reveals difficult trade-offs between short-run mitigation and long-run growth. Improved agricultural productivity has powerful positive impacts, but remains difficult to achieve and may not address the immediate impacts of higher prices.

*JEL classification:* O13, Q18

*Keywords:* Price transmission; Terms-of-trade shocks; Food security; Mozambique

## 1. Introduction

Mozambique has made tremendous strides in reducing poverty over the past 14 years, following the conclusion of the civil war in 1994. Household survey data indicate that the national poverty headcount fell from 69% to 54% during 1997–2003. Reduction in rural poverty has been even more pronounced, although the proportion of people who are poor in these areas remains higher than in urban centers. Given these trends and with the country still growing rapidly, it was expected that the next household survey due in 2009 would confirm that poverty has continued falling. However, the recent dramatic increases in world agricultural and fuel prices may set back at least some of these gains.

Rising world prices certainly represent a negative terms-of-trade shock for Mozambique, since the country imports almost all of its fuel and is a net importer of food. However, the *poverty* impact of higher prices depends on a range of factors, including: (i) the structure of production and consumption at the household level, (ii) the extent of the agricultural supply response, (iii) the extent of export response, and (iv) the fuel intensity of the economy. On the one hand, higher agricultural prices may represent an opportunity to raise rural incomes, since about 80% of the labor force derives their livelihoods from agriculture and related activities. Conversely, many households rely on purchased food, particularly in urban areas, and so may be adversely affected by rising food prices. Moreover, higher fuel prices will also affect poverty due to fuel's economy-wide linkages, especially to Mozambique's burgeoning processing sectors. Finally, macroeconomic adjustments and public policy responses to accommodate the terms-of-trade shock will also affect household incomes. Accordingly, the impact of higher prices will vary over the short and long term, and across rural and urban areas and regions within the country.

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*Note:* Data and programs for replication of this article's main results will be posted online alongside the article, at the publisher's website.

**Data Appendix Available Online**

A data appendix to replicate main results is available in the online version of this article. Please note: Wiley-Blackwell, Inc. is not responsible for the content or functionality of any supporting information supplied by the authors. Any queries (other than missing material) should be directed to the corresponding author for the article.


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Table 1
Changes in international and domestic retail prices

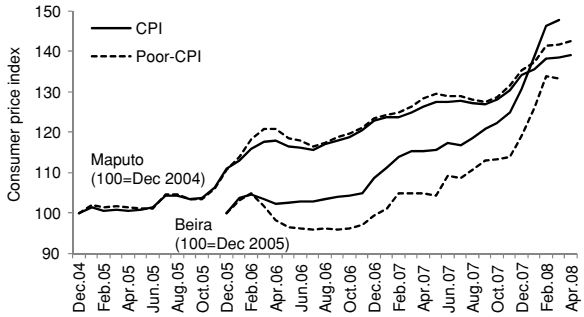
| | July 2005 | July 2006 | July 2007 | July 2008 | Change 2006–2008 (%) |
|---|---|---|---|---|---|
| Average international price | | | | | |
| Rice, Thailand, 5% (U.S. $/ton) | 277.0 | 315.0 | 329.0 | 732.0 | 132.4 |
| Maize (U.S. $/ton) | 108.0 | 114.0 | 147.0 | 265.0 | 132.5 |
| Wheat, U.S., HRW (U.S. $/ton) | 144.0 | 202.0 | 238.0 | 328.0 | 62.4 |
| Crude oil, spot (U.S. $/barrel) | 56.0 | 72.0 | 74.0 | 133.0 | 84.7 |
| Average retail price in Maputo | | | | | |
| Rice (Meticais/kg) | 9.3 | 11.4 | 14.5 | 19.3 | 68.8 |
| Maize (Meticais/kg) | 5.9 | 6.5 | 6.4 | 10.2 | 57.0 |
| Wheat flour (Meticais/kg) | 11.0 | 11.8 | 15.5 | 24.5 | 107.6 |
| Gasoline (Meticais/liter) | – | 27.2 | 33.7 | 41.6 | 52.9 |
| Diesel (Meticais/liter) | – | 27.2 | 27.5 | 35.4 | 29.9 |
| Kerosene (Meticais/liter) | – | 16.5 | 20.3 | 28.7 | 74.1 |
| Rice average retail prices (U.S. $/ton) | | | | | |
| Beira | 391.9 | 307.9 | 503.9 | 1,141.1 | 191.1 |
| Chimoio | 419.9 | 488.1 | 596.9 | 1,190.9 | 183.6 |
| Cuamba | 296.4 | 711.5 | 372.1 | 755.2 | 154.8 |
| Maputo | 381.1 | 452.4 | 562.0 | 800.8 | 110.1 |
| Nampula | 373.2 | 460.7 | 418.6 | 1,020.7 | 173.5 |
| Pemba | 512.3 | 555.6 | 542.6 | 1,120.3 | 118.7 |
| Tete | 532.8 | 634.9 | 515.5 | 1,161.8 | 118.1 |
| Exchange rate (Meticais/U.S. $) | 24.4 | 25.2 | 25.8 | 24.1 | – |

*Source:* The World Bank, Development Economics Prospects Group (http://decpg.worldbank.org); Ministry of Agriculture, Weekly Agriculture Market Bulletin (http://www.sima.minag.org.mz/index.htm); Ministry of Energy.

This article assesses the impact of higher fuel and food prices at both household and macroeconomic levels. It also considers policy options to mitigate some of the negative impacts of higher prices. Section 2 presents information on the extent of international food and fuel price increases and their transmission to local markets in Mozambique. Section 3 presents household-level analysis focused on the first-order impact of the food price increases. Section 4 complements previous sections by examining the impact of higher food and fuel prices within a general equilibrium framework. Section 5 discusses the likely impact of alternative policy options. A final section summarizes and concludes.

## 2. Price transmission

The government has allowed the recent increase in world agricultural and fuel prices to pass through to domestic markets, by avoiding introducing trade distortions or subsidies while providing support to economic sectors most vulnerable to rising energy prices.[1] Table 1 compares nominal fuel and staple food prices in international and Maputo retail markets. The increase in domestic fuel prices is consistent with the increase in international prices. While the pass-through has been lower for rice and maize, some additional pass-through is expected over the coming months as the local harvest no longer cushions local retail prices. By contrast, wheat prices have increased much faster than international prices.




*Source:* Mozambique National Institute of Statistics (INE, 2008) and authors' calculations.

Fig. 1. Changes in CPI and poor-CPI in Maputo and Beira.

Broader measures also indicate considerable price transmission. Fig. 1 presents the consumer price index (CPI) for the major cities of Maputo and Beira.[2] Fuel and food represent more than half of the consumption bundle in each city. Both graphs indicate rapid price rises from October 2007. The rate of growth in prices is considerably more rapid in Beira reflecting both a higher share of food in the basket and a more rapid increase in the price of the food basket.

It is also interesting to explore whether the changes in the cost of living have been higher or lower for the poor. Hence, we compare the evolution of prices in the CPI with a specific poor-consumer price index (PCPI), which focuses on the goods consumed by the poor. With respect to food, the weights in the CPI calculation were adjusted to reflect both the composition of the food basket of the poor and the weight of food in total consumption of the poor. With respect to nonfood items, quality and units issues make adjustment more difficult. To obtain the poor consumers' nonfood basket, nonfood items manifestly not consumed by the poor, such as airline tickets and automobiles, were eliminated from the CPI nonfood basket. The weights on the remaining nonfood items were then scaled such that the sum of weights for nonfood items equals the observed nonfood consumption share of poor households. The adjustments to develop the PCPI in Maputo and Beira reflect observed consumption patterns of the poor in each city. In both cities, the PCPI, like the CPI, exhibits rapid growth since October 2007. In Maputo, recent price increases have been slightly faster for poor consumers, while the reverse is true in Beira. In both cities the difference between PCPI and CPI is not very large, at least for the period starting October 2007.

Recent data published by the Ministry of Agriculture suggest that prices have been transmitted to internal markets as well

[1] In June 2008 the government temporarily removed import duties and VAT on diesel and import duties on kerosene, thus partially offsetting the increase in world prices since January 2008.

