No 2014-20 – December

Working Paper

CEPII

Agricultural Supply Chains and Farmers Constraints: Welfare Impacts in ECOWAS countries

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Highlights

- The effect of more competition on farm gate prices depends on the initial level of competition in that country and crop. For many crops, in particular food crops, there is already a lot of competition and further changes in the level of competition will not affect farm gate prices much.

- In some other specific cases, in particular in cash crops and livestock, the initial level of competition is low and more competition is likely to have larger impact on producer prices.

- In terms of the effect of complementary policy and other factors affecting the allocation decision of farmers, the largest impacts often come from an increase of international price where we often find a pass-through that is higher to one and from changes in the transaction cost on the production of the crop that increases the farm gate price in equilibrium.

- Complementarities between shocks to the structure of competition among exporters and shocks to household constraints need to be taken seriously in the design of agricultural policies.

Abstract

We study the interplay between market structure and other domestic factors that affect the production and consumption decisions of agricultural families in Africa. We are interested in modeling the production allocation of factors of production to various cash and food crops and in how this allocation depends on competition along the supply chain and on the constraints faced by different types of farmers. The model describes the behavior of farms, exporters and importers in a simple partial equilibrium setting. In particular, we build three different versions of the model to deal with the three basic scenarios that we face in our empirical work. That is, we build a model to explore the case of cash crop production (mostly for exports). We then adapt this model to deal with the case of a country that is a net exporter of a food crop. Finally, we develop a different version of the model for the case of a country that is a net importer of a food crop. We study changes in market structure and in key parameters of the model that capture various household constraints and institutional access. We analyze the changes in real income of household caused by the hypothetical price changes of cash and food crops predicted by the models' simulations in Burkina Faso, Ghana, Nigeria and Senegal.

Keywords

Supply chains, Food crops, Cash crops, Market Structure.

JEL

Q12, Q13.

Working Paper

CEPII

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CEPII Working Paper
Contributing to research in international economics

Editorial Director:
Sébastien Jean

Production:
Laure Boivin

No ISSN: 1293-2574

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Agricultural Supply Chains and Farmers Constraints: Welfare Impacts in ECOWAS countries[1]

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1. Introduction

In Africa, rural poverty is a widespread phenomenon. The countries that historically managed to pull out of poverty are those that have been successful in diversifying their economies away from agriculture and other natural resource based activities. The earlier development literature has emphasized the role of agriculture as a facilitator of growth and diversification. A productive agricultural sector can provide non-expensive food and raw materials to start a process of industrialization. However, in Africa, the agriculture sector has so far failed to become an engine of growth and economic transformation for most countries in the continent. This failure has led many stakeholders to advocate a radical change in the growth strategy of Sub-Saharan Africa and to suggest that countries in the region should import food and shift their focus away of the agriculture sector.

This recent debate has to be clearly assessed, however. Agriculture mostly comprises tradable commodities. In Africa, international market conditions combine with domestic market configurations in shaping agriculture growth and poverty reduction. The levels of productivity in agriculture in most African countries are on the order of one third of those enjoyed by small-holders in Asia. Part of the problem lies in the market structures and in the poor institutions, policies, and infrastructure serving the agriculture sector. Often, the commercialization of the agriculture output is produced along a value chain where intermediaries, exporters, and downstream producers interact with farmers. While in Africa the farming sector is composed mostly of atomistic smallholders, the lower-layers of the value chains are usually dominated by a small number of firms. Farmers may suffer from the non-competitive behavior of other agents along the chain, or be constrained from selling output in markets because transport and other services are not available or are too costly.

