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Food Pricing Policy and Rural Poverty: Insights from Maize in Kenya

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1. Introduction

In 2000, more than 45 percent of sub-Saharan Africa's population was estimated to be in poverty (World Bank, 2000). Over the past decade, substantial research has been focused on the relationship between agricultural marketing policy and poverty (see World Bank, 1994; Barrett and Carter, 1997; Kherallah et al, 2002). Some countries in Africa have undertaken food market "liberalization" measures designed to give the private sector the primary role in the distribution of staple food. However, many other countries continue to use variable taxes and levies to influence external trade, and have also retained their food marketing boards, which continue to directly set prices and influence price levels through stockholding policies. Kenya is an example of the latter group of countries. The Kenya National Cereals and Produce Board remains the largest single buyer of maize in the country, accounting for roughly 40% of the total marketed maize produced in the country (Jayne et al., 2005). To date, there has been little detailed analysis of the effects of specific agricultural marketing interventions and policies on poverty, even though discussions to guide the future direction for food marketing policy require such analysis.

This paper examines the effect of Kenya's maize marketing board operations on the level and distribution of poverty. A recent analysis by Jayne et al, (2005) has estimated that the pricing and marketing operations of the National Cereal and Produce Board (NCPB) have served to raise maize market prices by roughly 20% since the mid 1990s, and thus our challenge is to determine how this price change ultimately affects poverty. Previous studies measuring welfare effects of changing food prices (e.g., Deaton, 1989; Budd, 1993; Barrett and Dorosh, 1996) considered instantaneous effects on incomes following a change in price, and therefore estimates were at the lower bound. By considering both adjustments in production and consumption, and the accompanying responses on the rural wage labor market, we extend this model to a second order approximation of equilibrium income changes. Further, we exploit the parallel between stochastic dominance and commonly used measures of poverty (i.e., Foster, Greer, and Thorbecke, 1984) to generate poverty rankings between the distribution of income with the effects of the NCPB maize policy and the distribution of counterfactual incomes. This approach effectively addresses usual concerns regarding the sensitivity of poverty estimates to the type of poverty measure used.

2. Data

The analysis uses household survey panel data on a nationwide sample of 1,397 small farm households in 24 districts collected by the Tegemeo Institute of Egerton University during the years 2000 and 2004. The sample size for the 2000 survey was 1,512 households out of which 1,397 participated in the repeated survey of 2004. Preliminary findings on attrited households suggest that they are mostly young and poor families with relatively low levels of asset endowments. Table 1 gives the geographical composition of the sample used in the analysis and the distribution of maize buyers and sellers in each region.

3. Methods

Second Order Approximation of Changes in Income

In Deaton (1989), the indirect utility function of a household is given as

$$V = \psi\left(wT + b + \pi, p\right). \qquad (1)$$

where, V is utility value of household i, w is the wage rate, T is the total time worked, b is rental income or transfers, p is price vector, and π is the household's profits from farming or other family business. Households are assumed to be profit maximizers. Therefore, π is the value of the profit function π (p, u, w); where, u is a vector of input prices and w is wage rate. Without attempting to speculate about functional form and assuming short run profit maximization decisions on rental income and wage employment, the general representation of the indirect utility function can be given by

$$V\left[\pi\left(p_p, u, w\right), p_c\right]. \tag{2}$$

Where p_p and p_c are vectors of producer prices and consumer prices respectively. Further, the price of maize (p_m) can be separated from the vector of other prices to give,

$$V\left[\pi\left(p_m, p_p, u, w\right), p_m, p_c\right]. \tag{3}$$

To study the effects of a change in the price of maize on a household's level of living (utility) we begin by totally differentiating Equation (3) holding all variables other than the price of maize constant.

$$dV = \left(\partial V / \partial \pi * \partial \pi / \partial p_m\right) dp_m + \partial V / \partial p_m \, dp_m \tag{4}$$

