Agricultural Prices and Income Distribution among Farmers:
A Whole-Household, Multi-Country, Multi-Year Analysis

by

Ana R. Rios[*], Gerald E. Shively[**], and William A. Masters[**]

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Abstract

Recent studies have emphasized that the poorest farmers are often net buyers of key commodities and therefore harmed by rising prices. We use LSMS data from Tanzania, Vietnam and Guatemala to test the degree of net purchases or sales by income level. We find that poorer farmers may be net buyers of individual crops, but only the poorest are net buyers of all crops. More generally, net sales among poor farmers are low. We conclude that agricultural price changes have a diverse but limited influence on poor farmers' welfare, because their farm sales tend to be offset by food purchases.

Key words: market participation, poverty, inequality, multi-continent multi-country

[*] Inter-American Development Bank. Corresponding author. Email: arios@iadb.org
[**] Department of Agricultural Economics, Purdue University.

Rising prices for crop outputs can raise farm income, but farm households also buy food and other agricultural products. Some households may be net buyers of what they produce, and so be harmed by higher product prices. Even households that devote a significant fraction of their resources to crop production can be net buyers of those products, if their own output is low and they have some income from other sources. Recent farm surveys have focused attention on these rural net buyers, notably Weber et al. 1988, von Braun 1995, Barrett and Dorosh 1996, Jayne et al. 2001, Boughton et al. 2007, and Levinsohn and McMillan 2007. Rural net buyers include some affluent households, but most are the rural poor who have some land but not enough to meet their needs, and use income from remittances or other activities to supplement what they produce at home.

This paper expands our understanding of how farmers' net buyer/net seller status is distributed along the range of farm household incomes, through two main innovations: First, we focus on farm households and compile comparable results across multiple countries and years. This allows us to consider a larger sample size over a wider range of conditions than in previous studies, while still drawing useful contrasts among comparable populations. Second, we contrast results for individual crops and for the aggregate of all crops, which is important since households may be net buyers of one crop but net sellers of others. In this way we provide an unprecedented perspective on the link between net-buyer/net-seller status and farm household incomes. Other studies such as Ravallion 2006 or Hertel and Winters 2006 provide nationally-representative results for selected countries, taking account of nonfarm households and the rural landless. Here we focus more narrowly on households with some farm production of their own, looking in detail at how price changes might influence income distribution within the agricultural sector.

Data

Our dataset merges the LSMS surveys conducted by the World Bank in Tanzania,

Vietnam and Guatemala, to produce a sample of 11,209 farm households across a range of

human, economic and ecological conditions in Africa, Asia and Latin America.   The Tanzania

data come from the Kagera Health and Development Survey (KHDS), conducted in the epicenter

of the AIDS outbreak in East Africa. We combine data from three waves to produce two

complete years of data: wave 1, conducted between September 1991 and May 1992; wave 2,

conducted between April and November 1992 and; wave 3, conducted between November 1992

and May 1993 (World Bank 2004). The Asian data come from two Vietnam Living Standards

Surveys (VLSS) conducted nation-wide, one conducted between September 1992 and October

1993 (World Bank 1994) and the other between December 1997 and December 1998 (World

Bank 2001). Data from Guatemala come from Encuesta de Condiciones de Vida (ENCOVI)

conducted between July and November 2000 (World Bank n.d.).

We begin by dropping all observations from households with no agricultural production

of their own, so as to focus on the farm population itself. Of course many rural households are

entirely landless, and they are all net buyers even if their employment is largely in agriculture on

other peoples' farms. Taking account of their income and expenditure patterns would be

important to obtain nationally-representative results, but our focus is limited to households with a

farm of their own. Then, to make the data comparable across countries and years, we computed

annual variables measuring common characteristics related to household composition and

agricultural production.[1] All physical quantities were painstakingly converted into standard units

of measurement, and monetary variables were converted from local currency into U.S. dollars at

each year's purchasing power parity (PPP) exchange rate, from the Penn World Tables version 6.2 (Heston, Summers and Aten 2006).[2]

Since all data are in value terms, we can add up sales and purchases for aggregate crop production and for all staple crops as well as individual crops and livestock. Aggregate crop production refers to all crops produced by the household.[3] Staple crops are limited to the basic tradable foods. In Tanzania these include maize, cassava, cooking bananas, millet, sorghum, cocoyam, yam, Irish potatoes and sweet potatoes. In Vietnam staples include maize, cassava, sweet potatoes, potatoes and rice. Staple crops in Guatemala consist of maize, cassava, cooking bananas and beans. Those crops selected as the main food crops differ across countries. These include cassava, cooking bananas and maize in Tanzania; rice and maize in Vietnam; and, maize and beans in Guatemala. Livestock refers to all animals raised by the household.

Methodology

The analysis of links between a farm's market participation and their household income distribution employs bivariate, non-parametric regressions estimated with local linear kernel smoothing.[4] Income is measured using annual consumption expenditure per capita. We use consumption expenditure as an indicator of poverty because it is a more stable measure of the household's welfare than measured income in any one year, particularly in farm households reliant on rain-fed agricultural production (Ravallion 1994), and because consumption expenditures is often recorded more accurately than income (Benjamin and Deaton 1993). Annual consumption expenditure per capita is calculated as the sum of the value of all consumption, including not only purchases but also consumption of household-produced food and other items such as personal care goods, household items, transportation, communication,

housing and so forth. We transform expenditure using natural logarithms to improve symmetry because the distribution of expenditure per capita is right skewed.

Market participation is measured as net crop sales, calculated as:

$$net\ sales_i = \sum_{j=1}^{J} \left(sales_{i,j} - purchases_{i,j}\right) \tag{1}$$

for a given set of J agricultural products produced in household i. The variable *sales* refers to transactions with non-household members (including payments in kind) plus any output that is used as an input to other production in the household, such as feed for animals, while *purchases* includes the value of any goods obtained in exchange for money. All are expressed in US dollars at purchasing-power parity prices. A household with positive (negative) net sales is a net seller (buyer) for whatever set of products included in J, which in our case will be all crops, all staple food crops and then also a few individual crops plus livestock.

To describe the welfare implications of price changes, we employ a method developed by Deaton (1989).[5] Deaton (1989) shows that, starting with the household living standard expressed as an indirect function of household income and prices, the direct effect of small price changes on social welfare can be estimated as:

$$\frac{\partial W}{\partial \ln p_k} = \sum_i \theta_i(x_i, z_i) \frac{p_k\left(y_{i,k} - q_{i,k}\right)}{x_i} \tag{2}$$

where the W is social welfare, p_k is price of good k, θ_i captures the social value of transferring one unit of money to household i, x_i is total consumption expenditure in household i, z_i denotes characteristics of household i, $y_{i,k}$ is total amount of good k produced by household i, and $q_{i,k}$ is the amount of good k consumed by household i. In empirical applications, however, θ_i is not specified given the subjectivity involved in determining this

parameter that can result in diverse $\mathcal{O}_i$'s for different applications and different observers.

Thus, applied analysis is based on the last term on the right-hand side of equation (3) which is

net sales of each product divided by total household expenditure. This is referred as the "net

benefit ratio" (NBR). In effect, the NBR measures the elasticity of real income with respect to a

price change.

We focus on the relationship between NBR and household expenditure per capita, to test

the degree to which farmers at each income level might benefit from agricultural price changes.

To preserve flexibility in the functional form we use non-parametric regressions of the NBR on

the natural logarithm of household expenditure per capita. Confidence intervals at the 95% level

are used to indicate the precision of our estimate at each point in the distribution.

Results

The relationship between farm households' net sales and their real income is analyzed

graphically, using 95% confidence intervals to assess statistical significance of estimated

differences in net sales at each income level. Results are discussed in turn for each country and

the merged sample. Since all data are in PPP dollars per capita they can be compared across

countries and years.