[2] Similar results were obtained for the northern city of Nampula.

(Ministry of Agriculture, 2008). Table 1 shows retail rice prices in selected local markets in July 2005 to July 2008. Retail prices rose substantially during this period throughout the country, both in port cities, such as Beira, and in inland markets, such as Tete and Chimoio. While recent percentage price increases are sometimes larger in inland markets, these were often from lower initial price levels. Absolute price changes were more consistent across markets, reflecting the transaction cost wedge between local and border prices. Overall, domestic market price trends suggest that the recent food price increase has been widespread and will affect households throughout the country.[3]

## 3. Household-level analysis

### 3.1. International experience

The first-order welfare impact of rising food prices depends on whether a household is a net consumer (buyer) or net producer (seller) of these food items. Typically, the urban poor are net consumers and are thus adversely affected by higher food prices. Effects on the rural poor are more varied, since they depend on the structure of consumption and household crop production and marketing. In a given country, regional differences can be expected and the average household net position may vary by crop. The 2007 World Development Report (World Bank, 2008) shows that, in four out of seven surveyed countries (Bolivia, Ethiopia, Bangladesh, Zambia), the rural poor are on average net consumers, while in three other countries (Cambodia, Madagascar, Vietnam) they are on average net producers (see Table 2). However, most empirical analyses suggest that the rural poor are net consumers (Christiaensen and Demery, 2007; Weber et al., 1988) and therefore suffer from higher food prices. As discussed in Zaman (2008), this is because the rural poor are often constrained by small landholdings, low productivity, input costs, and distance to markets. As a result, they are generally unable to produce the marketable surplus required to exceed their food expenditures. These expenditures are typically financed via the sale of household labor and engagement in other nonfarm activities.

### 3.2. The net benefit ratio of a food price shock

In a seminal piece related to the estimation of the short-run welfare impact of price changes on household welfare, Deaton (1989) postulated that the first-order welfare effect of relative food price changes is proportional to the net benefit ratio (NBR). This ratio is the difference between the consumption and production ratio. The "consumption ratio" is defined as the elasticity of the cost of living with respect to changes in price, which is driven by consumption shares. The "production ratio" is the elasticity of food sales to total household monetary income. The NBR proxies for a measure of the short-run impact of food price changes on household welfare, and can be interpreted as the elasticity of real income with respect to a food price change. For net producers this elasticity is negative and for net consumers it is positive. The basic model used by Deaton can be represented as follows for a single household:

$$\Delta w = \Delta p \cdot (PR - CR),$$

where $\Delta w$ is the change in welfare, $\Delta p$ is the food price change, and $PR$ and $CR$ are the food production and consumption ratios, respectively. The proxy used for the production ratio ($PR$) is the share of the value of agricultural sales and own production in total household income, while the proxy used for consumption ($CR$) is the share of the value of food purchases and own consumption in total household expenditures.

A brief literature review of the empirical application of this approach is provided by Zaman (2008). Deaton, in his work in Thailand, showed that, relative to either the poorer or wealthier rural households, it was middle-income farmers that benefited the most from an increase in food prices. These methods were subsequently applied by Barrett and Dorosh (1996) using data from Madagascar, Budd (1993) in Cote d'Ivoire, and Klytchnikova and Diop (2006) in Bangladesh. These techniques do not allow for any behavioral change on the part of producers/consumers (i.e., production and consumption patterns remain unchanged). The analysis thus illustrates the first-order impact of the food price shock. Second-order adjustments, such as shifts in consumption (production) away from (to) commodities with relatively large price increases should dampen any negative first-order impacts. These will be considered in Section 4.

### 3.3. Estimating the NBR for Mozambique

Consumption ratios are calculated using data from Mozambique's 2003 nationally representative household survey, which contains the recent information on household incomes and expenditures (INE, 2003).[4] As indicated above, a households' consumption ratio is determined by its expenditure shares. At the national level, the share of food in total household consumption is 60%. It is highest for rural households in the north and center regions of the country (about 70%) and lowest for the richest quintile in Maputo city (11%) (see Fig. 2).

Own production is important in Mozambique, accounting for three-quarters of rural household food consumption. This suggests that rural households may be fairly insulated from variations in market prices. Indeed, even though food accounts for a

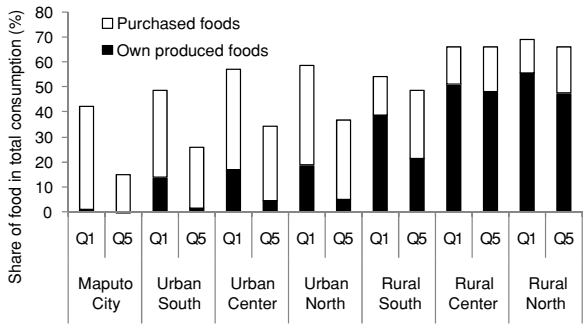
[3] The main harvest month is in May/June. The high prices registered in July 2008 could also reflect a poor 2008 harvest. Reliable information on the quality of the harvest will not be available until the end of 2008.

[4] The survey was carried out from July 2002 to June 2003 and interviewed 8,700 households with the reference period for consumption being one week. Households were visited at least three times during the reference period. More recent data on rural farm household net buyer status is shown in Boughton et al. (2007) and Tschirley and Abdula (2007).

Table 2
Net buyer/seller positions of eight lower-income countries

| | Bolivia 2002 | Ethiopia 2000 | Bangladesh 2001 | Zambia 1998 | Cambodia 1999 | Madagascar 2001 | Vietnam 1998 |
|---|---|---|---|---|---|---|---|
| Share of internationally traded staples in food consumption of the poor (%) | 25.5 | 24.1 | 41.2 | 40.4 | 56.3 | 62.7 | 64.4 |
| Distribution of poor (%) | | | | | | | |
| Urban (buyers) | 50.9 | 22.3 | 14.9 | 30.0 | 8.4 | 17.9 | 6.1 |
| Rural landless (buyers) | 7.2 | – | 53.3 | 7.4 | 11.5 | 14.8 | 5.8 |
| Smallholders net buyers | 29.1 | 30.1 | 18.8 | 28.8 | 25.8 | 18.9 | 35.1 |
| Smallholders self-sufficient | 7.1 | 39.5 | 4.6 | 20.8 | 18.0 | 27.3 | 19.4 |
| Smallholders net sellers | 5.6 | 8.0 | 8.4 | 13.0 | 36.3 | 21.1 | 33.6 |

*Source:* The World Bank, World Development Report 2008 (www.worldbank.org).




*Source:* Authors' calculations using the 2003 national household survey (INE, 2003).

Fig. 2. Own and purchased food expenditure shares.

larger share of total consumption of rural households, the share of *purchased* food in total food consumption is lower for rural households (25%) compared to urban households (81%). Higher dependence on marketed foods is also observed at higher-income levels and in the southern region. Home consumption is less prevalent for urban households in general, and in the capital city, Maputo, consumption of own-produced foods is virtually nonexistent.

Production ratios were derived using the 2003 household survey. Although the survey does not contain specific information on agricultural production, it has information on income from the sale of agricultural output and on own consumption levels. In the analyses that follow, agricultural production is proxied by sale of agricultural items combined with own consumption/production. Thus, the production ratio is the share of agricultural sales and own production in total household income (including own consumption). Similarly, the consumption ratio was calculated as total expenditure on all food items, including the value of own consumption, relative to total household expenditure. The net benefit ratio was calculated by subtracting the consumption ratio from the production ratio, and is shown in Table 3.

Household NBRs vary substantially across households. Thus, for each geographic location and income group, it is important to distinguish between net sellers (positive NBR) and net buyers (negative NBR). As shown in Table 3, 74% of rural households are net food sellers, whereas 76% of urban households are net buyers. Accordingly, the net benefit ratio is 10% for the rural and −22% for the urban households. This means that, on average, a 10% food price increase would, in the short run, raise rural real incomes by 1.0% and reduce urban real incomes by 2.2%. Table 3 also highlights sharp differences across rural and urban areas and regions within the country. The population in the urban south and center are most severely hurt by food price increase, followed by the urban north. Moreover, the population in the rural south would also be negatively affected. Based on the NBR, rural households in the north and the center benefit as a group from rising world prices. Table 4 shows the NBR across national expenditure quintiles. The poorest households in Maputo tend to lose the most in the short run from food price increases, while middle-income groups in rural north and center would gain the most. This is consistent with the findings of Deaton (1989).