From Hotelling's lemma

$$\partial \pi / \partial p_m = o_m . \tag{5}$$

Where o_m is the profit maximizing maize output. Roy's identity implies that

$$\partial V / \partial p_m = -c_m \, \partial V / \partial \pi . \tag{6}$$

In Equation (6), c_m is the utility maximizing quantity of maize consumed. Substituting Equation (5) and Equation (6) into Equation (4) and re-arranging terms we get

$$dV = \partial V / \partial \pi \left(o_m - c_m\right) dp_m \quad . \tag{7}$$

The first component of Equation (7) $\partial V / \partial \pi$ is the marginal utility of income or profit. The second component $\left(o_m - c_m\right) dp_m$ is the change in net income resulting from the change in the price of maize, which can be computed from the household survey data. To estimate the marginal utility of income, one would require an explicit model of the supply and demand systems. However, limitations in data availability render such estimation infeasible. We assume that the marginal utility of income is constant across all households[3]. With this assumption $\partial V / \partial p$ is a common scaling factor that can be standardized at a value of 1, which is equivalent to assuming that changes in incomes are fully transformed into utility changes in a one-to-one correspondence for all households. Therefore, we can write

$$dV_i = (o_{mi} - c_{mi})dp_m = dy_i \tag{8}$$

When divided by income before the price change, Equation (8) becomes

$$dy_i / y_i^o = (q_{mi} - l_{mi})d \ln p_m . \tag{9}$$

Where, $q_{mi} = (p_m^o \times o_{mi}) / y_i^o$ is the value of maize production (gross maize revenue) for household i as a proportion of household income, and $l_{mi} = (p_m^o \times c_{mi}) / y_i^o$ is the budget share of maize. Equation (9) can be re-arranged to give

$$\frac{(dy_i / y_i^o)}{(d \ln p_m)} = (q_{mi} - l_{mi}). \tag{10}$$

Since $(dy_i / y_i^o) = d \ln y_i$, Equation (10) becomes

$$\frac{d \ln y_i}{d \ln p_m} = (q_{mi} - l_{mi}). \tag{11}$$

Equation (11) can readily be interpreted as the maize price elasticity of income. The elasticity captures the very short run (instantaneous) changes in incomes as a result of the policy, and is akin to the 'net benefit ratio' (NBR) or 'net consumption ratio' that is used to study the impact of food price changes on income distribution in Deaton (1989), Budd (1993), and Barret and Dorosh (1996). This framework can be extended by considering both the supply and demand responses as suggested in (Minot and Goletti 2001). However, the framework in (Minot and Goletti 2001) is not complete because it ignores the demand side

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[3] This is equivalent to one of the fundamental assumptions in demand analysis; that aggregate demand is a function of prices and aggregate wealth. Both the equal marginal utility of income and the aggregation assumption are obtainable when individual preferences admit indirect utility functions of the Gorman form; $v_i(p,w_i) = a_i(p) + b(p)\, w_i$. For further discussions on this topic, see Mas-colell et al (1995) and Deaton and Muellbauer (1980).

adjustments in labor markets following the supply response and the effects of these on incomes of suppliers of rural wage labor. Assuming under-employment of rural labor, the short run effects of supply adjustments are not likely to change the wage rate; rather the wage bill will change proportionally to the supply elasticity due to changes in man-hours hired. Under these postulates, the complete second order approximation of changes (SOAC) in income is given by

$$SOAC = (q_{mi} - l_{mi})dp_{m-percent} + \tfrac{1}{2}\left[(q_{mi})\varepsilon^{s}_{mz} - (l_{mi})\varepsilon^{d}_{mz}\right](dp_{m-percent})^2 + \tfrac{1}{2}\left[\varepsilon^{s}_{mz}(ws_{mi} - wr_{mi})\right](dp_{m-percent})^2 \qquad (12)$$

Where, ε^{s}_{mz} is own price elasticity of maize supply, ε^{d}_{mz} is the own price elasticity of maize demand, ws_{mi} is the share of income from hired-out farm labor associated with the maize enterprise, and wr_{mi} are payments to hired labor for maize production as a proportion of income.

The first part of Equation 12 is the percentage change in income evaluated at initial share of maize income and initial budget share; the very short run effects. The second and third parts are the remainder term evaluated at some unknown point between the initial values and the equilibrium values of maize income share and maize budget share. We assume that at that point, there would have been sufficient adjustments such that the maize income share and budget share will approximate their initial values, even though production, consumption, and income levels would have changed. Therefore, the second derivatives with respect to income shares and budget shares are evaluated at their respective initial values, and so are hired labor payments to maize and income shares from supplying labor to maize farms.