Tanzania

Figures 1 and 2 present our results for the Tanzania sample, first for 1991-92 and then for

1992-93. The top panel in each figure presents only the regression lines, and the bottom panels

provide confidence intervals around them. Note that for most farmers, net sales of all crops and

of all staple crops show quite different results than net sales of individual products. Confidence

intervals are wide at the extremes because of small sample sizes, but in most cases there is a significant tendency for poorer farmers to have less net sales. The poorest farmers, with real expenditure below US$100 per capita, have net sales around US$100 per household in 1991-92 and around zero in1992-93. In contrast, richer farmers in the sample with real expenditure around US$1,000 have net sales of several hundred dollars in both years. The poorest are much more likely to be net buyers in 1992-93 than in 1991-92. Fluctuations could be explained by weather conditions affecting crop yields, and indeed Mitchell et al. (2003) and FAOSTAT data show lower precipitation and lower crop yields during the crop year corresponding to the 1992-93 sample.[6]

Vietnam

Figures 3 and 4 present the corresponding results for Vietnam, covering 1992-93 and 1997-98. Farmers have higher incomes and more net sales than in Tanzania, and confidence intervals are generally narrower because sample sizes are much larger, but a similar pattern emerges: poorer farmers are more likely to be net buyers, especially in 1992-93. In 1997-98, the poorest were net buyers of rice and of all staple foods together, but net sellers of other crops. In both years, net sales of products other than maize rise sharply with income, a result that is consistent with Heltberg and Tarp (2001) who find that the probability of selling in output markets increases with household expenditure. Maize is an unusual case of a crop that is disproportionately sold by poorer and middle-income farmers. For all crops net sales were larger in 1997-98 than in 1992-93, perhaps a result of more favorable market conditions as well as better weather such as increased rainfall. Again, Mitchell et al. (2003) and FAOSTAT data

indicate higher rainfall and higher yields respectively during the crop year corresponding to the data collected in the 1997-98 sample.[7]

Guatemala

For Guatemala we have data for only one year (2000), shown in Figure 5. As we found for Vietnam in the relatively good year of 1997-98, the poorest farmers in Guatemala are often net buyers of their staple crops (in this case, primarily maize) but sellers of other crops. On balance, their net crop sales are near zero, and net sales are significantly positive only among middle- and higher-income farmers. Interestingly, the confidence interval is widest for beans, as farmers at every level vary widely in their net sales or purchases.

Merged Sample

To show the full range of our data across all three countries and various years, we plot the regression lines for crops and also for livestock in Figure 6. In this context the slope of the relationship between net sales and household incomes is steeper for all crops than for staple crops or for livestock, which is shown on a separate panel with a smaller vertical scale. The threshold of real income per capita below which farmers are typically net buyers is about US$150 per year. Looking across these varied countries and years we can conclude that the poorest farm households are often net buyers of all crops and of staple foods, but the threshold below which this is generally true is extremely low -- well below one dollar per day in real per-capita expenditure.

Household Marketing Behavior, Income Distribution and Price Changes

So far our analysis has examined net sales in absolute terms, measured in real US dollars per year, per household. Now, we follow equation (2) to normalize by total expenditure and consider proportional effects. As before, regression results for each country and year are presented separately, starting with the regression lines for all crops, staple crops and selected individual products in the top panel of each figure, followed by panels with each regression line and its associated 95% confidence interval.

Tanzania

Figures 7 and 8 provide proportional results analogous to those shown in Figures 1 and 2. In the first year (1991-92), sales of the all-crop aggregate accounts for a slightly larger fraction of total household expenditure among the poor than among wealthier farmers, but the slope is not very steep and turns opposite in the following year. As shown in Figure 8, in 1992-93 the poorer farm households were either net buyers or earned a smaller fraction of their income from net sales for most products shown, and in the case of maize there was no significant relationship between net sales and farm household expenditure.

Vietnam

Results for Vietnam 1992-93 and Vietnam 1997-98 are presented in Figure 9 and Figure 10 respectively. Again the relationship between the net benefit ratio and household expenditures per capita differs both across products and over time. Most dramatically, in the earlier time period the poorest Vietnamese farmers had net sales near zero for all products except maize. Maize was disproportionately sold by the poor, but other products had net sales that were a larger

fraction of expenditure at higher income levels. In contrast, by 1997-98 the net sales of most crops had risen more for poorer than for richer farmers, and net sales of all crops were between 60 and 80 percent of expenditure for farmers at every income level.

Guatemala

Figure 11 presents the relationship between NBR and expenditure per capita for various goods in the Guatemala sample. The positive relationships seen in Figure 5 disappear when looking at the data in proportional terms, as farm households at every income level on average earn a very small fraction of their total expenditure from net crop sales. Only among the poorest households in the case of beans and livestock are they significant net purchasers, with the degree of net purchases approaching zero at higher levels of expenditure per capita. This indicates that the poor would be the major beneficiaries from lower bean and livestock prices.

Merged Sample

In the merged sample, the hyperbolic shape of regression functions for all crops, staple crops and livestock suggests that middle expenditure households benefit the most from price increases, with poor households losing in the case of staple crops and livestock (Figure 12). The net benefit ratio of maize is a horizontal line at zero indicating that price changes will be distributionally neutral.

Summary and implications

How do agricultural price changes affect income distribution among farm households? Using LSMS data from Tanzania, Vietnam and Guatemala, we find that higher-income farmers

usually have larger net sales, and that lower-income farmers are sometimes net buyers of key crops who would actually be harmed by a price increase. The very poorest farmers may, on average, be net buyers of all crops. But in Vietnam and Tanzania we find great variability across the two years, and one of the few generalizations was can draw is that many farmers, often including the poorer farm households, have net sales close to zero. Their purchases of farm products offset their sales, so on average a price change has limited power to influence their real income. Beyond that, the link from price changes to farm household welfare differs widely across crops, countries and years. An important conclusion from this study, therefore, is that even the weak effect of prices on the poorest depends on the luck of its timing as well as sector and country. This finding underscores that caution must be exercised when drawing conclusions about a link between agricultural prices and poverty, because of the low magnitude and variation in the degree to which poor farmers are net sellers or net buyers.

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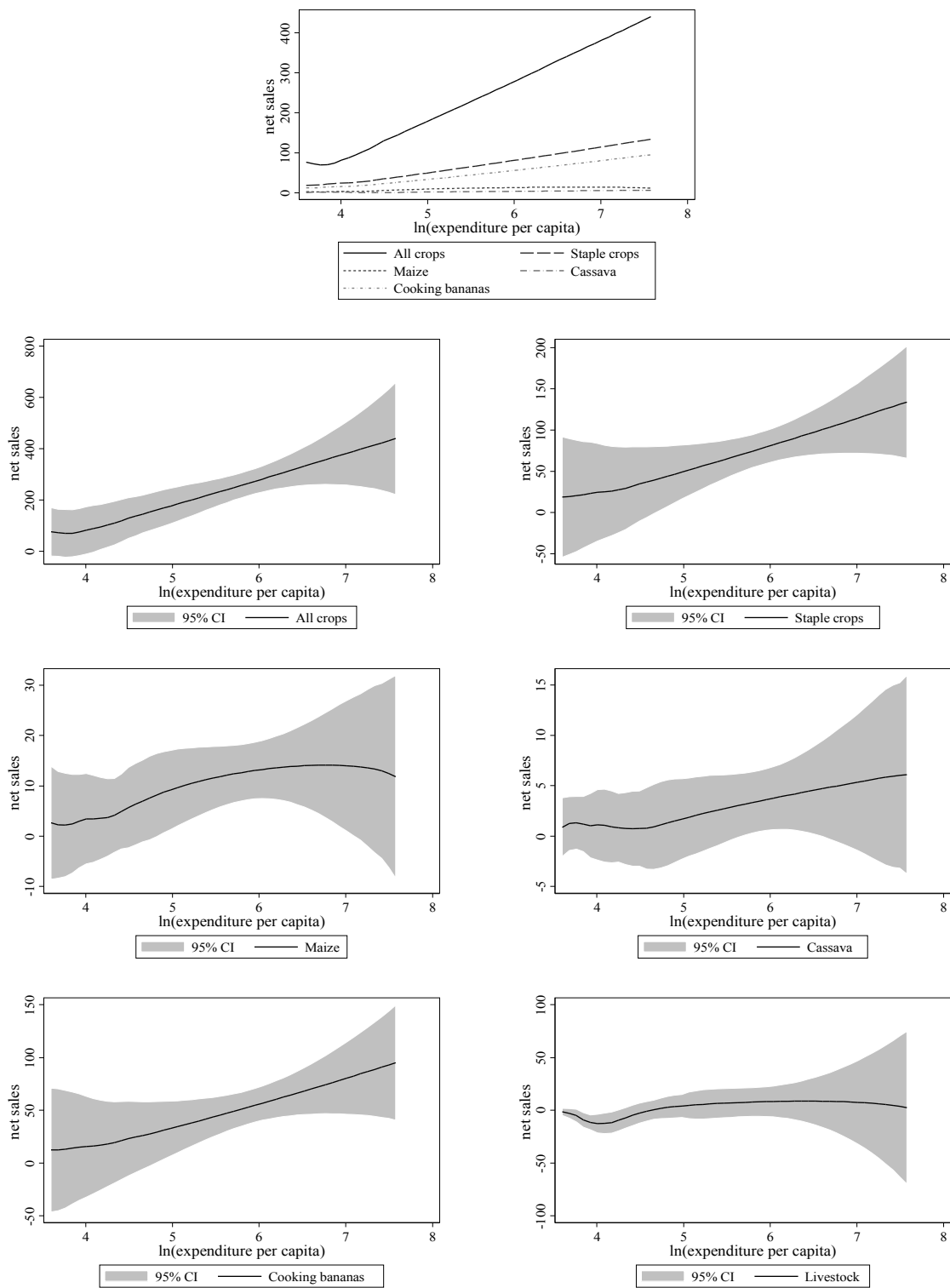
Note: Bandwidth=1.25, degree of the polynomial smooth=1