## 4. General equilibrium analysis

### *4.1. Macroeconomic dimensions of the price shock*

The previous section examined rising food prices from a microeconomic perspective. However, changes in terms-of-trade brought about by rising world prices are fundamentally macroeconomic phenomena. It is thus indispensable to consider macroeconomic dimensions, including the balance of payments, the distribution of the shock across macroeconomic aggregates, and the implications for wages. We consider each of these factors in turn.

#### *4.1.1. Balance of payments*

Mozambique is a food-deficit country, importing all of the wheat and three-quarters of the rice demanded internally (i.e., 470,000 and 320,000 tons annually). Maize is both imported by the south and exported from the north. Overall, the country

Table 3
Calculation of net benefit ratios for Mozambique

| | Net position (% of households) | | Effect of 100% food price increase (%) | | |
|---|---|---|---|---|---|
| | Net food sellers (NBR > 0) | Net food buyers (NBR > 0) | Food/total income (PR) | Food/total expenditure (CR) | Net benefit ratio (NBR) |
| Mozambique | 58.5 | 41.5 | 65.0 | 64.5 | 0.5 |
| Urban areas | 23.7 | 76.3 | 28.3 | 49.7 | −21.5 |
| Rural areas | 73.7 | 26.3 | 80.9 | 70.9 | 10.0 |
| South region | 38.4 | 61.6 | 45.4 | 55.2 | −9.8 |
| Urban areas | 14.6 | 85.4 | 16.4 | 42.2 | −25.8 |
| Rural areas | 51.2 | 48.8 | 60.8 | 62.1 | −1.3 |
| Maputo city | 4.1 | 95.9 | 3.4 | 30.8 | −27.4 |
| Centre region | 65.0 | 35.0 | 72.8 | 69.2 | 3.5 |
| Urban areas | 23.5 | 76.5 | 31.5 | 54.2 | −22.6 |
| Rural areas | 75.5 | 24.5 | 83.2 | 73.0 | 10.1 |
| North region | 67.8 | 32.2 | 73.3 | 67.7 | 5.6 |
| Urban areas | 36.9 | 63.1 | 42.4 | 58.2 | −15.8 |
| Rural areas | 82.1 | 17.9 | 87.5 | 72.1 | 15.4 |

*Source:* Authors' calculations using the 2003 national household survey (INE, 2003).

Table 4
Net benefit ratios by expenditure quintile for Mozambique

| | All households | Household expenditure quintiles | | | | |
|---|---|---|---|---|---|---|
| | | Q1 | Q2 | Q3 | Q4 | Q5 |
| Mozambique | 0.5 | −1.6 | 0.9 | 2.9 | 0.9 | −0.8 |
| Urban areas | −21.5 | −22.8 | −20.6 | −22.9 | −22.4 | −18.7 |
| Maputo city | −27.4 | −39.9 | −32.2 | −28.4 | −22.9 | −12.0 |
| South region | −25.8 | −21.6 | −29.6 | −32.0 | −26.0 | −18.6 |
| Center region | −22.6 | −27.7 | −17.2 | −22.0 | −26.6 | −20.1 |
| North region | −15.8 | −14.7 | −15.5 | −13.3 | −15.4 | −20.4 |
| Rural areas | 10.0 | 7.6 | 11.5 | 12.5 | 11.0 | 7.2 |
| South region | −1.3 | 3.6 | −1.9 | −0.9 | −4.1 | −5.2 |
| Center region | 10.1 | 5.1 | 11.5 | 14.0 | 11.5 | 8.6 |
| North region | 15.4 | 14.0 | 18.3 | 16.5 | 16.1 | 11.5 |

*Source:* Authors' calculations using the 2003 national household survey (INE, 2003).

Table 5
Trade in agriculture, food, and petroleum products in 2006

| | Value (U.S. $ million) | Share of total exports/imports (%) | Share of total GDP (%) |
|---|---|---|---|
| Value of imports | 2,966 | 100.0 | 43.0 |
| Agriculture and food | 351 | 11.8 | 5.1 |
| Staple grains and derived products | 153 | 5.2 | 2.2 |
| Petroleum and petrochemicals | 537 | 18.1 | 7.8 |
| Petroleum products | 361 | 12.2 | 5.2 |
| Value of exports | 1,971 | 100.0 | 28.5 |
| Agriculture and food | 318 | 16.1 | 4.6 |
| Staple grains and derived products | 4 | 0.2 | 0.1 |

*Source:* National accounts data with local currency converted to U.S. $ using the average exchange rate for 2006.

is also a net importer of maize. Major agricultural exports include tobacco, cashew, cotton, sugar, and fish. Overall, national accounts for 2006 indicates that the free-on-board (FOB) value of agriculture and food exports amounted to about 90% of the cost, insurance, and freight (CIF) value of agriculture and food imports. Food price increases are therefore a negative terms-of-trade shock, despite being partially offset by rising prices for some agricultural exports. Table 5 provides basic information on trade for the year 2006.

Table 5 also indicates that, in macroeconomic terms, the fuel price shock is likely to dominate. Fuel and petrochemical imports amounted to 18% of imports in 2006 compared to 12% for agriculture and food. Moreover, the recent price shock has centered on fuel and cereals, which represented 12% and 5% of imports, respectively. Since Mozambique does not export fuel or petrochemical products, there is no compensating rise in export prices to mitigate the negative terms-of-trade shock.[5]

The impacts of rising fuel prices on the balance of payments can be considered through the following identity:

$$B + P_o E - (P_n M_n + P_o M_o) = \Delta R,$$

where $B$ are net financial flows, $E$ are exports, $M_o$ and $M_n$ are fuel and nonfuel imports, $P$ are world prices, and $\Delta R$ are changes in international reserves. The identity indicates that increases in world oil prices ($P_o$) must be accompanied by some combination of reduced fuel imports ($M_o$), reduced nonfuel imports ($M_n$), increased exports ($E$), increased foreign borrowing ($B$), or falling foreign reserves ($\Delta R$). Since fuel prices are expected to remain high, at least over the medium term, foreign borrowing (B) and the use of foreign reserves (ΔR) can only act as transition measures.[6] Thus, the long-run solution involves exporting more and/or importing less.

[5] Mozambique has recently started exporting natural gas. However, these exports are relatively small and most of the revenues accrue to foreign exploration companies. Pricing contracts are also fixed so that the natural gas price that Mozambique receives varies little with world prices for hydrocarbons.

[6] There is no evidence that Mozambique will benefit from a significant special dispensation of donor funding to cope with the current crisis.

*4.1.2. Macroeconomic aggregates*

Exporting more and importing less involves a (sometimes painful) shift in the structure of the economy away from the production of nontradeables (e.g., services) toward the production of tradeable goods, which are either exported or displace imports. Exporting more and importing less also involves a reduction in absorption, which is the measure of the total volume of goods and services available in the economy. Absorption is a measure of total welfare and can be depicted by rearranging the national income identity:

$$GDP + M - E = Absorption = C + I + G,$$

where *GDP* is gross domestic product, *M* is imports, *E* is exports, *C* is household consumption, *I* is public and private investment, and *G* is recurrent government spending. With constant GDP, a decrease in imports and an increase in exports imply a reduction in absorption. In this case, Mozambique—already one of the poorest countries in the world—becomes even poorer. If the adjustments needed to reduce imports and increase exports cause GDP (or the rate of GDP growth) to decline, then absorption is further reduced (relative to trend).