The remainder term is an approximation of higher order effects after economy-wide adjustments on markets for other commodities and rural farm wages. Such impacts can ideally be estimated with the aid of Computable General Equilibrium (CGE) models. However, standard CGE models based on household data would involve considerable aggregation across household types. Chen and Ravallion (2004), contend that they form crude tools for welfare distributional analysis, and therefore do not yield results that can be considered necessarily superior to those from a second order approximation of the equilibrium.

The very short run (first order) effects are instantaneous income changes that are embedded in the income data of households. Therefore, to generate a second order approximation of resultant income changes only the second and third part of Equation (12) is applied on income data. On the same vein, counterfactual incomes are generated by subtracting the first part of Equation (12) from the household income data. The policy is estimated to have increased the mean of maize prices by 19.7% between 1995 and 2004 (Jayne et al 2005). Therefore, for $dp_{m-percent}$ in Equation 12, we consider 19.7% and, to determine the sensitivity of impacts to the degree of price change, we consider 15% and 25% price increases as well.

Stochastic Dominance and Poverty Dominance

After generating the vector of incomes with the effects of the policy and another vector with counterfactual incomes, the next step is to ascertain which of the two income distributions has more poverty. Foster and Shorrocks (1988a, 1988b) demonstrate that the FGT poverty measures correspond to stochastic dominance partial ordering. If P_a is the measure of poverty, we say $F(z)$ has more poverty or at least as much poverty as $G(z)$ if $G(z)$ dominates $F(z)$ in the a degree. For the purposes of this work, $p_1(F;z)$ the headcount ratio, and $p_2(F;z)$ the income gap measure are used, implying that first order D_1, and second order D_2 stochastic dominance evaluations are respectively considered.

A distribution $G(z)$ dominates another $F(z)$ in the first degree if the value of its cumulative distribution is less than or equal to that of $F(z)$ for all z, and strictly less than that of $F(z)$ in at least one z_i. This would imply that $F(z)$ has a higher probability for lower values compared to $G(z)$, and therefore the headcount ratio is higher in F than in G for any poverty line in $(0, z]$. Second degree poverty dominance could be used whenever first degree dominance cannot be established. This is equivalent to using the poverty gap measure when the headcount ratio fails to find more poverty in either distribution.

A distribution $G(z)$ dominates another, $F(z)$ in the second degree when the cumulative difference of the area under $F(z)$ from the area under $G(z)$ is non-positive; formally given as $\int_0^z [G(y) - F(y)]dy \leq 0$ for $y \Xi [0, z]$. $G(z)$ dominates $F(z)$ in the second degree translates to the conclusion that the headcount ratio may be the same in G as in F but income shortfalls from any poverty line in $(0, z]$ are higher in F than they are in G. The next section provides results of stochastic (poverty) dominance tests. The dominance tests were generated with the aid of DAD software.

4. Results

Commonly used poverty lines for Kenya include the World Bank \$1 a day per person poverty line (approximately \$30 per month per person) and the Welfare Monitoring Survey (WMS) poverty line, which is approximately \$16 per month per adult equivalent (GOK 2000). The wide difference between these poverty thresholds poses a potential source of uncertainty when welfare rankings are based on one and not the other – the identification problem. To avoid such, first degree poverty orderings are proclaimed only when they hold for the World Bank threshold. This is because the World Bank poverty line (approximately \$30 per month per person) nests the WMS threshold (\$16 per month per adult equivalent) and all other poverty lines less than $30 per person per month. We consider second degree dominance tests whenever first degree dominance tests are inconclusive.

After simulating the effects of the government marketing board (NCPB) operations in the maize market that are assumed to have raised local market prices for maize by 19.7%, we compute first degree poverty dominance curves for various farming zones (Figures 1 through 5). Dominance tests and accompanying curves for 15% and 25% increases in maize prices give similar results to the ones for 19.7 % in all the zones. This gives some confidence that the results are not sensitive to the degree of price increase brought about by NCPB operations, which might in fact vary somewhat geographically across the sample.

Referring to Figures 1 though 5, the first point at which the two cumulative income distributions cross is the upper-bound poverty line for the headcount ratio. For any level of income below the crossing point, the value of the cumulative distribution of counterfactual incomes is lower than that of incomes with effects of price supports. Because each of the two distributions has a single income observation from every household, the distribution with a higher cumulative value has more observations with values less than the crossing point, and hence a higher probability for lower incomes. It therefore follows that if we take the crossing point or any level of income less than the crossing point to be a poverty line, the headcount ratio will be higher with price supports.