Figure 1. Net Sales-Expenditure Relationship, Tanzania 1991-92
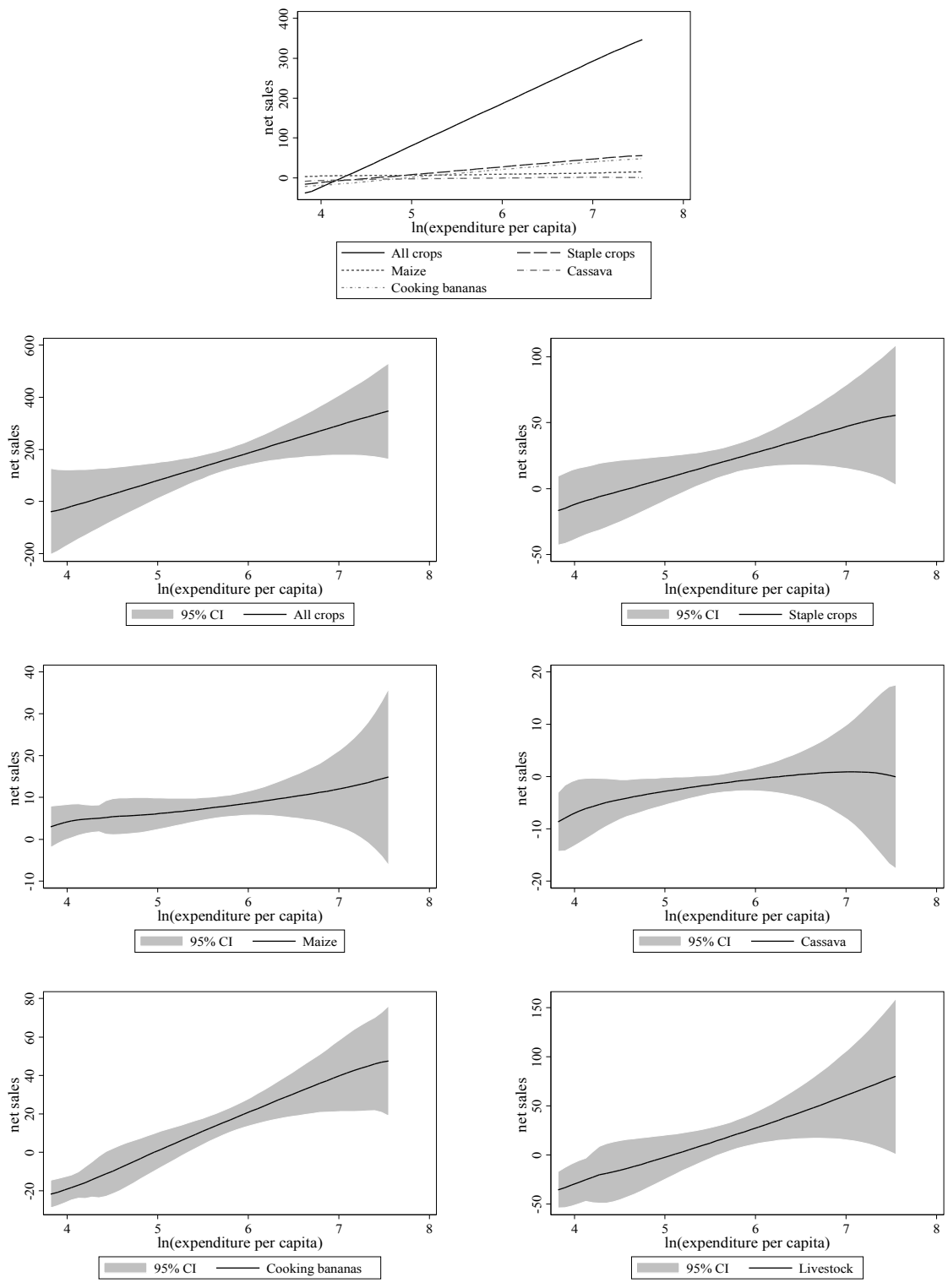
Note: Bandwidth=1.25, degree of the polynomial smooth=1

Figure 2. Net Sales-Expenditure Relationship, Tanzania 1992-93
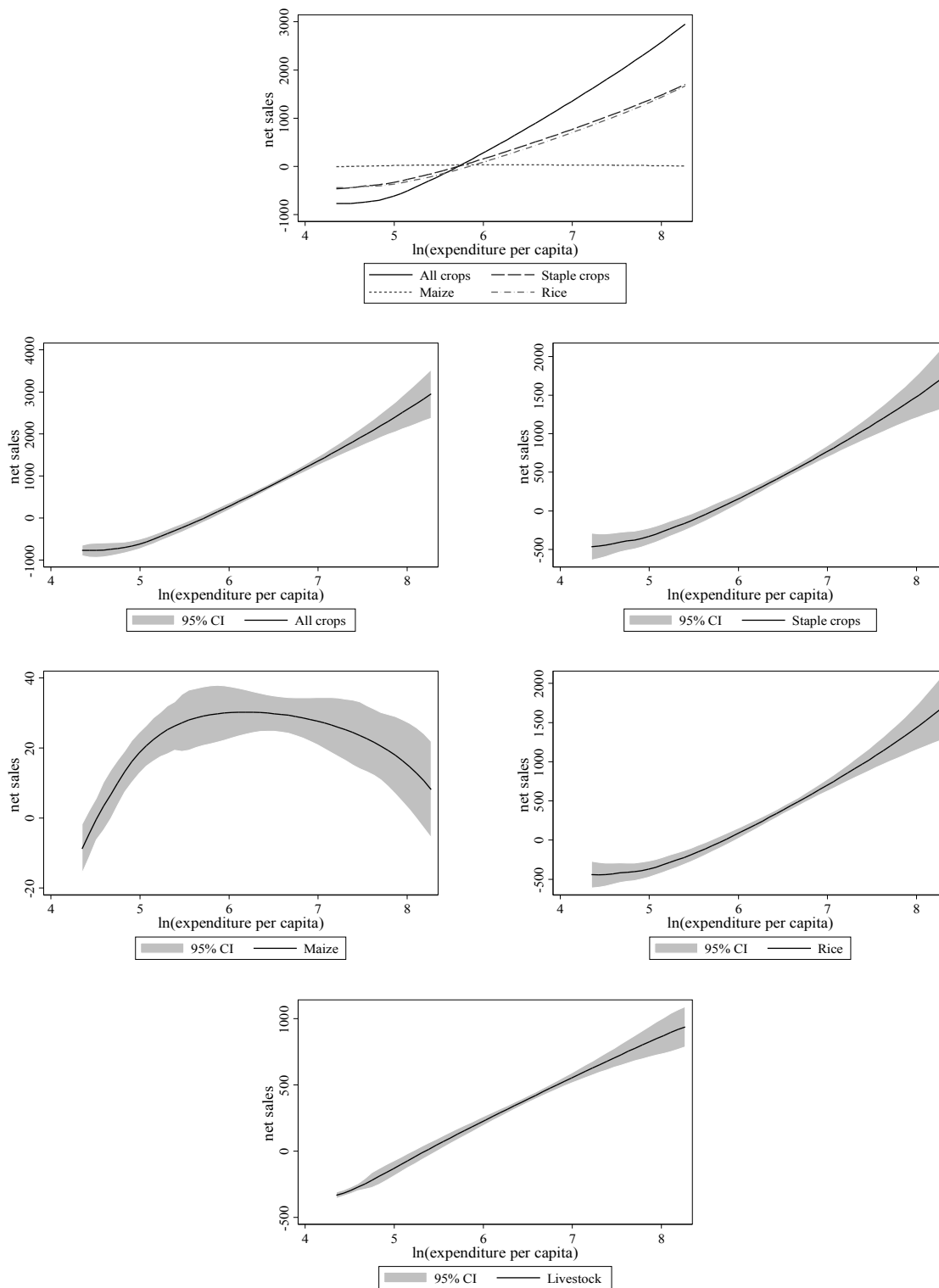
Note: Bandwidth=1.25, degree of the polynomial smooth=1