While most farmers in Sub Saharan Africa produce food crops for home consumption, some are engaged in high-value export agriculture like tobacco, coffee, cocoa, cotton or tea. Cash crops are a major source of export revenue for a large number of Sub-Saharan African countries and the livelihood basis for millions of rural households growing those crops. Given their potential key role in development and as a vehicle for poverty reduction, it is not surprising that the policy debate has focused on how to promote the production of these crops, how to create the enabling conditions for

[1] This work was supported by DFID funds under the Support to West Africa Regional Integration Program (SWARIP) window of the Multi Donor Trust Fund for Trade and Development phase II supported by Finland, Norway, Sweden, and the United Kingdom. The views expressed here are the authors' and do not necessarily reflect those of the World Bank, their Executive Directors, or the countries they represent or those of DFID. All errors are our responsibility.

smallholders to benefit from the opportunities created by commercial agriculture, and what role should governments play in this process. On the other hand, food crops like maize, rice, millet, sorghum, and soybean are essential for the everyday life of most African farmers as they constitute their dietary base. Growing protests against high food prices in different parts of the developing world, including in Burkina Faso, Cameroon, Cote d'Ivoire, Mauritania, Mozambique, and Senegal have elevated food security as one of the top issues in the international agenda (Conceição and Mendoza, 2009). The food import bill of the world's poorest countries, most of them in Sub Sahara Africa, has considerably increased in recent years, threatening to erase much of the gains in poverty reduction that have been achieved in the last decade. Like in the case of cash crops, food products are also commercialized along a supply chain that includes farmers, silo owners, intermediaries and food processors. In this setting, the structure of the domestic supply chains in staple products affects domestic food prices, agricultural income at the farm level, expenditures, and poverty. Our overall objective is to study market and institutional constraints affecting the further development of the traditional agriculture export sector (cash crops) and the import-substitution agriculture sector (food crops), how this affect poverty and inequality reduction, food security issues, and the development of a competitive agribusiness sector in Africa.

Traditionally, the literature has focused on how external conditions affect poverty (Winters, McCulloch, and McKay, 2004; Goldberg and Pavcnik, 2004; Goldberg and Pavcnik, 2007; Nicita, 2009; Porto, 2010a; Porto 2010b). In contrast, the focus of our research agenda breaks new ground by exploring domestic factors and the interplay with international markets. To this end, we elaborate on the work done by Porto, Depetris Chauvin, and Olarreaga (2011) to further explore the role played by the structure of domestic competition in agricultural supply chains. Combining theory, household surveys, and in-depth knowledge of the local context, we use simulation analysis to isolate and quantify the effect of changes in the level of competition in domestic markets, both in food crops and in export crops, on household income. In this setting, we will also investigate the role played by household constraints and institutions in agriculture that hinder productivity and market access. The emphasis on the quality of institutions in the development process has recently emerged. Acemoglu, Johnson and Robinson (2001, 2002) and Acemoglu and Johnson (2005), for instance, establish causality from better large-scale institutions (like legal and political regimes) to development. Dollar and Kraay (2003), in turn, study how (domestic) institutions affect trade and growth. There is yet another literature that explores how, in low-income countries and especially in rural economies where market failures abound, small local institutions can play a fundamental role as bridges towards economic development and poverty alleviation. Examples that are close to our intended work include Anderson and Baland (2002) and Besley, Coate, and Loury (1993), on ROSCAs; Garg and Collier (2005), on safety nets and employment; Kranton (1996), on cooperatives; Besley (1995), on risk insurance; Banerjee, Gertler, and Ghatak (2002) on tenancy reform.

In this paper, we present results for four ECOWAS countries, namely Burkina Faso, Ghana, Nigeria and Senegal. We begin in Section 2 introducing the model of supply chains. In this model, farmers must decide what to consume and what to produce, given prices and various constraints such as endowments, transport costs, production costs and infrastructure access. In the case of exported cash crops, farmers sell products to oligopsonies, which then do the international trading. In the case of exported food crops, there are oligopsonies in charge of exports, but there is also a domestic residual market of net-consumers of that crop. Finally, in the case of imported foodstuff, excess demand is met via international trade, and net-consumers must purchase these agricultural goods from oligopolies. In Section 3, 4, 5 and 6 we review the household survey data, we describe the basic institutional arrangements in the selected crops, and we present the results of the simulations and the welfare impact for Burkina Faso, Ghana, Nigeria and Senegal. These simulations are comparative static results from the model in section 2, where we study changes in market structure and in key parameters of the model that capture various household constraints and institutional access. We also present here some poverty results stemming from the simulations by combining the prediction of the model with the information from the household surveys. In particular, we analyze the changes in real income of Burkinabè, Ghanaian, Nigerian and Senegalese households caused by the hypothetical price changes of cash and food crops predicted by the models' simulations. In section 7 we conclude.