For example, taking the case of the Eastern Lowlands zone (Figure 1 and first row of Table 1), the two cumulative distributions cross at US$ 80.43; which is higher than the World Bank (US $30) poverty line. Further, the cumulative value of the distribution of counterfactual incomes is below that of incomes with effects of price supports at any value less than the crossing point. This means that if any income level below the crossing point is taken as a yardstick (e.g. the US $30 World Bank poverty line), the distribution of income with price supports has a higher probability for lower values compared to counterfactual distribution of income with no price supports. A higher probability for lower values translates to a higher headcount ratio, as measured in the vertical axis. We conclude that NCPB operations in the maize market have increased the number of the poor in Eastern Lowlands. Figure 2, 3, 4, and 5 show similar results for Coastal Lowlands, Western Lowlands, Western Highlands, and Central Highlands respectively. Corresponding crossing points for Figures 2 through 5 are also summarized in Table 1.

In the western transitional zone, the crossing point of first degree stochastic (poverty) dominance curves does not nest the World Bank threshold (Figure 6 and sixth row of Table 1). Therefore poverty orderings in this region will be based on the poverty gap measure, which leads us to consider second order dominance test (Figure 7). This test determines the cumulative difference of the area under the distribution of incomes with NCPB operations from the area under the distribution of counterfactual incomes. The latter dominates the former as long as the cumulative differences remain non-positive. Figure 7 shows that the differences are non-positive across the entire range of income. This means that the distribution of counterfactual income without price supports dominates in the second degree the distribution of income with price supports. Equivalently, we say that if any level of income is taken to be a poverty line then income shortfalls from any such poverty line are higher with price supports. This leads to the conclusion that in this region the NCPB maize operations reduce incomes among those already poor, but do not appreciably affect the numbers of the poor.

Conditions in the western transitional zone with regard to land potential, market infrastructure, and crop mix approach those in the high potential maize zone (HPMZ). In Kenya, a large proportion of marketed maize is grown in the high potential maize zone. The region boasts excellent conditions for growing maize and wheat, and farm sizes are relatively large. Among the seven agro-climatic zones considered, it is only in this zone where the maize price-increasing policy does not increase poverty as measured by the headcount ratio and the poverty gap measure. In Figure 8 and last row of Table 1, the crossing point of the two cumulative distributions is below both the World Bank poverty line and the WMS threshold. Similarly, Figure 9 and Table 2 for second degree dominance test shows that cumulative differences in the area under the two distributions remain non-positive only up to the 45th percentile of income, which is equivalent to \$27.17 or Kshs 2,120. This threshold is lower than the World Bank poverty line and therefore the test is inconclusive.

In summary, we find that the effects of the price-increasing policy of the NCPB is largely influenced by the proportion of net purchasing and net selling rural households in each zone. As shown in Table 3, the marketed maize output in Kenya is concentrated in one zone (High-Potential Maize Zone). Most other rural areas of Kenya derive the bulk of their cash income from other crops, non-farm income, and livestock.

4.0 Conclusions

This study estimates the effects on poverty resulting from price changes associated with the operations of a maize marketing board in Kenya. Previous empirical work on welfare effects of changing food prices considered instantaneous effects on incomes following a change in price, and therefore estimates were at the lower bound. By considering both adjustments in production and consumption, and the accompanying responses on the rural wage labor markets, we estimate a second order approximation of equilibrium income changes. We then exploit the parallel between stochastic dominance and commonly used measures of poverty to generate poverty rankings between the distribution of income with the effects of the government marketing operations and the distribution of counterfactual incomes. This approach effectively addresses concerns regarding the sensitivity of poverty estimates to the type of poverty measure used.

Results indicate that price supports and tariffs on imported maize exacerbated the percentage of households living in poverty in all regions of the country except one - where most of the surplus maize originates. The proportion of the poor is increased in most areas where the majority of rural households are buyers of maize. In one zone (Western Transitional) the maize price-increasing policy has not raised the number of the poor; however, their income shortfalls from the poverty lines are increased. These results hold for differences of up to 40% in supply and demand responses between the highest and lowest income quintiles.