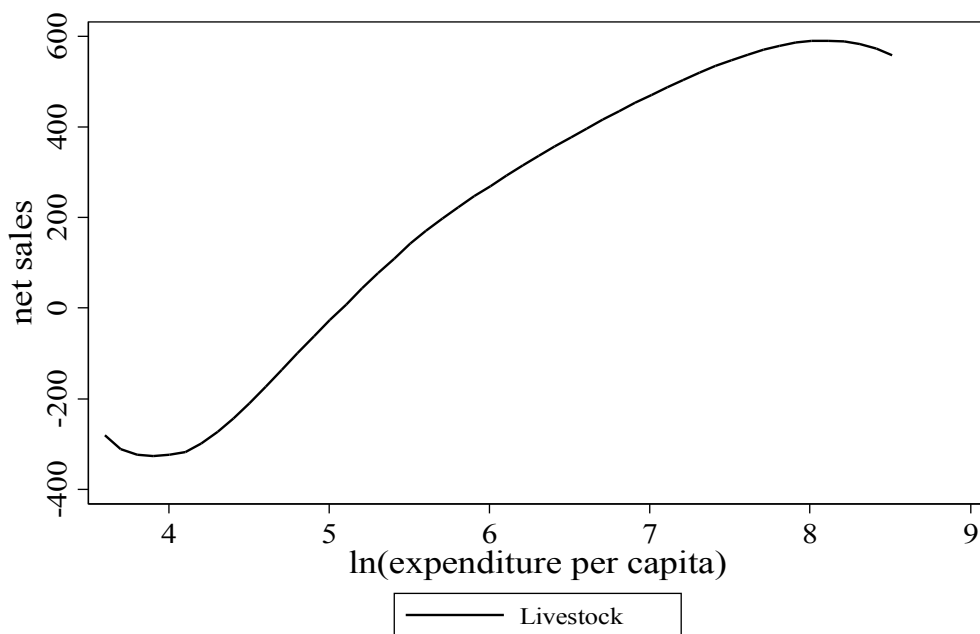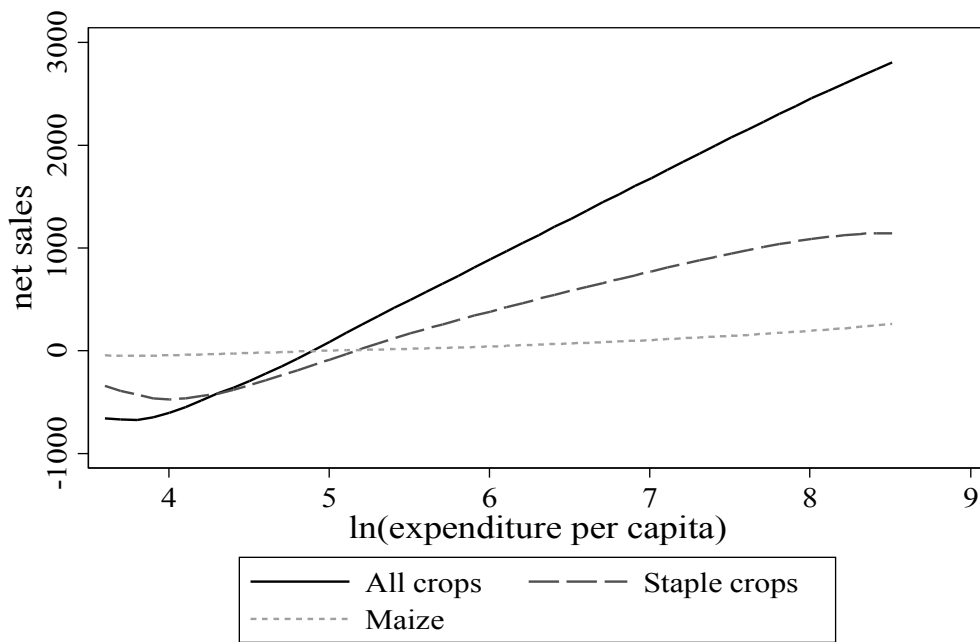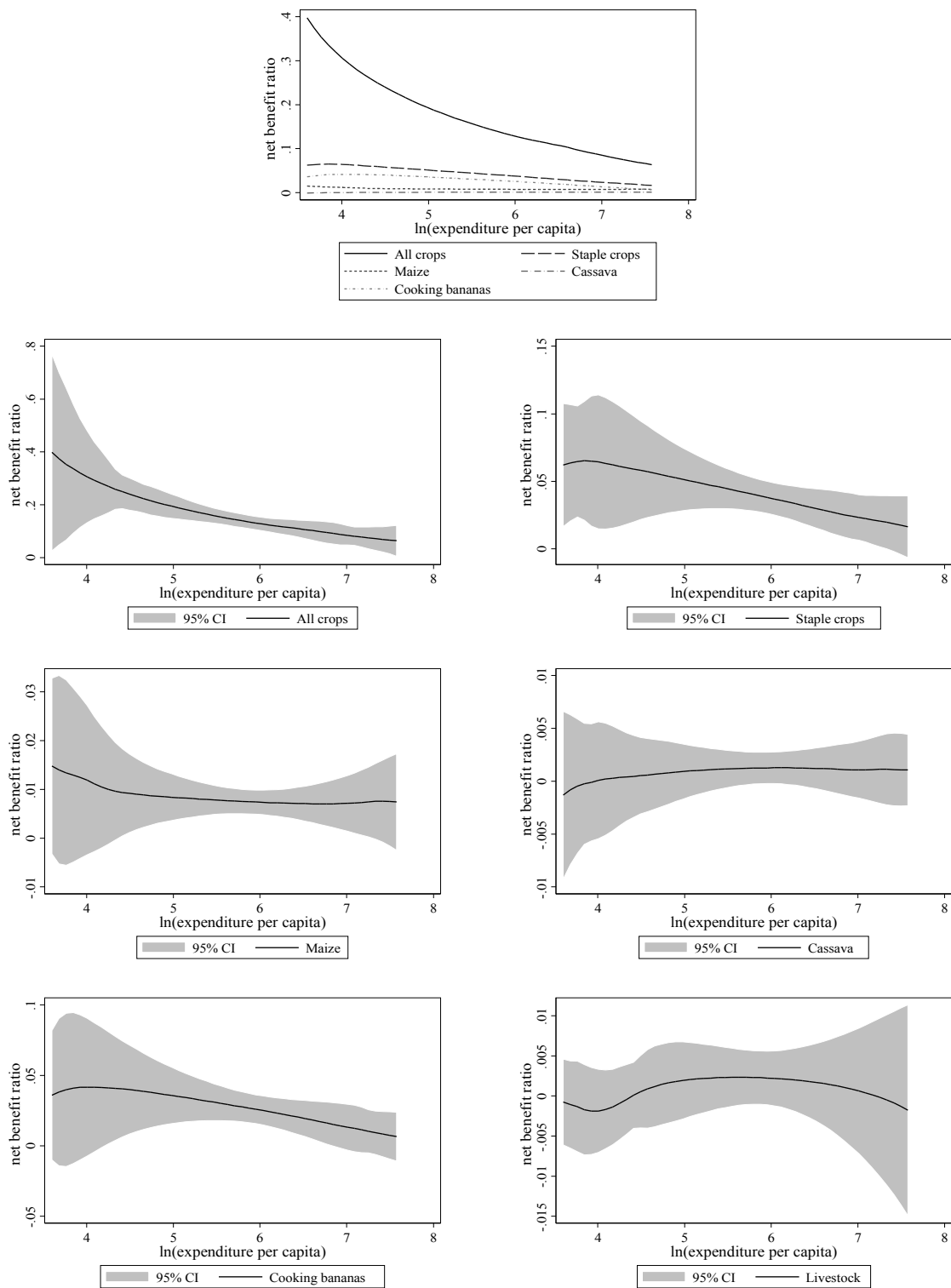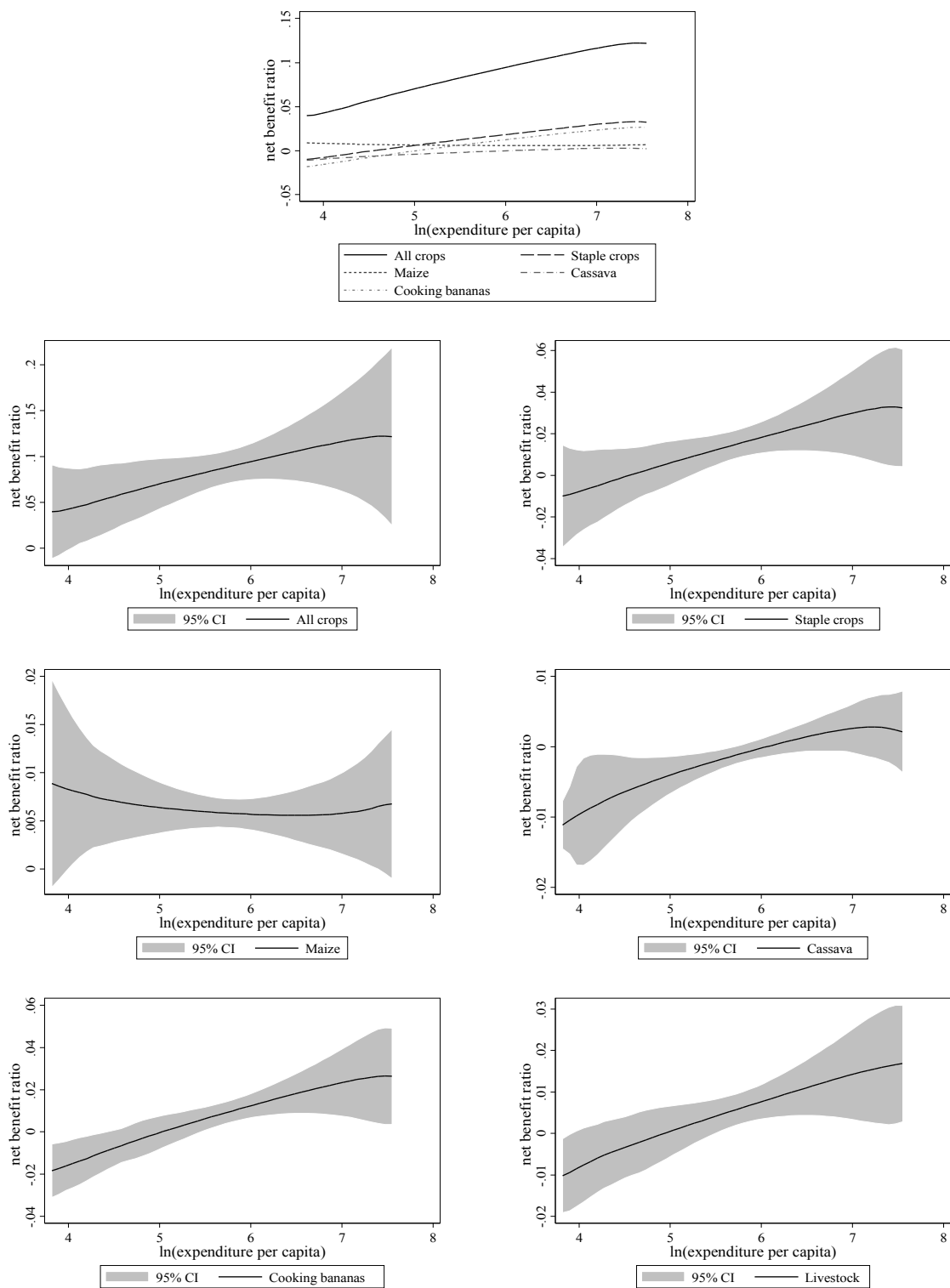Figure 