Reduced absorption must be borne by consumption (*C*), investment (*I*), and/or government spending (*G*). The household-level analysis in Section 3 focused on changes in consumption. However, in the case of Mozambique, where foreign assistance represents half of government spending and almost all public investment, it would be possible to redirect foreign aid to subsidize food and fuel consumption. In this case, household consumption (*C*) would be preserved at the cost of reduced public investment (*I*) in education, health, and other sectors. In other words, while absorption is likely to decline after a negative terms-of-trade shock, the distribution of reduced absorption across the macroeconomic aggregates of GDP is strongly influenced by policy. As shown in Section 2, policy makers in Mozambique have allowed higher world prices to be transmitted to domestic markets, without any large-scale efforts to insulate household consumption. Nevertheless, in the following section, we will consider the implications of policies to insulate domestic markets.

*4.1.3. Wages*

Rising world prices will alter Mozambique's structure of production. In general, a negative terms-of-trade shock favors the production of tradeables over nontradeables. More specifically, production of commodities whose prices have risen, such as cereals, should increase due to enhanced profitability, while fuel-intensive producers' profitability should decline. In addition, structural changes may be driven by the shifting composition of absorption. The changing production structure will affect factor returns. For example, if rising world prices favor cereals and if cereals production uses land and unskilled labor intensively, then land rental rates and unskilled wages should rise relative to the market returns for capital and skilled labor. In this case, a rise in rural wages following a food price increase could mitigate and even reverse the negative first-order impacts for food-deficit households.

The impact of higher food prices on wages has been examined empirically in other countries (Zaman, 2008). Ravallion (1990, 2000) uses data from Bangladesh and India to argue that, while the rural poor are adversely affected in the short run by rising food prices, the long-run impact can be neutral after adjusting for changes in wage rates. This result is due to the response of rural wages to the price of food grains (a second-order or medium-term impact). However, the extent to which wages respond to changing food prices has been questioned by Rashid (2002). Using time-series data from Bangladesh, the author argues that changes in rice prices since the 1980s have had negligible effect on agricultural wages. Christiaensen and Demery (2006), using data from a number of African countries, extend this analysis by including the additional second-round effect of increased farm productivity. They conclude that policies leading to higher food prices are likely to increase poverty, even after accounting for wage and productivity effects.

The inability of Rashid (2002) and Christiaensen and Demery (2006) to isolate a wage effect could be due to a number of factors, including the magnitude of the food price shock, difficulties in measuring real rural wages, the technologies employed in response to the food price shock, the size of the agricultural sector relative to the rest of the economy, and the degree of labor mobility between agriculture and nonagriculture. The shocks currently being confronted by the world economy and Mozambique are the largest in a generation. Accordingly, second-order effects are more likely to be significant. In light of this and other macroeconomic dimensions, we now turn to a modeling framework that attempts to capture both first- and second-order impacts of the prices shock.

*4.2. A general equilibrium model of Mozambique*

The impact of higher world prices is simulated using a comparative static computable general equilibrium (CGE) model of Mozambique. These models have a number of characteristics that make them suitable for analyzing external shocks, trade/tax policies, income distribution, and structural change. First, CGE models simulate the functioning of a market economy, including markets for labor, capital, and commodities, and track how changes in economic conditions are mediated through price and quantity adjustments. Second, the structural nature of these models permits a decomposition of multiple shocks, such as simultaneous increases in fuel and food prices. Third, CGE models respect economy-wide constraints, including the balance of payments and macroeconomic aggregates. Fourth, CGE models contain detailed sectoral breakdowns allowing for differential price increases across commodities. Finally, these models provide a theoretically consistent framework for welfare and distributional analysis.

The structure and behavioral specification of a CGE model determines its results. As shown in Table 6, the Mozambique

Table 6
Structure of the Mozambican economy in 2003

| SAM sectors | Sector or group name | GDP share (%) | Production share (%) | Export share (%) | Export intensity | Import) share (%) | Import-intensity |
|---|---|---|---|---|---|---|---|
| | Total GDP | 100.0 | 100.0 | 100.0 | 11.5 | 100.0 | 23.5 |
| 1–21 | Agriculture | 25.9 | 15.4 | 20.3 | 14.9 | 3.3 | 5.2 |
| 1 | Maize | 3.5 | 1.9 | 0.2 | 1.0 | 0.3 | 4.1 |
| 2 | Sorghum | 1.1 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | Unshelled rice | 0.7 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | Wheat | 0.0 | 0.0 | 0.0 | 0.0 | 1.7 | 100.0 |
| 22 | Mining | 0.3 | 0.4 | 0.3 | 4.9 | 0.2 | 6.7 |
| 23–40 | Manufacturing | 13.7 | 20.5 | 54.5 | 35.4 | 70.1 | 56.9 |
| 32 | Gasoline | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 100.0 |
| 33 | Diesel | 0.0 | 0.0 | 0.0 | 0.0 | 7.0 | 100.0 |
| 34 | Other fuels | 0.0 | 0.0 | 0.0 | 0.0 | 2.3 | 80.5 |
| 35 | Other petrochem. | 0.4 | 0.6 | 0.3 | 6.1 | 10.0 | 74.5 |
| 37 | Metals | 5.2 | 5.8 | 48.0 | 94.8 | 5.3 | 71.2 |
| 41–43 | Construction and energy | 9.2 | 13.9 | 11.2 | 79.8 | 5.4 | 79.6 |
| 44–51 | Services | 50.9 | 49.7 | 13.7 | 3.2 | 21.0 | 9.2 |

*Source:* Mozambique 2003 social accounting matrix (SAM) (McCool et al., forthcoming).
*Notes:* "GDP" refers to value added at factor cost, and "Production" refers to total sales by domestic activities. "Export intensity" is the share of exports in domestic output, and "import penetration" is the share of imports in total domestic demand.

model contains 51 activities/commodities, including 23 agricultural sectors.[7] Five factors of production are identified: three types of labor (unskilled, semiskilled, and skilled), agricultural land, and capital. Segmented rural and urban labor markets distinguish between rural nonfarm and urban economies. Labor and agricultural land is assumed to be fully employed, while capital is immobile earning sector-specific returns. Within this structure and subject to macroeconomic constraints, producers in the model maximize profits under constant returns to scale, with the choice between factors governed by a constant elasticity of substitution (CES) function.[8] Factors are then combined with fixed-share intermediates using a Leontief specification, which captures the varying fuel intensity of sectors. Under profit maximization, factors receive income where marginal revenue equals marginal cost based on endogenous relative prices. Thus, macroeconomic wage effects in the model are endogenously determined by sector-specific factor demands and economy-wide factor supply constraints.

As discussed earlier, higher fuel prices will reduce foreign exchange availability, forcing Mozambique to export more and import less. Accordingly, sectors with high trade shares (either a large share of production exported or a high degree of import competition) are expected to expand more than nontraded sectors. Fuel is especially crucial since it is entirely imported and does not have domestic or imported substitutes. The Mozambique model captures changes in international trade by allowing producers and consumers to shift between domestic and foreign markets depending on changes in the relative prices of imports, exports, and domestic goods. Under a constant elasticity of transformation (CET) function, profit maximization drives producers to sell in markets where they achieve the highest returns based on domestic and export prices (where the latter is determined by the world price times the exchange rate adjusted for internal transaction costs). Conversely, under a CES Armington function, cost minimization determines final and intermediate demand for imported and domestic goods based on relative prices (both of which include relevant taxes).[9] Under a small country assumption, Mozambique faces perfectly elastic world supply/demand at fixed world prices.

Various institutions are identified in the model, including enterprises, the government, and 10 representative household groups (i.e., rural and urban households disaggregated across national income quintiles). Households and enterprises receive income in payment for producers' use of their factors of production, and then pay direct taxes to government (based on fixed tax rates) and save (based on marginal propensities to save). Enterprises pay their remaining income to households, which, in turn, use their income to consume commodities under a linear expenditure system (LES) of demand. Each household in the CGE model is then linked to its corresponding households in the 2002 household survey (INE, 2003). Under this expenditure-side microsimulation module, changes in representative households' consumption and prices in the CGE model are passed down to the survey, where household consumption expenditures are recalculated. This new level of per capita expenditure for each survey household is compared to the official poverty line, and standard poverty measures are recalculated. The Mozambique

[7] Thurlow (2008) provides a description of the CGE model and the 2003 social accounting matrix (SAM) to which it is calibrated.