These findings suggest the need for government to consider alternative means to promote agricultural growth that do not exacerbate rural poverty in the process. Reallocating budget resources from price supports to cost-reducing / productivity-enhancing investments may better provide incentives for surplus-producing farm households to intensify food production and raise their incomes while simultaneously benefiting net-purchasing rural households and urban consumers through lower food prices. Public investments that have a proven track record in terms of enhancing crop productivity include agricultural crop research and development (Oehmke and Crawford, 1996; Alston et al., 2000), investments in physical infrastructure to reduce marketing costs (Antle, 1983), and well-structured extension programs (Evenson, 2001).

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Table 1. First Order Poverty Dominance of Counterfactual Incomes over Incomes with Effects of Price Controls (Headcount ratio higher with Price Controls)

Broad Agro-climatic Zone	First Crossing Point of Cumulative Income Distributions (Upper Bound Poverty Line for Headcount ratio)						Robustness to the World Bank and the WMS poverty line
	US Dollar ($) amount (std deviation)			Amount in Kenya shillings (Kshs) (std deviation)			
	15 %	19.7 %	25 %	15 %	19.7 %	25 %	
Coastal Lowlands	57.49 (0.00)	57.46 (0.00)	57.30 (0.00)	4,486 (0.00)	4,484 (0.00)	4,471 (0.00)	Satisfies both
Eastern Lowlands	69.90 (12.53)	80.43 (8.64)	80.43 (8.80)	5,455 (978)	6,276 (674)	6,276 (687)	Satisfies both
Western Lowlands	49.99 (0.00)	75.44 (5.58)	74.68 (4.11)	3,901 (0.00)	5,887 (435)	5,828 (321)	Satisfies both
Western Highlands	43.01 (3.83)	47.21 (11.94)	56.89 (9.08)	3,356 (299)	3,684 (932)	4,439 (709)	Satisfies both
Central Highlands	92.36 (40.89)	142.90 (22.94)	123.68 (47.55)	7,207 (3,190)	11,151 (1,790)	9,652 (3,711)	Satisfies both
Western Transitional	29.52 (3.96)	30.10 (3.48)	30.61 (3.18)	2,304 (309)	2,349 (272)	2,389 (248)	Satisfies only WMS poverty line
High Potential Maize Zone	13.59 (2.38)	14.49 (1.83)	14.49 (1.56)	1,061 (186)	1,131 (143)	1,131 (122)	Satisfies None

Table 2. Second Order Poverty Dominance of Counterfactual Incomes over Incomes with Effects of Price Controls (Poverty Gaps Higher with Price Controls)

Broad Agro-climatic Zone	Amount at which cumulative difference between income distributions reaches zero (upper bound poverty line for poverty gap measure)						Robustness to the World Bank and the WMS poverty line
	US Dollar ($) amount (std deviation)			Amount in Kenya shillings (Kshs) (std deviation)			
	15 %	19.7 %	25 %	15 %	19.7 %	25 %	
High Potential Maize Zone	24.39 (1.89)	27.17 (1.82)	30.01 (2.07)	1,903 (147)	2,120 (142)	2,342 (162)	Satisfies only WMS poverty line

Table 3. Household characteristics with respect to income, landholding size, and maize marketing behavior, 2000 and 2004.

Zone	Number of Sampled Households	Per Capita Income	Cropped Land size	Maize Marketing Position			Household Maize Sales [7]		
				Net Seller	Autarky	Net Buyer	Net Seller	Autarky	Net Buyer
		-Ksh-	-acres-	----------- percent ----------			----------- kgs ------------		
Western Lowlands[1]	170	10920	2.95	5	13	82	315	0	-540
Eastern Lowlands [2]	150	19355	5.36	23	11	66	564	0	-290
High-Potential Maize Zone [3]	332	29922	7.73	68	10	22	3022	0	-595
Western Highlands [4]	180	14055	2.96	23	19	58	580	0	-399
Western Transitional [5]	150	16578	5.31	23	15	62	1166	0	-694
Central Highlands [6]	242	28010	2.8	16	21	53	413	0	-316
Total	1,224	21647	4.81	32	16	52	2028	0	-462

Source: Tegemeo Institute/Egerton University Rural Household Survey, 2000 and 2004
Districts comprising each zone: [1] Kisumu and Siaya. [2] Kitui, Mwingi, Machakos, and Makueni. [3] Trans-Nzoia, Uasin Gishu, Bomet, Nakuru, and upper elevation divisions within Kakamega. [4] Kisii and Vihiga. [5] Bungoma and lower elevation divisions of Kakamega. [6] Muranga, Nyeri, Meru,and Laikipia.
[7] negative Figures indicate quantity of maize and maize meal purchased.