3. Net Sales-Expenditure Relationship, Vietnam 1992-93
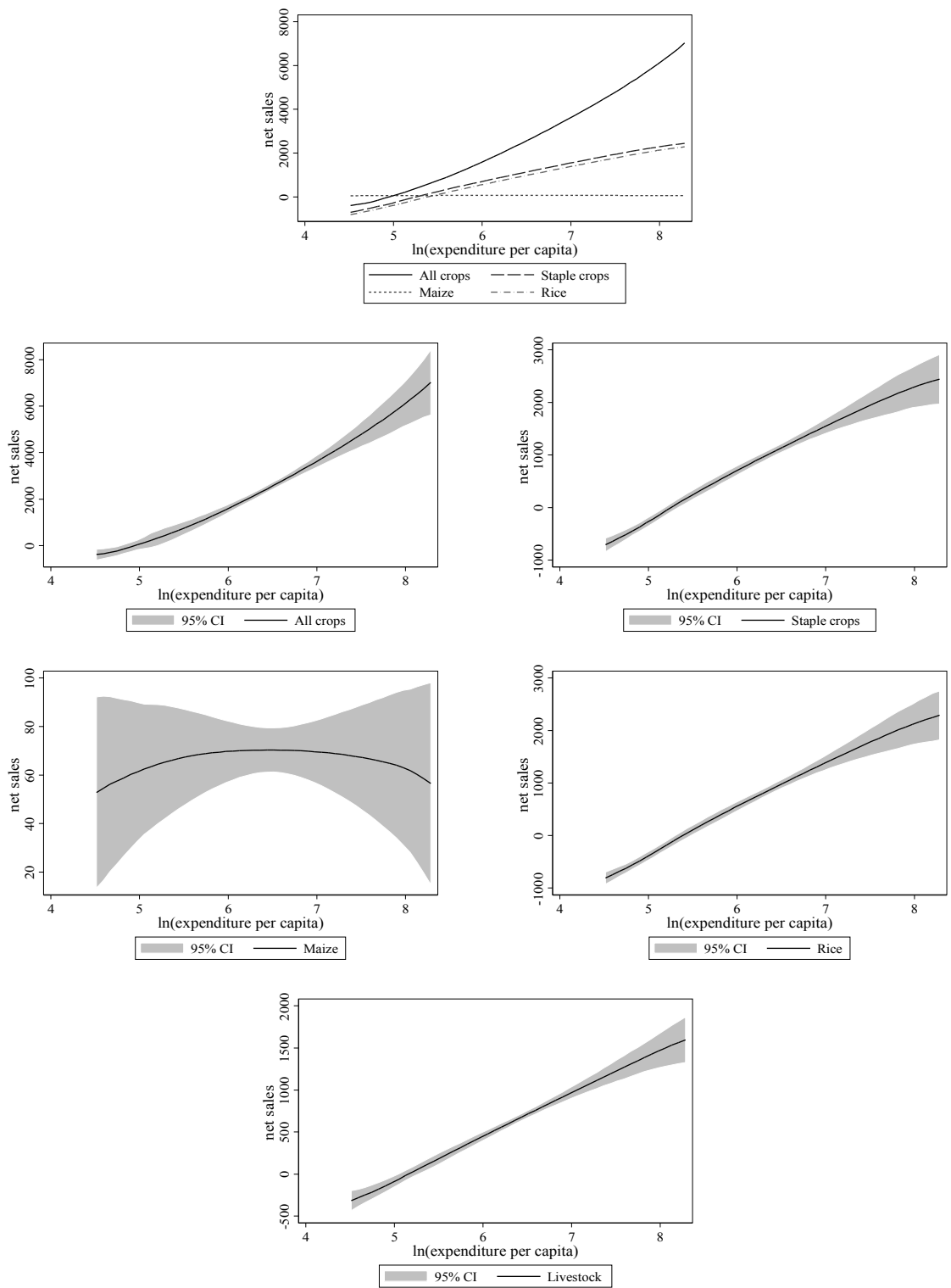
Note: Bandwidth=1.25, degree of the polynomial smooth=1