[8] Assuming that fixed rigid production technologies are relatively fixed over the medium term, we assume low and uniform factor substitution elasticities (0.5).

[9] Trade function elasticities are taken from the Global Trade and Analysis Project (Dimaranan, 2006).

model thus simultaneously accounts for wage and price effects in determining households' real incomes and poverty outcomes.

The government receives income from sales and direct taxes and import tariffs, which it uses to purchase commodities in the form of government recurrent expenditure. The remaining income of government is (dis)saved. All domestic and foreign savings (i.e., foreign borrowing and assistance) are collected in a savings pool from which investment is financed. Here, three closure rules are used to capture the macroeconomic dimensions of the price shock. First, government recurrent expenditure is fixed and the fiscal deficit (i.e., public savings or investment) adjusts to align revenues with total expenditures. Second, a savings-driven closure is assumed in order to balance the overall savings–investment account (i.e., household and enterprise savings rates are fixed and investment adjusts to changes in incomes and the fiscal deficit to ensure that the level of investment and savings are equal). Finally, for the current account, it is assumed that the exchange rate adjusts to maintain a fixed level of foreign savings (i.e., the external balance is held fixed in foreign currency). Together these three closure rules allow the model to capture the balance of payments constraint and absorption trade-offs discussed earlier.

Table 7
World price shocks

| Agriculture and food price simulations | | Fuel price simulations | |
|---|---|---|---|
| Commodity | Shock (%) | Commodity | Shock (%) |
| Agricultural commodities | | Petroleum and petrochemicals | |
| Maize | 75 | Gasoline | 75 |
| Sorghum | 50 | Diesel | 75 |
| Rice | 75 | Other fuels | 75 |
| Wheat | 75 | Other petrochemicals | 25 |
| Pulses and groundnuts | 50 | | |
| Horticulture | 25 | | |
| Raw tobacco | 25 | | |
| Cotton | 25 | | |
| Livestock | 25 | | |
| Processed agricultural commodities | | | |
| Meat and fish products | 40 | | |
| Other processed foods | 40 | | |
| Grain flours | 50 | | |
| Processed sugar | 40 | | |
| Processed tobacco | 25 | | |
| Processed cotton | 25 | | |

*Note:* Equivalent shocks are applied to world export and import prices.

### *4.3. Impact simulations and results*

#### *4.3.1. Simulation descriptions*

This article focuses on the impact of the world price increases taking place between the second half of 2007 into 2008. However, the CGE model is calibrated to a 2003 base social accounting matrix (SAM), raising the issue of what magnitude price shock should be imposed on the model. For instance, oil prices rose more than threefold during 2003–2008 (from U.S. $32 to more than U.S. $100 per barrel), but this increase did not occur all at once. Between 2003 and 2006, the world price for oil doubled to U.S. $64 a barrel. This is responsible for the higher fuel import shares in Table 5, which is for 2006, compared to Table 6, which is for 2003 (i.e., from 10% to 12%). The intention of the modeling effort is to gain insights into the impacts of the recent price increases using available tools and data. For the purposes of the CGE model, tripling oil prices seems unrealistic. It was decided that the model should be shocked with only the 2007–2008 price increases. The thought experiment that is being undertaken is what would have happened in 2003 had fuel and food prices increased in similar proportions to the recent world price increases.

The actual shocks applied are depicted in Table 7. The shocks applied tend to be somewhat smaller in magnitude than the price increases depicted in Table 1. Inflation explains a part of the difference. The shocks applied should reflect real price increases while the shocks in Table 1 reflect nominal price increases in USD. Also, while the authors believe that the current higher price environment is likely to endure in the medium term (3–5 years), they also believed it was likely that commodity prices would come off of the peaks registered in the middle of 2008 (such as oil at U.S. $145 per barrel), which has indeed occurred. Overall, the objective of the shocks is to reasonably capture the shift in international relative prices that occurred in late 2007 and into 2008.

Four simulations are run to analyze the impact of the price shocks. The first simulation ("Fuel") uniquely shocks fuel prices. The second simulation ("Food—Fixed land") considers the shocks to agriculture and processed food prices under the assumption that land allocations between crops cannot be altered (i.e., a very short-run scenario with similar assumptions to the household survey analysis in Section 3). The third simulation ("Food—Flexible land") considers the shocks to agriculture and processed food prices assuming that farmers can reallocate land across crops (i.e., a stronger supply response). This implies a one- to three-year adjustment period. The fourth simulation ("Combination") combines the first and third simulations.

#### *4.3.2. Model results*

The impacts of the fuel and food price shocks are depicted in Tables 8–11. Macroeconomic impacts are shown in Table 8. As suggested by the structure of imports presented earlier in this section, the fuel shocks generate more severe impacts on the overall terms-of-trade. The decline in the terms-of-trade due to fuel price increases is more than double the decline due to food price increases. Macroeconomic impacts are commensurately larger. Compared with the food price shocks, the fuel shocks force a larger increase in the quantity of exports and a larger decrease in the quantity of imports in order to balance the external account. Due principally to these changes in trade flows,

Table 8
Macroeconomic results for world price shocks

| | | Change from base year value (%) | | | |
|---|---|---|---|---|---|
| | | Fuel scenario | Food scenario | | Combined scenario |
| | | | Fixed land | Flexible land | |
| Quantities | GDP | −0.6 | −0.5 | −0.5 | −1.2 |
| | Absorption ($C+I+G$) | −3.5 | −1.8 | −1.8 | −5.1 |
| | Consumption ($C$) | −5.8 | −1.9 | −1.8 | −7.3 |
| | Investment ($I$) | 1.5 | −2.5 | −2.8 | −1.2 |
| | Recurrent government ($G$) | 0.0 | 0.0 | 0.0 | 0.0 |
| | Exports ($E$) | 5.6 | 0.6 | 1.0 | 5.9 |
| | Imports ($M$) | −6.4 | −4.0 | −3.7 | −9.6 |
| Prices | Nominal exchange rate | 4.5 | −5.0 | −5.6 | −1.5 |
| | Real exchange rate | 15.4 | 1.3 | 0.6 | 15.2 |
| | Terms-of-trade | −12.9 | −4.8 | −4.8 | −16.2 |

*Source:* Results from the Mozambique CGE model.

the decline in total absorption (or overall welfare) under the "Fuel" simulation (3.5%) is approximately double the decline registered for either of the "Food" simulations.

As emphasized above, the components of absorption are influenced by economic structure and macroeconomic closure rules. The heavy dependence of Mozambique on foreign savings implies that real investment depends in part on the nominal exchange rate. Depreciation (appreciation) of the nominal exchange rate increases (decreases) the local currency value of investment and can lead to a real increase (decrease) in investment under a savings-driven closure. While the "Food" and "Fuel" simulations lead to a real depreciation of the currency, the nominal currency value moves in opposite directions between the two sets of simulations. In the two "Food" simulations, the increases in world prices for agricultural and processed commodities automatically shift relative prices toward tradeable commodities. The relative price shift toward tradeables generated by the world price increases is in fact so strong that the nominal currency actually appreciates in order to reestablish external balance. By contrast, in the "Fuel" scenario, the world price increases do little to shift the price ratio between tradeable and nontradeable sectors because both sectors use fuel as an intermediate input (and there is very little domestic production of fuel and petrochemicals). As a result, a strong nominal depreciation is required to balance the external account.

Principally, as a result of opposing movements in the nominal exchange rate, real investment rises under the "Fuel" simulation (because foreign assistance lays greater claim to domestic resources due to the depreciated currency) and decreases in the two "Food" simulations (for the same reasons but in an opposite direction). Since real government consumption is fixed in real terms across all scenarios, the decline in absorption in the "Fuel" scenario is borne entirely by household consumption. And, household consumption must decline further to accommodate the rise in the real value of investment. Overall, real household consumption in the "Fuel" scenario falls by more than three times the declines registered in the two "Food" simulations due to a larger decline in absorption overall and differential movements in the components of absorption, particularly investment.