Figure 1

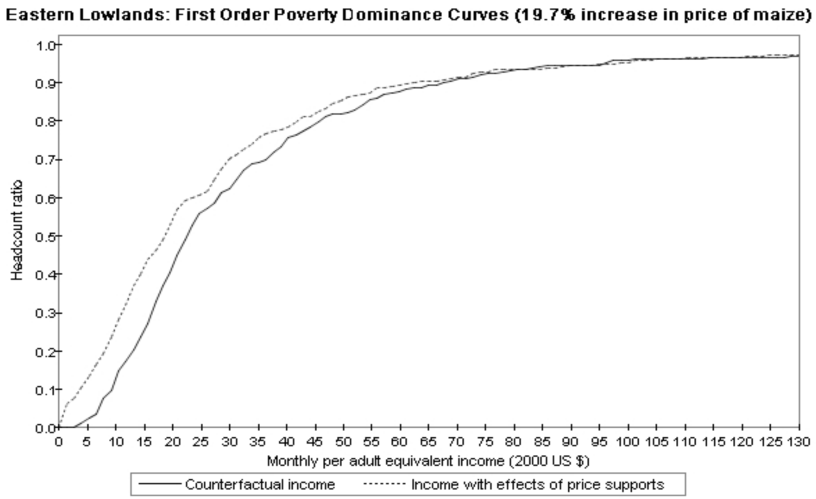


Figure 2

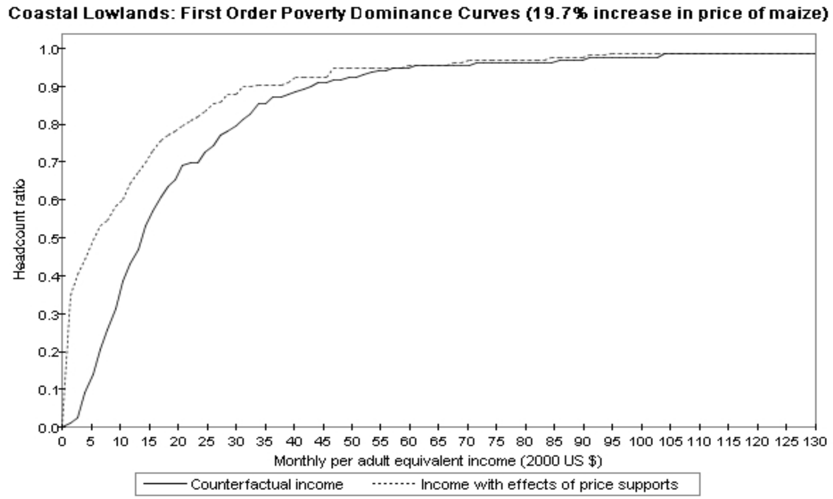
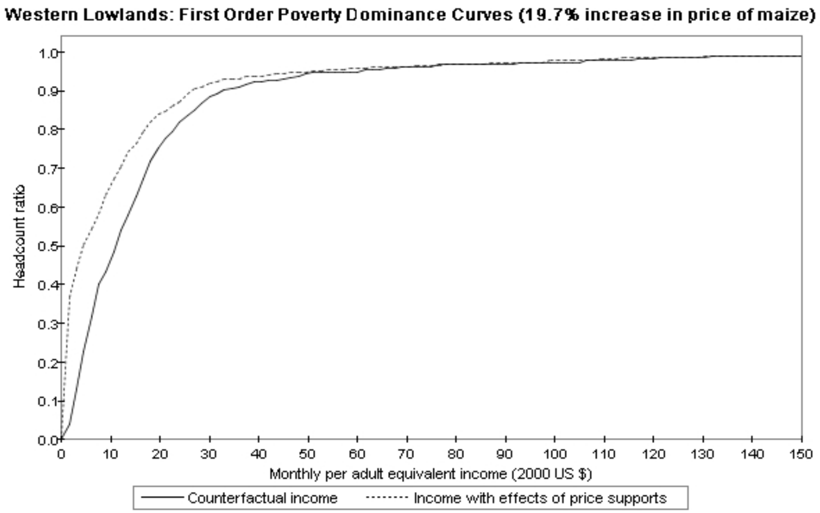