Figure 4. Net Sales-Expenditure Relationship, Vietnam 1997-98
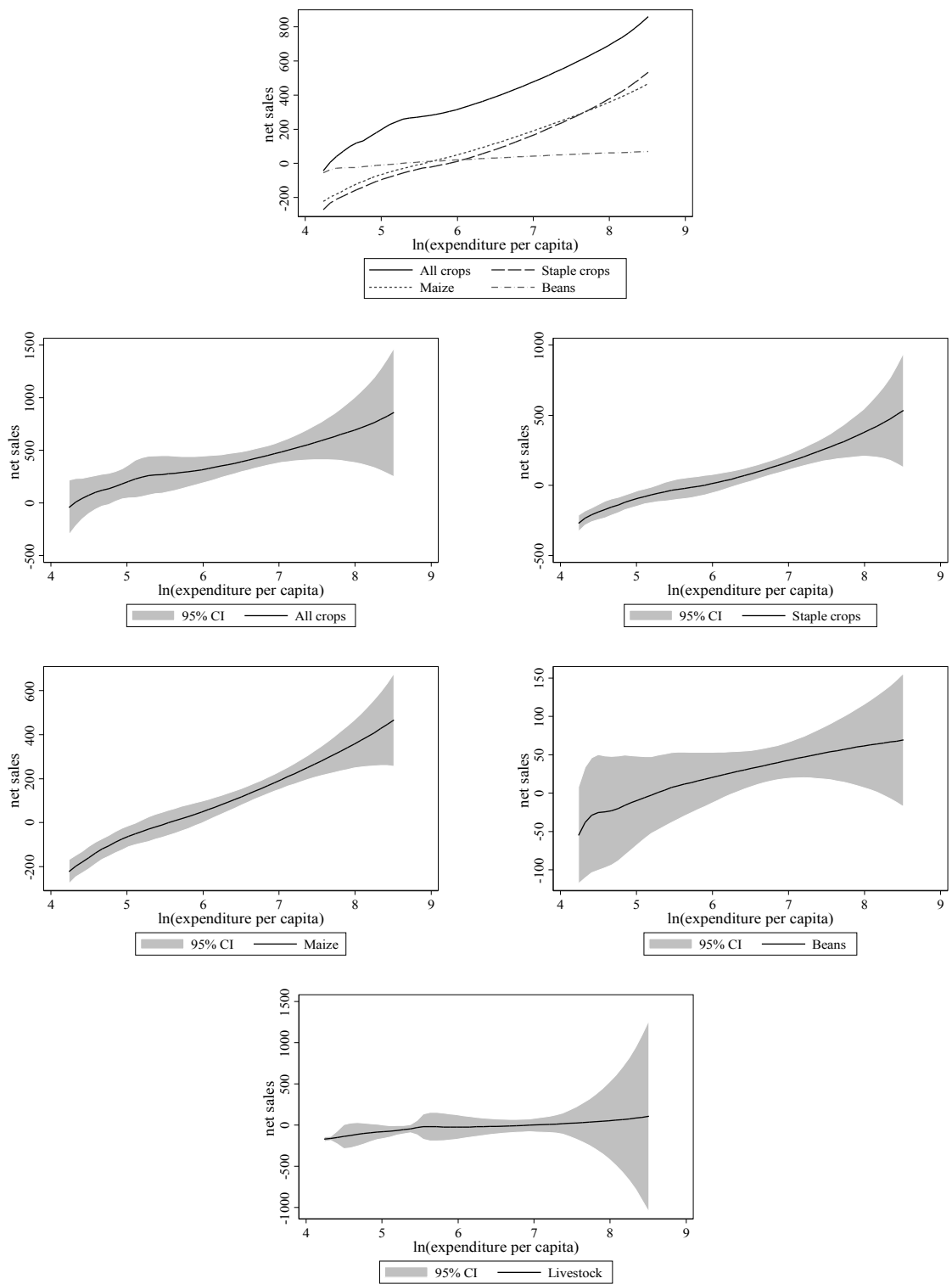
Note: Bandwidth=1.25, degree of the polynomial smooth=1