The differences between the "Fixed" and "Flexible" food simulations manifest themselves primarily through the production response. With flexible land, agricultural production can be reallocated toward export crops, particularly those whose world prices are rising, permitting a greater increase in exports than in the fixed land simulation. Furthermore, the export stimulus and import compression are achieved with a smaller decline in the real exchange rate.

The combined effects of the "Fuel" and "Food" scenarios, which are the actual shocks that Mozambique received, are considerable. The scenario "Combined" shows effects that are roughly the sum of the two preceding scenarios. Terms-of-trade decline by more than 16%, and in order to balance the external account, exports increase by nearly 6%, and imports decline by almost 10%. These shifts in production generate a decline in GDP of slightly more than 1%. All of these adjustments imply a reduction in the quantity of goods and services in the economy resulting in a reduction in absorption of more than 5%. Since recurrent government expenditure is assumed to be fixed and investment declines by only 1.2%, household consumption bears the bulk of the adjustment, declining by more than 7.0%. This is a substantial decline in a country where approximately half of all households are absolutely poor (i.e., they experience difficulty meeting caloric needs).

The implications of the world price shock for production are presented in Table 9. The table shows, in the first column, the share in value added of each sector depicted at base 2003 values. For ease of interpretation, most depicted sectors are aggregates of the sectors available in the 2003 SAM and employed in the CGE model. The columns under each simulation provide the percentage change in the real output of each sector relative to the base. Across all simulations, exporting and import competing sectors are favored. The food price shocks particularly favor export products that experience price increases. In

Table 9
Sectoral production results for world price shocks

| | Base value-added share (%) | Change from base year value-added (%) | | | |
|---|---|---|---|---|---|
| | | Fuel scenario | Food scenario | | Combined scenario |
| | | | Fixed land | Flexible land | |
| Agriculture | 25.9 | 0.2 | 0.6 | 0.5 | 0.7 |
| Cereal crops | 5.3 | −0.8 | 3.1 | 3.2 | 2.9 |
| Roots crops | 7.2 | −0.9 | 0.3 | −0.9 | −1.8 |
| Pulses and groundnuts | 2.3 | 1.1 | 1.4 | 3.0 | 4.2 |
| Horticulture | 3.3 | −1.2 | 0.6 | −0.7 | −1.7 |
| Export crops | 1.1 | 9.4 | 5.3 | 11.9 | 21.2 |
| Livestock | 1.7 | −0.4 | 3.9 | 4.1 | 4.2 |
| Forestry | 2.7 | −0.3 | −1.1 | −1.2 | −1.9 |
| Fishery | 2.3 | 3.8 | −7.2 | −7.9 | −5.9 |
| Nonagriculture | 74.1 | −0.2 | −0.3 | −0.3 | −0.5 |
| Industry | 23.1 | 1.0 | 0.2 | 0.3 | 1.4 |
| Mining | 0.3 | −0.1 | −0.3 | −0.4 | −0.5 |
| Manufacturing | 13.7 | 1.0 | 1.7 | 2.1 | 3.2 |
| Primary product processing | 7.4 | 1.3 | 3.3 | 4.1 | 5.7 |
| Other industry | 9.1 | 1.1 | −2.0 | −2.3 | −1.2 |
| Electricity | 1.9 | 1.7 | −1.3 | −1.5 | 0.2 |
| Water | 0.3 | −2.2 | −0.1 | 0.0 | −2.1 |
| Construction | 7.0 | 1.0 | −2.3 | −2.6 | −1.5 |
| Services | 50.9 | −0.7 | −0.5 | −0.6 | −1.4 |

*Source:* Results from the Mozambique CGE model.

the combined scenario, particularly strong growth is registered in "Export crops," led by tobacco and cotton, and "Processed products," led by processed cotton and processed sugar. Production of nontradeables, such as root crops (which is dominated by cassava, the largest single crop in value-added terms) and services (which represents about half of the economy) decline in all scenarios. These declining sectors free resources that permit the tradeables sectors, particularly the export sectors, to expand.

These results highlight the importance of export supply response with particular emphasis on the agricultural sector. Agriculture and derived products comprise the bulk of the export response with particular emphasis on cashew, tobacco, cotton, sugar, and other processed foods. Exports from these sectors are projected to approximately double, although the increases take place from relatively small bases. Biofuels represent another export potential that is not modeled here but is considered in detail in Arndt and Tarp (2008).

A robust export response is crucial to avoid severe import compression. Even with the export response attained, the onus of adjustment is already taking place largely on the import side. This can be seen from the macroeconomic impacts in Table 8. Imports values are about double those of exports and the percentage decline in imports is greater in absolute value than the relative expansion of exports. While export responses tend to concentrate in specific sectors, imports decline across the board. Particularly large declines in imports are registered in products where domestic sectors compete strongly with imports, such as maize, grain milling, and meats.

Table 10
Factor price results for world price shocks

| | | Change from base year factor prices (%) | | | |
|---|---|---|---|---|---|
| | | Fuel scenario | Food scenario | | Combined scenario |
| | | | Fixed land | Flexible land | |
| Rural labor | Skilled | −5.2 | 2.9 | 3.3 | −1.6 |
| | Semiskilled | −5.8 | 0.7 | 0.9 | −4.6 |
| | Unskilled | −5.3 | 3.7 | 4.2 | −0.7 |
| Urban labor | Skilled | −4.0 | −1.6 | −1.5 | −5.7 |
| | Semiskilled | −7.4 | −1.1 | −0.9 | −8.2 |
| | Unskilled | −6.8 | −0.9 | −0.7 | −7.3 |
| Capital | | −5.5 | −1.5 | −1.5 | −6.4 |
| Agricultural land | | −4.2 | 11.4 | 12.4 | 9.5 |

*Source:* Results from the Mozambique CGE model.

Implications for factor prices are shown in Table 10. As discussed above, both shock vectors stimulate tradeable agriculture and processed foods. These sectors use unskilled (primarily rural) labor intensively though the stimulus to these sectors is much more pronounced in the "Food" simulations. In nearly all cases, urban wages decline more than rural wages. The exception is urban skilled labor in the "Fuel" scenario, which benefits from a fairly broad-based expansion of traded nonagriculture. Relative to other factors, the food shocks favor unskilled rural labor and land. Under the "Fixed land" scenario, the returns to rural labor and land are lower than under the "Flexible land" scenario. The relatively large differential impacts across factors

in the food simulations carry over into the "Combined" simulation, where rural labor, especially unskilled labor, fares better than urban labor and capital. There is also a pronounced positive impact on land returns.

Welfare implications, measured as percentage change in equivalent variation, are presented in Table 11. As discussed in Section 3, substantial home consumption among rural households provides considerable insulation from both fuel and food prices shocks. In addition, as shown in Table 10, rural wages rise relative to urban wages, particularly in response to the food price shocks. As a result of these consumption and income impacts, rural households are less strongly affected than urban households in all simulations. The stimulating effect of improved agricultural terms-of-trade for the rural economy does not outweigh the negative impacts of the fuel shock, and welfare declines for all households in the "Combined" simulation. The degree of land ownership is the primary factor differentiating outcomes across quintiles in rural areas. The results for the "Fixed land" scenario are consistent with the household-level analysis in Section 3, which showed middle-quintile rural households faring better than others under the food price shock. In urban areas, welfare losses are large in magnitude and relatively constant across the income distribution.

Poverty impacts are large, particularly in urban areas. Table 11 shows that the combined shocks result in a four percentage point increase in the national poverty headcount rate. The effect is much stronger in urban areas where the poverty rate increases by eight percentage points. In fact, the "Combined" simulation sets the urban poverty rate above the rural rate. Fuel price increases are the principal driver of increased poverty in both rural and urban zones. As would be expected, the capacity to reallocate land reduces poverty with the effect being slightly stronger in rural zones.