Figure 3



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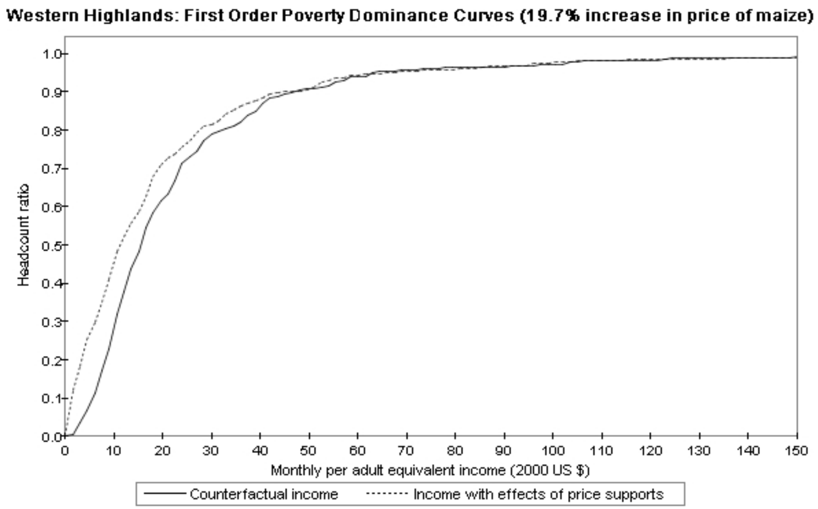
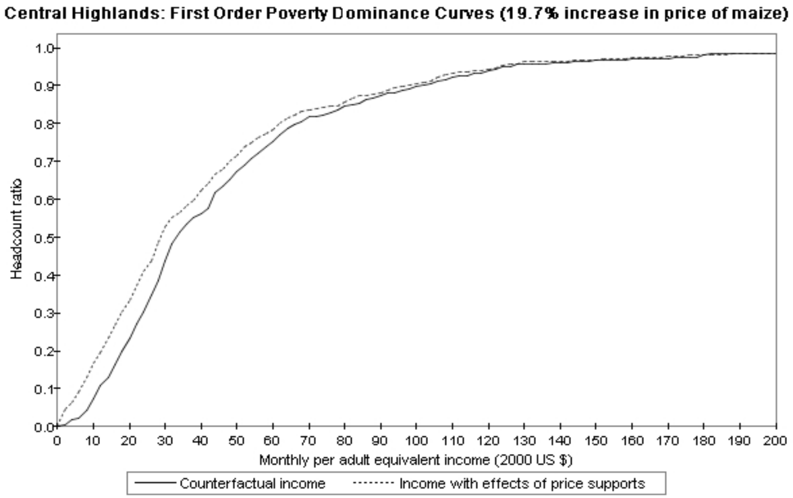


Figure 5



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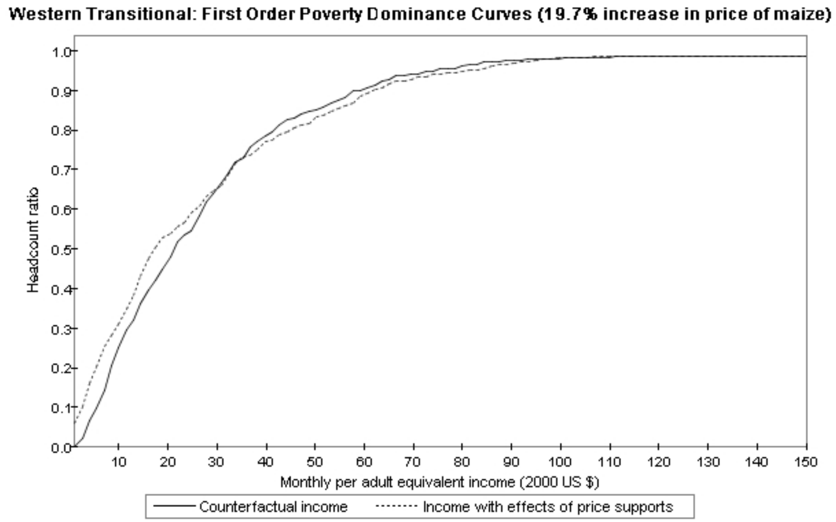