2. The Model

In this section, we introduce the model used to study the interplay between market structure and domestic complementary factors in the production and consumption decisions of agricultural families (farms) in Africa. We are interested in modeling the production allocation of factors of production to various cash and food crops and in how this allocation depends on competition along the supply chain and on the constraints faced by different types of farmers. The model describes the behavior of farms, exporters and importers in a simple partial equilibrium setting. In particular, we build three different versions of the model to deal with the three basic scenarios that we face in our empirical work. That is, we build a model to explore the case of cash crop production (mostly for exports) in section 2.1. This version can be used to study crops such as cotton, coffee, tea, tobacco, cacao, vanilla, etc. We adapt this model to deal with the case of a country that is a net exporter of a food crop in section 2.2. Food crop exports can include any relevant crop in a particular country, namely maize, rice, fish, livestock, etc. Finally, we develop a different version of the model for the case of a country that is a net importer of a food crop (section 2.3). The three versions of the model share common elements, such as the structure of utility, the constraints in production, and the market structure, but differ in the way the models are solved to account for exportable and importable prices.

2.1. Cash Crop Exports

Farmers

Consider an economy with a continuum of farmers i, with measure L. Each farmer possesses an endowment e_i of factors of production. It is useful to think about this endowment as a summary indicator of possibly various factors such as land, labor, and capital. Farmers can transform this endowment one-to-one into three different products: a food crop for auto-consumption (h); a food crop to sell in the market (f); a cash, export crop to be traded with other countries (c).

Food crops can be exchanged in the market at price p^f, which is determined endogenously given total supply and demand. The farmer, though, takes this price as given. Export crops are traded internationally but the farmers cannot export or import goods directly. They instead sell to intermediaries who, after some processing, sell abroad at fixed international prices. The cash crop farm gate price is p^c. We also allow for the presence of transport and transaction costs t_i which may capture lack of access or distance to the market. Farmers earn monetary income d_i from these sales.

Farmer´s utility is defined as

$$U_i = \vartheta_i h_i^{\alpha} + d_i,$$

where $\vartheta_i$represents the relative preference of farmer i to produce for the market, after controlling for its endowment, market accessibility and fixed cost to produce crops. This parameter reflects family traditions, including specific knowledge transferred over generations. Importantly, we use it to model different attitudes toward risk and food security. For instance, a farmer may value the own production of food to sustain family needs more than another farmer with similar characteristics. Parameter α measures the decreasing marginal utility of own-food consumption. Farmer´s monetary income is d_i, which is equal to

$$d_i = (1 - t_i)\left(p^f - m^f\right) * f_i + (1 - t_i)(p^c - m^c) * c_i - F_i,$$

where $m^f$and m^c are the marginal (unit) costs[2] of producing food crops and export crops respectively, and F_i is the fixed cost of producing crops for export. Note that while the marginal costs are common to all farmers, fixed cost may vary. Differences in fixed costs arise because of differences in setup costs due to various farm constraints and market access constraints, such as missing credit markets, missing input markets, know-how, scale, etc. These factors create a fixed cost of investment in cash-crop and these costs can vary widely across farmers. To simplify, we assume that marginal costs are instead the same for all farmers. This can be rationalized if farmers use (potentially) the same technology. In principle, the model can accommodate heterogeneity in marginal costs as well as in fixed costs. Given the fixed costs, we assume throughout the analysis that $(p^c - m^c) > \left(p^f - m^f\right)$ so that it may be eventually profitable to produce c. In other words, per unit sold, a farmer earns more

[2] In our model we do not model agricultural inputs explicitly. However, an improvement in the trading conditions of inputs can be modeled as a reduction in the marginal costs of producing a given crop.

money with the cash crop than with the food crop. Only a fraction of those farmers, however, will earn enough to cover the fixed costs. Note also that, given the linear technology implied by the constant marginal costs, a farmer will not produce tradable food crops and export crops at the same time. If cash export crops are more profitable, the farmer will allocate all his endowment (net of self-sufficiency requirements) to this crop (and vice versa).