## 5. Policy responses

A number of policy responses to the rising food and fuel prices are simulated in this section using the Mozambique CGE model. First, in the "Subsidies" scenario, we examine the impact of applying fuel and food subsidies at the border. These subsidies are designed to eliminate 25% of the international price increases for all of the commodities shown in Table 7. Second, in the "Liberalization" scenario, we eliminate import tariffs on agricultural products and processed foods. However, fuel taxes, which generate significant revenues, are maintained. Finally, in the "Agricultural technology" scenario, we model investments in the agricultural sector that are presumed to lead to a 10% improvement in total factor productivity across all agricultural sectors. A primary difficulty in analyzing such a policy revolves around uncertainty as to the costs and institutional arrangements required to achieve the productivity gains. These issues are not addressed here. However, in order to emphasize that costs will be incurred, a 10% increase in recurrent government spending is imposed on the model alongside the agricultural productivity gains. Consistent closure rules are applied implying that the incremental spending is deficit financed. Tables 12–15 present results of the three policy response simulations, and are of the same format as Tables 8–11, which presented the price impact results. All three policy simulations are compared to the "Combined" simulation, which depicts the price shocks under the assumption of a constant policy environment.

### 5.1. Food and fuel subsidies

As discussed earlier, the food and fuel subsidies provide benefits to consumers, but these short-term gains come at the expense of investment for the future. Table 12 indicates that household consumption declines by two percentage points less than in the "Combined" simulation. However, investment declines by a further six percentage points due to the finance required for subsidization. Consistent with the household consumption aggregate, household welfare analysis shown in Table 15 illustrates a two percentage point gain relative to the "Combined" scenario. Interestingly, rural households gain relatively more than urban households across all quintiles even though urban households are, by far, the principal consumers of imported foods. This is also reflected in the poverty rates, which show a larger mitigation effect for rural than urban households. Within each zone, the incidence of the subsidy is relatively even across household expenditure quintiles, with a slight tendency for higher-income households to benefit more.

The relatively larger gains registered by rural households in the "Subsidy" scenario stem from second-order macroeconomic impacts. By subsidizing expensive fuel and food imports, the subsidy effectively increases the macroeconomic burden of adjustment, particularly with respect to the balance of payments. Greater imports of fuel and food imply increased foreign currency needs, which in turn require an even more dramatic export response and/or greater import compression in nonsubsidized sectors. From Table 12, one sees that the subsidy forces the largest cut in absorption (the best economy-wide indicator of welfare) of any scenario. This is because it requires the largest increase in exports and reduction in imports. These adjustments are achieved via a substantial depreciation of the real exchange rate, which provides even greater stimulus to agricultural exports.

Overall, while large-scale subsidies enhance household welfare in the short run, they are expensive, are not particularly well targeted, and exacerbate the burden of macroeconomic adjustment. If financing the subsidies reduces the investment budget, future growth is likely to be sacrificed. Though not modeled, subsidy policies are often difficult to administer and subject to fraud. Finally, international experience indicates that, once enacted, general subsidies can prove to be exceedingly difficult to remove, thus generating a long-term drain on government finances.

Table 11
Welfare and poverty results for world price shocks

| | | Base-year value | Change from base year (%) | | | |
|---|---|---|---|---|---|---|
| | | | Fuel scenario | Food scenario | | Combined scenario |
| | | | | Fixed land | Flexible land | |
| Equivalent variation | | | | | | |
| National | | | −5.9 | −2.1 | −2.0 | −7.4 |
| Rural households | Quintile 1 | | −3.4 | −0.7 | −0.9 | −3.9 |
| | Quintile 2 | | −3.6 | −0.1 | −0.1 | −3.2 |
| | Quintile 3 | | −3.7 | 0.3 | 0.4 | −2.7 |
| | Quintile 4 | | −4.2 | −0.1 | 0.2 | −3.4 |
| | Quintile 5 | | −5.1 | −0.3 | 0.1 | −4.4 |
| Urban households | Quintile 1 | | −5.4 | −5.3 | −5.8 | −11.1 |
| | Quintile 2 | | −6.2 | −5.6 | −5.8 | −11.6 |
| | Quintile 3 | | −6.0 | −5.0 | −5.3 | −10.9 |
| | Quintile 4 | | −7.1 | −4.5 | −4.5 | −11.1 |
| | Quintile 5 | | −7.1 | −2.8 | −2.7 | −9.4 |
| Poverty headcount | | | | | | |
| National | | 54.1 | 57.6 | 55.1 | 54.9 | 58.2 |
| Rural households | | 55.3 | 58.3 | 55.4 | 55.2 | 57.7 |
| Urban households | | 51.5 | 56.2 | 54.3 | 54.2 | 59.5 |

*Source:* Results from the Mozambique CGE model.

Table 12
Macroeconomic results for policy responses

| | | Change from base-year value (%) | | | |
|---|---|---|---|---|---|
| | | Combined scenario | Subsidies (food and fuel) | Liberalization (food only) | Agricultural technology |
| Quantities | GDP | −1.2 | −1.1 | −1.2 | 1.2 |
| | Absorption ($C$+$I$+$G$) | −5.1 | −5.3 | −5.2 | −3.1 |
| | Consumption ($C$) | −7.3 | −5.3 | −7.1 | −3.9 |
| | Investment ($I$) | −1.2 | −8.2 | −2.0 | −7.8 |
| | Recurrent government ($G$) | 0.0 | 0.0 | 0.0 | 10.0 |
| | Exports ($E$) | 5.9 | 7.6 | 6.7 | 7.1 |
| | Imports ($M$) | −9.6 | −9.5 | −9.4 | −8.8 |
| Prices | Nominal exchange rate | −1.5 | 0.5 | −0.7 | 13.5 |
| | Real exchange rate | 15.2 | 17.4 | 16.2 | −2.9 |
| | Terms-of-trade | −16.2 | −16.2 | −16.2 | 3.5 |

*Source:* Results from the Mozambique CGE model.

### 5.2. Trade liberalization

Trade liberalization is the second policy response considered. In principle, trade liberalization is equivalent to subsidization at the border if the subsidy simply offsets the tariff. However, because tariffs are relatively low in Mozambique, the subsidy analyzed above brought domestic prices below world price equivalents. Hence, trade liberalization implies a much smaller loss in revenue. In addition, a zero tariff is much easier to administer than an overlapping tax and subsidy policy. Though not modeled here, reduced border tariffs also tend to reduce evasion, thus providing a further cushion to the revenue effect of reduced border tariffs through greater collection of VAT at the border.[10] Finally, reduced or eliminated tariffs are consistent with Mozambique's fundamental open economy policy stance.

Since tariff rates are already relatively low (though effective protection rates for some processing sectors, such as grain milling, are high), the economy-wide impacts of reducing tariffs are relatively small. Household welfare, shown in Table 15, increases marginally with the gains fairly evenly distributed across rural/urban areas and across expenditure quintiles. A shift in the components of absorption (i.e., a reduction in investment) contributes to these gains. Trade liberalization also opens the economy to the world engendering an increase in exports and a decrease in imports. These adjustments may be unwelcome during a period when similar adjustments are required to confront the commodity price shocks.

In summary, the world price shocks may provide an opportunity to undertake selected trade liberalization that should

[10] See Arndt and Tarp (2008) and van Dunem and Arndt (2006) for a discussion on the relationship between tax rates and tax evasion in Mozambique.