Figure 7

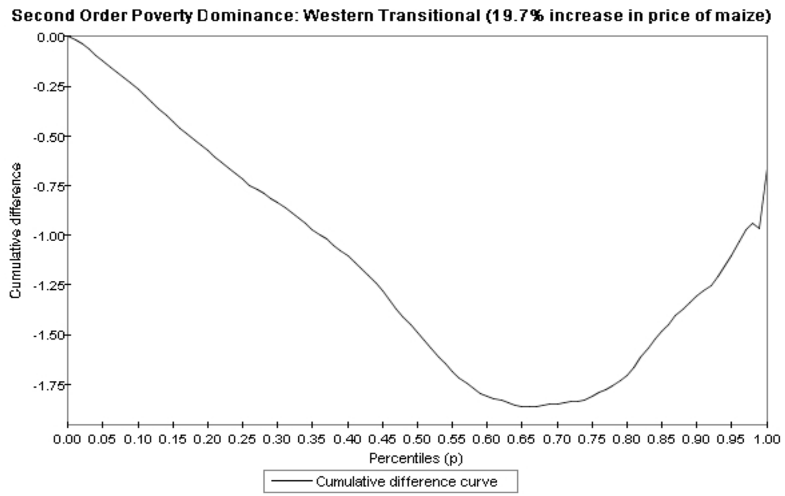


Figure 8

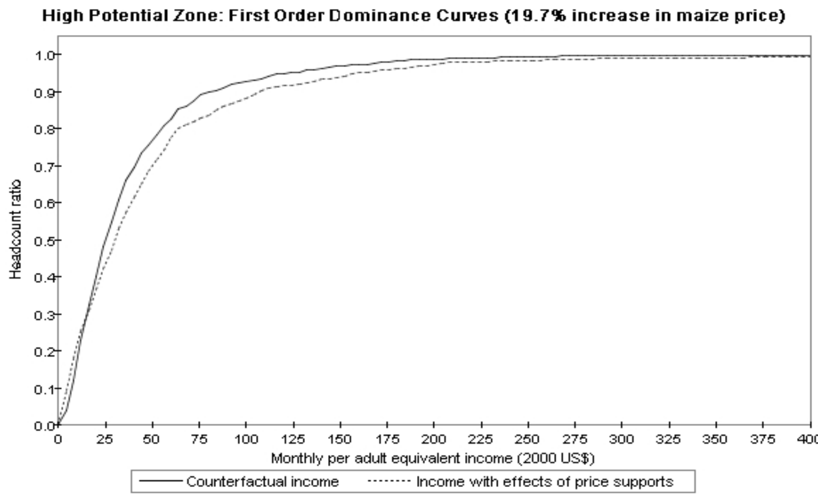
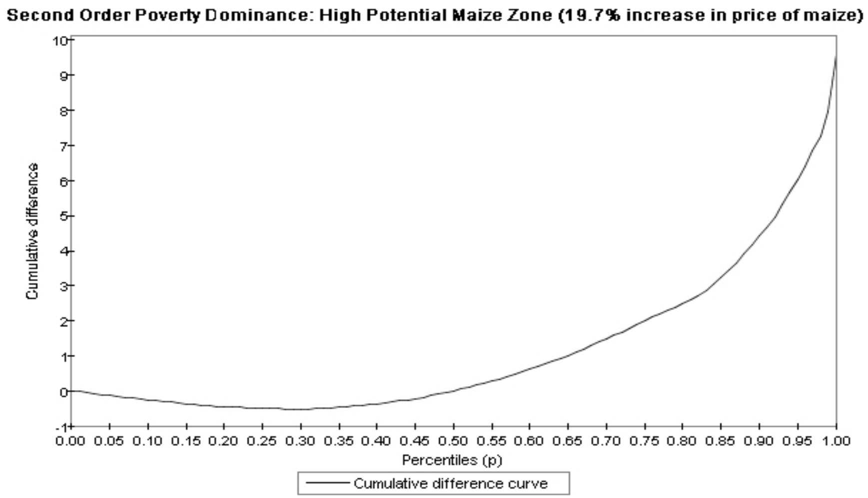


Figure 9


Second Order Poverty Dominance: High Potential Maize Zone (19.7% increase in price of maize)
10
9
8
7
6
5
4
3
2
1
0
-1
Cumulative difference
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00
Percentiles (p)
Cumulative difference curve