The farmer solves the following optimization problem:

$$\text{Max}\, u_i(h, d),$$

subject to

$$d_i = (1 - t_i)\left(p^f - m^f\right) * f_i + (1 - t_i)(p^c - m^c) * c_i - F_i,$$

$$e_i = h_i + f_i + c_i.$$

Farmers maximize utility with respect to h_i, f_i and c_i. The optimal production of self-sufficient food h when compared to food sales production f is:

$$\bar{h}_{1i} = \left(\frac{\alpha\vartheta_i}{(p^f - m^f) * (1 - t_i)}\right)^{1/1-\alpha}.$$

Instead, optimal h when compared with cash crop production c is:

$$\bar{h}_{2i} = \left(\frac{\alpha\vartheta_i}{(p^c - m^c) * (1 - t_i)}\right)^{1/1-\alpha}.$$

Note that $\bar{h}_2 < \bar{h}_1$ by definition since $(p^c - m^c) > \left(p^f - m^f\right)$. The existence of a fixed cost for producing c implies that total cash crop profits should be higher than both specialization in *h* and production of *h* and *f* in the optimum.

The cutoff value of the fixed cost *F* that would make a farmer indifferent between producing $\bar{h}_{1i}$ of h and $\left(e_i - \bar{h}_{1i}\right)$of f and $\bar{h}_{2i}$ of h and the rest $\left(e_i - \bar{h}_{2i}\right)$of c is

$$\bar{F}_{1i} = \vartheta_i \bar{h}_{2i}^{\alpha} + (1 - t_i)(p^c - m^c) * \left(e - \bar{h}_{2i}\right) - \vartheta_i \bar{h}_{1i}^{\alpha} + (1 - t_i)\left(p^f - m^f\right) * \left(e_i - \bar{h}_{1i}\right).$$

The value of the fixed cost that would make the farmers indifferent between producing only *h* and $\bar{h}_{2i}$ of h and the rest $\left(e_i - \bar{h}_{2i}\right)$of c is

$$\bar{F}_{2i} = \vartheta_i \bar{h}_{2i}^{\alpha} + (1 - t_i)(p^c - m^c) * \left(e_i - \bar{h}_{2i}\right) - \vartheta_i e^{\alpha}.$$

Given these conditions, it is easy to determine conditions that are consistent with different kinds of production decisions/allocations:

1. If $e_i < \bar{h}_{1i}$ and $e < \bar{h}_{2i}$, the farmer produces $h_i = e_i$.

2. If $e_i < \bar{h}_{1i}$, $e_i > \bar{h}_{2i}$, and $F_i > \bar{F}_{2i}$, the farmer will produce $h_i = e_i$.

3. If $e_i < \bar{h}_{1i}$, $e_i > \bar{h}_{2i}$, and $F_i < \bar{F}_{2i}$, the farmer will produce$c_i = e_i - \bar{h}_{2i}$ and $h_i = \bar{h}_{2i}$.

4. If $e_i > \bar{h}_{1i}$ and $F_i < \bar{F}_{1i}$, the farmer will produce $c_i = e_i - \bar{h}_{2i}$ and $h_i = \bar{h}_{2i}$.