Table 13
Sectoral production results for policy responses

| | Base value-added share (%) | Change from base year value-added (%) | | | |
|---|---|---|---|---|---|
| | | Combined scenario | Subsidies (food & fuel) | Liberalization (food only) | Agricultural technology |
| Agriculture | 25.9 | 0.7 | 1.0 | 0.7 | 8.7 |
| Cereal crops | −0.9 | 2.9 | 3.0 | 2.7 | 11.6 |
| Roots crops | 1.1 | −1.8 | −1.6 | −1.9 | 6.8 |
| Pulses and groundnuts | −1.2 | 4.2 | 4.4 | 4.5 | 14.5 |
| Horticulture | 9.4 | −1.7 | −1.4 | −1.7 | 7.4 |
| Export crops | −0.4 | 21.2 | 20.3 | 22.1 | 37.1 |
| Livestock | −0.3 | 4.2 | 4.4 | 3.8 | 10.7 |
| Forestry | 3.8 | −1.9 | −1.4 | −1.8 | −2.6 |
| Fishery | −0.2 | −5.9 | −4.0 | −5.2 | 3.0 |
| Nonagriculture | 1.0 | −0.5 | −0.6 | −0.5 | 0.4 |
| Industry | −0.1 | 1.4 | −0.1 | 1.2 | 0.4 |
| Mining | 1.0 | −0.5 | −0.1 | −0.4 | −1.5 |
| Manufacturing | 1.3 | 3.2 | 3.6 | 3.2 | 4.8 |
| Primary product processing | 1.1 | 5.7 | 6.5 | 5.6 | 8.7 |
| Other industry | 1.7 | −1.2 | −5.8 | −1.6 | −6.0 |
| Electricity | −2.2 | 0.2 | 0.6 | 0.4 | −1.3 |
| Water | 1.0 | −2.1 | −1.7 | −2.2 | −1.5 |
| Construction | −0.7 | −1.5 | −7.6 | −2.2 | −7.4 |
| Services | 0.0 | −1.4 | −0.9 | −1.4 | 0.4 |

*Source:* Results from the Mozambique CGE model.

Table 14
Factor price results for policy responses

| | | Change from base-year factor prices (%) | | | |
|---|---|---|---|---|---|
| | | Combined scenario | Subsidies (food and fuel) | Liberalization (food only) | Agricultural technology |
| Rural labor | Skilled | −1.6 | 1.5 | −1.5 | 0.4 |
| | Semiskilled | −4.6 | −2.9 | −4.7 | −0.5 |
| | Unskilled | −0.7 | 2.4 | −0.6 | −1.4 |
| Urban labor | Skilled | −5.7 | −3.8 | −5.6 | 0.7 |
| | Semiskilled | −8.2 | −6.0 | −8.2 | −1.8 |
| | Unskilled | −7.3 | −5.6 | −7.4 | −3.2 |
| Capital | | −6.4 | −5.0 | −6.4 | −7.0 |
| Agricultural land | | 9.5 | 13.3 | 9.8 | 5.5 |

*Source:* Results from the Mozambique CGE model.

be done anyway, particularly reducing high effective protection rates afforded to some food processing sectors. Given the regional differentiation of the Mozambican economy, these tariff reductions may provide some relief to consumers in urban centers, particularly Maputo where the import intensity of demand is highest. However, at the same time, the moment is likely inopportune for a policy-induced shut-down of some food processing factories. The prudent way forward is likely to involve incremental liberalization and thus commensurately smaller gains for consumers.

### 5.3. Agricultural technology

The final policy scenario indicates that improved agricultural technology is the preferable policy response to higher world prices. Agricultural technology improvements represent a powerful impetus to the economy (see Table 12). As a result of the productivity gain and associated increase in agricultural production, the economy achieves substantial gains in exports and a reduction in imports. Unlike in previous scenarios, the real exchange rate actually appreciates due to better export performance. The reduction in absorption is about 40% smaller than in the "Combined" scenario. In addition, by increasing marketed surplus, agricultural technology gains reduce agricultural commodity prices. Thus, the gains from agricultural technology accrue primarily to urban households (see Table 15). This usefully offsets the impacts of the world price shocks, whose adverse affects are concentrated on urban households. Despite the domestic commodity price declines, rural households also experience significant gains in welfare. Within rural and urban

Table 15
Welfare and poverty results for policy responses

| | | Base-year value | Change from base year (%) | | | |
|---|---|---|---|---|---|---|
| | | | Combined scenario | Subsidies (food & fuel) | Liberalization (food only) | Agricultural technology |
| Equivalent variation | | | | | | |
| National | | | −7.4 | −5.4 | −7.2 | −4.1 |
| Rural households | Quintile 1 | | −3.9 | −1.8 | −3.6 | 0.0 |
| | Quintile 2 | | −3.2 | −0.8 | −2.8 | −0.2 |
| | Quintile 3 | | −2.7 | −0.3 | −2.3 | 0.3 |
| | Quintile 4 | | −3.4 | −0.8 | −3.0 | −0.9 |
| | Quintile 5 | | −4.4 | −1.9 | −4.1 | −2.9 |
| Urban households | Quintile 1 | | −11.1 | −9.8 | −10.9 | −4.5 |
| | Quintile 2 | | −11.6 | −9.9 | −11.4 | −6.2 |
| | Quintile 3 | | −10.9 | −9.4 | −10.7 | −5.3 |
| | Quintile 4 | | −11.1 | −9.2 | −10.9 | −6.9 |
| | Quintile 5 | | −9.4 | −7.7 | −9.3 | −6.0 |
| Poverty headcount | | | | | | |
| National | | 54.1 | 58.2 | 56.8 | 58.0 | 55.7 |
| Rural households | | 10.7 | 57.7 | 55.9 | 57.3 | 56.1 |
| Urban households | | 9.6 | 59.5 | 58.6 | 59.5 | 54.9 |

*Source:* Results from the Mozambique CGE model.

zones, the registered gains are strongly progressive across income quintiles.

However, while the benefits of improved agricultural productivity are pronounced, the potential source of these gains remains unclear. Enhancing agricultural productivity in Mozambique has been on the policy agenda since the end of the civil war in the early 1990s. Unfortunately, little has been achieved to date (Uaiene, 2008) and whatever gains have taken place are difficult to ascribe to actions undertaken by the government (Arndt et al., 2007). Thus, while this policy scenario underlines the long-term importance of expanding agricultural production, experience suggests that this will be difficult to achieve and is unlikely to address the immediate impacts of the current food and energy crisis.

Some other policy responses are also being considered, but are not examined here. For example, a common recommendation from the World Bank to low-income countries is to expand social protection programs. Mozambique has an existing social protection program, which distributes cash to poorer families. However, this program is already set to expand in 2008–2009 and extending it further would place considerable pressure on administrative capacity. Moreover, even with the planned expansion, the program will remain very small from an economy-wide perspective.[11] Subsidizing urban public transport is also being considered as a means of offsetting the increased costs necessitated by higher fuel prices. However, public transport passengers, while not necessarily rich, are also not typically among the most vulnerable groups. Transport subsidies can also become expensive and difficult to administer. Nevertheless, directing public funds to urban transport can be desirable, although the overall goal would be to integrate transport subsidies within a more comprehensive urban investment plan.

[11] CGE models are well suited to examining large-scale social protection programs as there is a strong likelihood of economy-wide impacts. The current program in Mozambique is too small to generate substantial general equilibrium impacts; hence, there is limited value to analyzing the program in a CGE framework.

## 6. Conclusions

The impacts of rising world fuel and food prices were analyzed using three approaches, aimed at capturing the short- and longer-term effects as well as differential impacts across rural/urban households in different regions of the country. The findings indicate that the world price increases registered in international markets since October 2007 represent a substantial negative terms-of-trade shock for Mozambique. Moreover, significant policies to insulate domestic fuel and food markets from the international price increases have not been put into place. Evidence from domestic price series indicates that the world price rises are being transmitted to the domestic economy. A poor persons' consumer price index (PCPI), developed for this analysis, indicates that the increase in the cost of the basket of commodities consumed by lower-income households is similar to the increases registered for the average economy-wide basket. However, regional differences were observed. Net benefit ratio analysis indicates that urban households and households located in the South are generally more vulnerable to food price increases, while rural households often benefit from their net seller position, particularly those in the middle of the income distribution.

Analysis using a CGE model of Mozambique indicates that the fuel price shock is more important from both macroeconomic and poverty perspectives. The CGE model simulations

also highlight the importance of agricultural production response in general and export response in particular. The findings from all approaches conclude that the macroeconomic and poverty impacts of the world price increase will be negative and substantial, particularly for urban households. The analysis of policy responses points to difficult trade-offs between short-run mitigation and long-run growth. Moreover, while improving agricultural productivity is most effective in addressing the adverse effects of higher food (and fuel) prices, expanding agricultural production will remain difficult despite improved agricultural terms-of-trade.

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