Figure 5. Net Sales-Expenditure Relationship, Guatemala 2000

Note: Bandwidth=1.25, degree of the polynomial smooth=1

Figure 6. Net Sales-Expenditure Relationship, Merged Sample

Note: Bandwidth=1.25, degree of the polynomial smooth=1
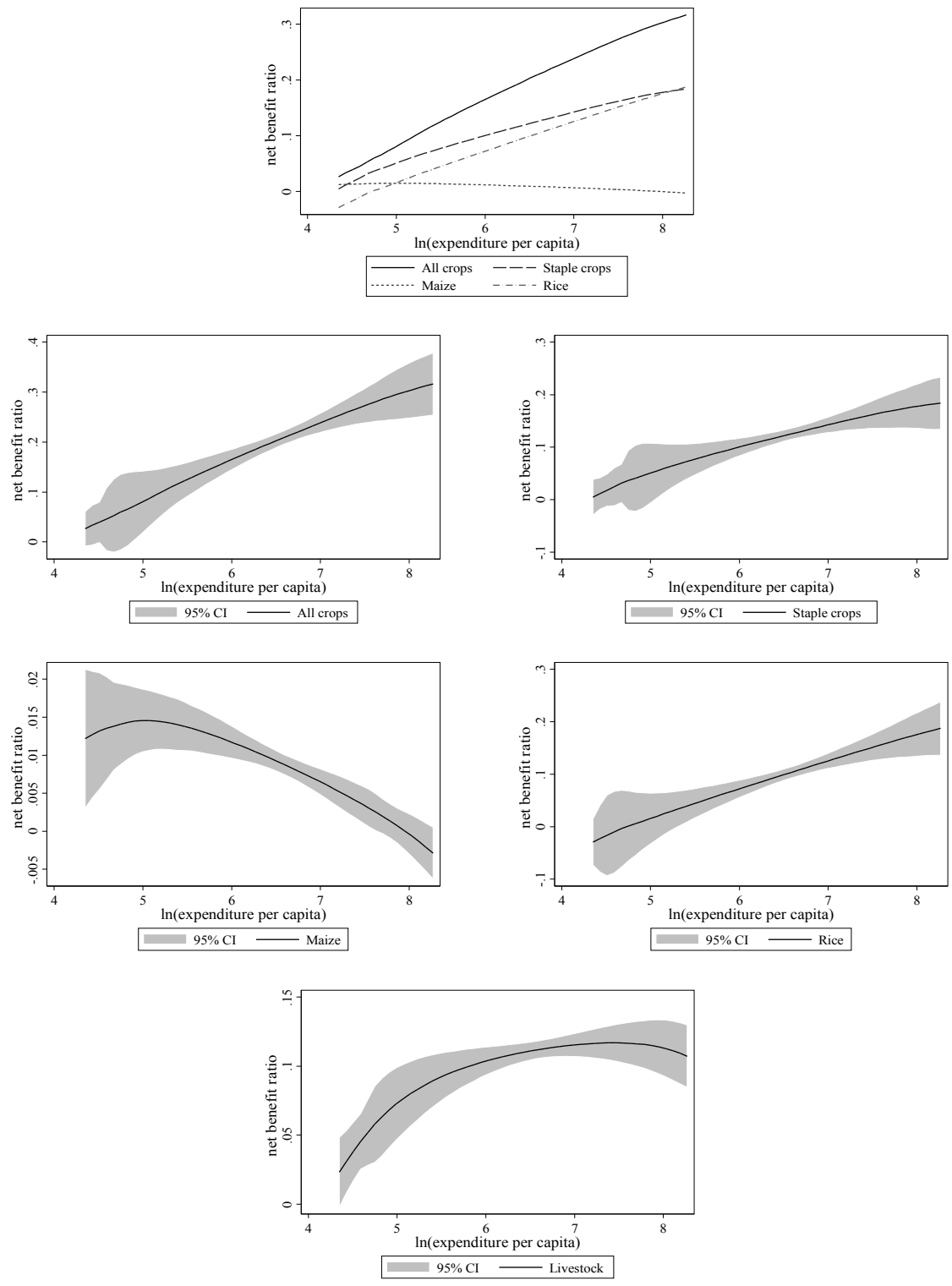
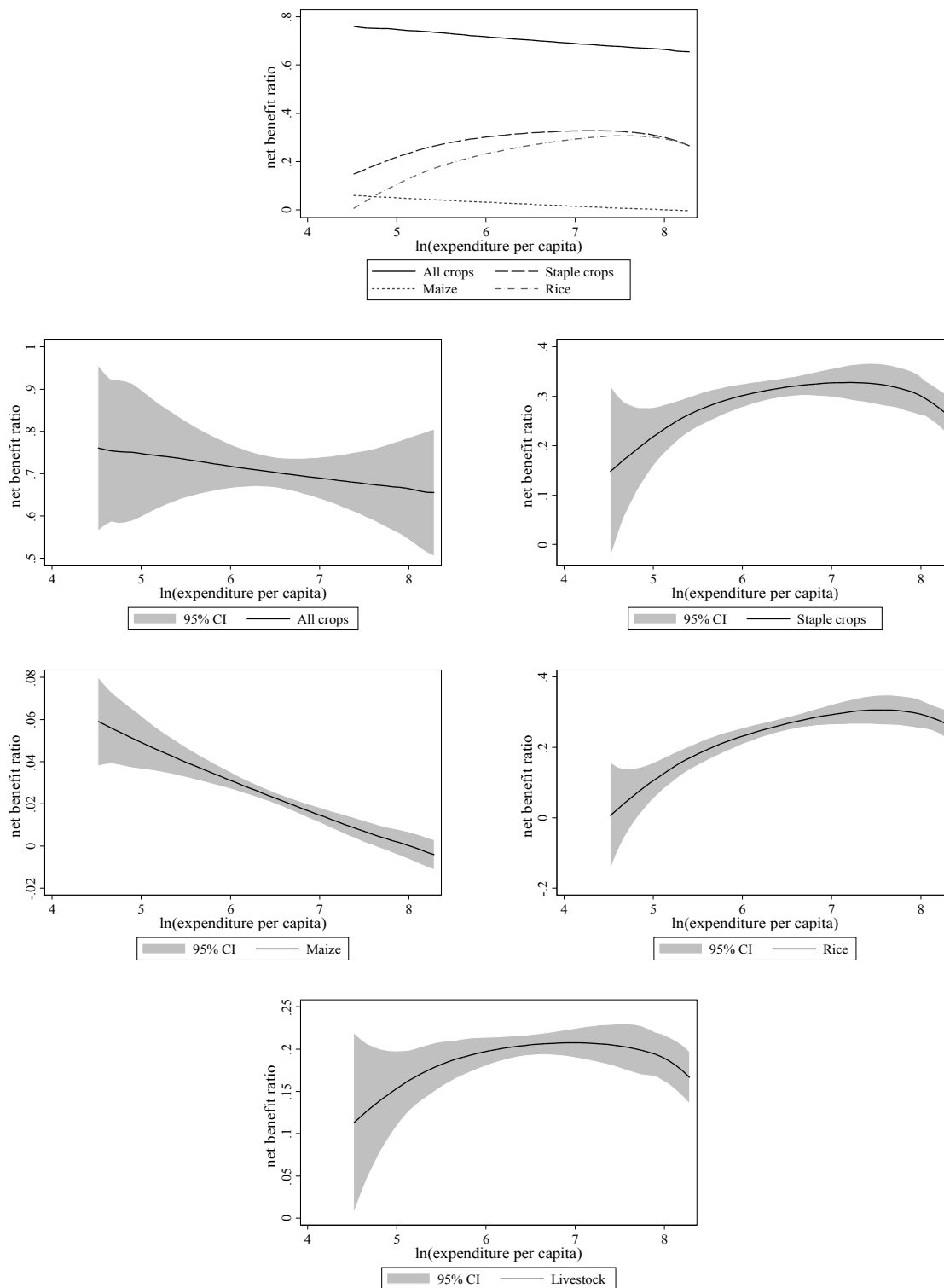Figure 7. Net Benefit Ratio-Expenditure Relationship, Tanzania 1991-92

Note: Bandwidth=1.25, degree of the polynomial smooth=1

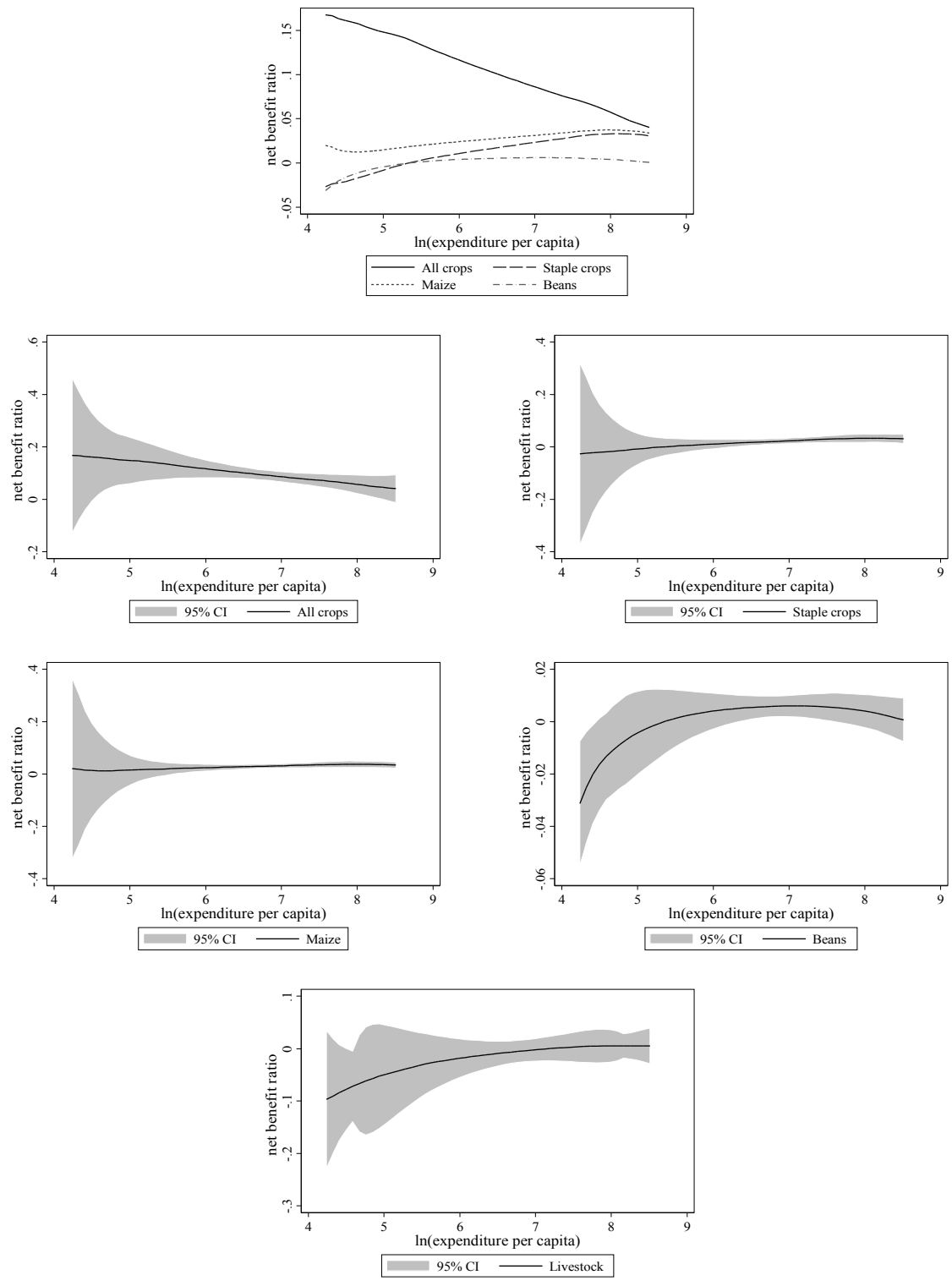Figure 8. Net Benefit Ratio-Expenditure Relationship, Tanzania 1992-93

Note: Bandwidth=1.25, degree of the polynomial smooth=1

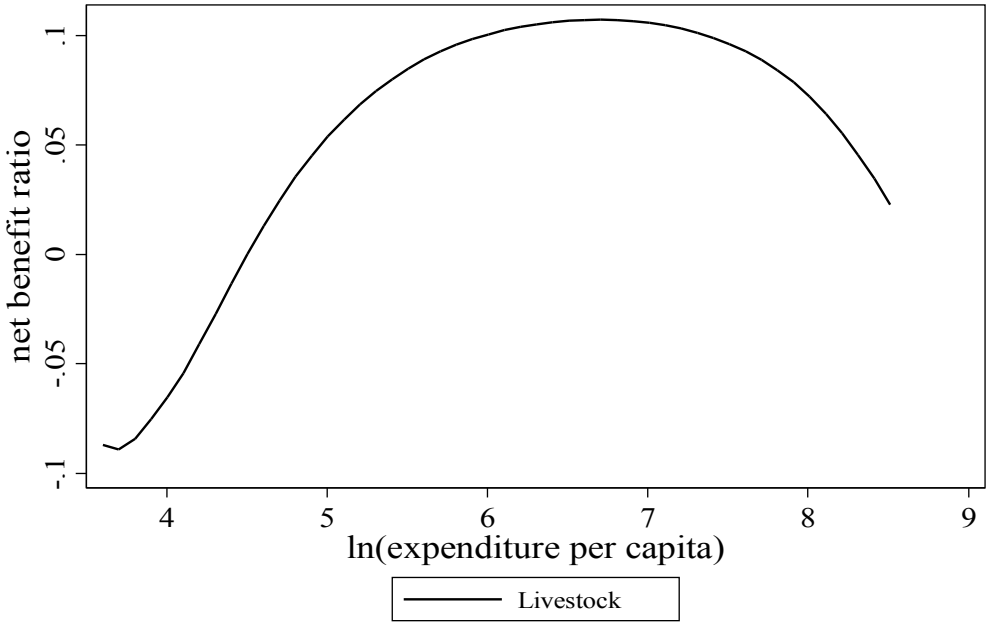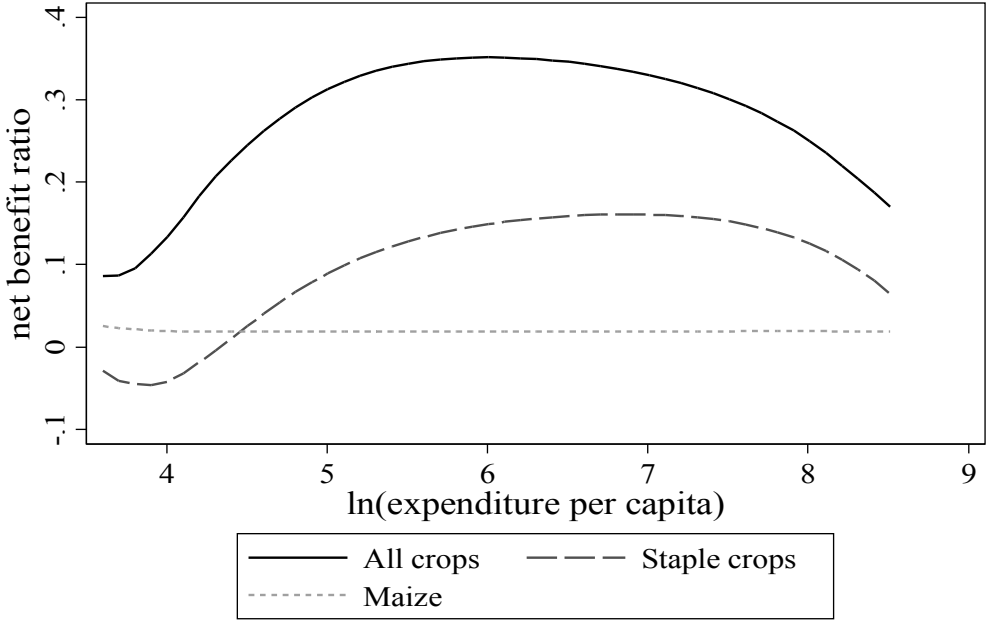Figure 9. Net Benefit Ratio-Expenditure Relationship, Vietnam 1992-93

Note: Bandwidth=1.25, degree of the polynomial smooth=1

Figure 10. Net Benefit Ratio-Expenditure Relationship, Vietnam 1997-98

Note: Bandwidth=1.25, degree of the polynomial smooth=1

Figure 11. Net Benefit Ratio-Expenditure Relationship, Guatemala 2000

Note: Bandwidth=1.25, degree of the polynomial smooth=1

Figure 12. Net Benefit Ratio-Expenditure Relationship, Merged Sample

[1] Kagera Health and Development Survey Datasets waves 2 and 3 contain semi-annual data. Annual data for the 1992-93 period results from combining waves 2 and 3. Data for categorical and ordinal variables and value of assets are obtained from wave 3 (end of an annual period). Variables measured in monetary units are obtained by adding up values from waves 2 and 3.

[2] PPP's exchange rates for each sample follow: Tanzania 1991-92, 91.05TZS/US$; Tanzania 1992-93, 107.89TZS/US$; Vietnam 1992-93, 1317.91VND/US$; Vietnam 1997-98, 2328.98VND/US$; Guatemala 2000, 2.97GTQ/US$.

[3] Agricultural crops produced by the household include annual crops, annual industrial crops, perennial industrial crops, fruit crops, and agro-forestry crops.

[4] We employ Epanechnikov kernel smoothing with a global bandwidth of 1.25. Kernel smoothing, an extension of the local average method, estimates $f(x)$ giving greater weight to observations closer to x and less weight to remote observations (Fox 2000). Literature indicates that the choice of kernel function - in this study, Epanechnikov- is not critical (Deaton 1997; Fox 2000). However, the Epanechnikov kernel is commonly used in the literature on agricultural markets (Deaton 1989; Benjamin and Deaton 1993; Budd 1993; Barrett and Dorosh 1996; Heltberg and Tarp 2001). The choice of bandwidth is based on a visual trial and error as Fox (2000) indicates that it is a generally effective approach. For more on non-parametric methods, see Silverman (1986), Deaton (1989, 1997), Wand and Jones (1995), Härdle (1990), and Fox (2000).

[5] Detailed derivation of the net benefit ratio is provided in Deaton (1989, 1997).

[6] Rainfall for the crop year corresponding to Tanzania 1991-92 and 1992-93 samples is 1,061 mm and 996 mm respectively. Maize yields are 1,380 Hg/ha and 1,214 Hg/ha for the 1991-92 and 1992-93 samples. Cassava yields for the 1991-92 and 1992-93 samples are 12,774 Hg/ha and 11,374 Hg/ha.

[7] Rainfall during the crop year corresponding to Vietnam 1992-93 and 1997-98 samples is 1,632 mm and 1,712 mm respectively. Coffee yields for 1992-93 and 1997-98 are 1,733 Hg/ha and 1,982 Hg/ha. Rice yields for 1992-93 and 1997-98 are 3,224 and 3,823.