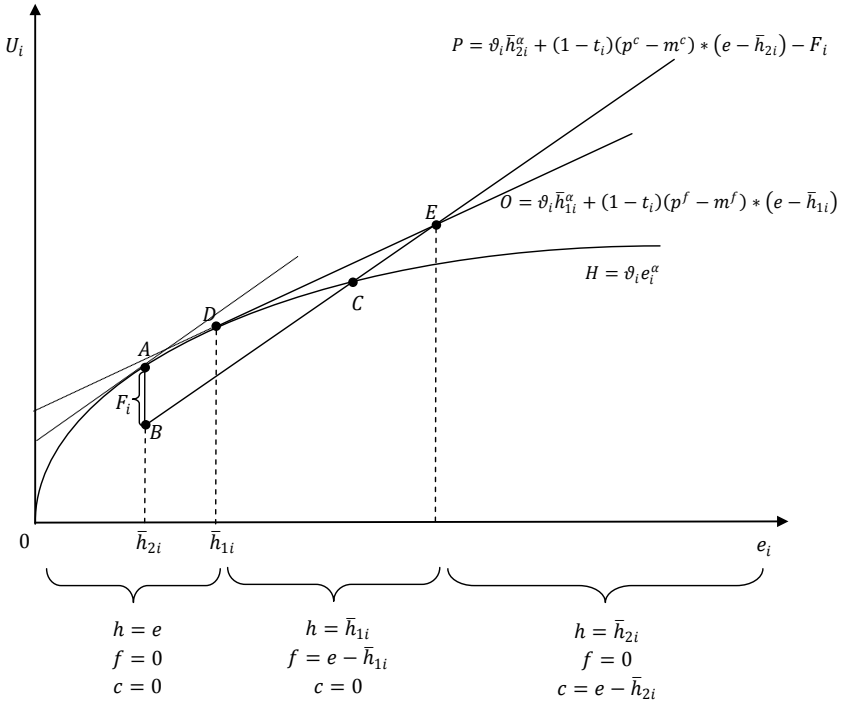
5. If $e_i > \bar{h}_{1i}$ and $F_i > \bar{F}_{1i}$, the farmer will produce $f_i = e_i - \bar{h}_{1i}$ and $h_i = \bar{h}_{1i}$.

These allocations imply the existence of essentially three types of farmers. Some farmers produce only for auto-consumption. These are farmers with very low endowments. For example, a large family leaving in a farm with little land can only produce some food for self-sufficiency purposes. Other farmers produce some auto-consumption for self-sufficiency and some tradable food crops to sell in the market. This may be surplus food to exchange for money or a different marketable crop. For instance, h may capture a variety of own-consumption crops such as potatoes, peas, onions, and white maize, while f may capture hybrid maize sold locally. Finally, a third group of farmers produces for auto-consumption and for the export market. This would be the case of a famer that produces, again, potatoes, peas, and perhaps some white maize, but also allocates inputs to cotton, coffee, cacao, tobacco, vanilla, or other similar tradable cash crops (non-food). In this later case, the farmer' endowment must be larger than the threshold ($\bar{h}_2$) so as to have enough production to compensate for the fixed costs incurred to access the export market.

We represent the optimal decision of the farmer based on its endowment in Figure 2.1.

The farmer chooses the allocation with the highest utility, which depends on several factors. To illustrate, we keep all parameters and factors in the background and focus on the impact of endowments. The curve H corresponds to the increase in farmer´s i utility if he produces only h, the line P is the utility of producing h and c, and the curve O is the total utility of producing h and f.
Several observations arise from this graph. Firstly, the marginal utility of h is decreasing, while those of c and f are constant. The intuition behind this is that the law of diminishing marginal utility is stronger for a specific product such as self-sufficiency food than for money in general. In the graph, this means that the marginal utility of producing h is equal to that of producing c and f in points A and D respectively, but it is lower for higher endowments. Points A and D correspond to the endowment thresholds algebraically determined earlier: $\bar{h}_{2i}$and $\bar{h}_{1i}$. Secondly, if the farmer were to decide to produce c, with endowment $\bar{h}_{2i}$ his/her utility would fall by F_i, which is the fixed cost introduced before. However, from that endowment level onwards, his/her utility increases more than by using the endowment to produce *f*, increasing by $(1 - t_i)(p^c - m^c)$. This will lead eventually to a point in which the farmer will be indifferent between producing *c* or *f*, point C in the diagram.

Figure2.1: Optimal Allocations

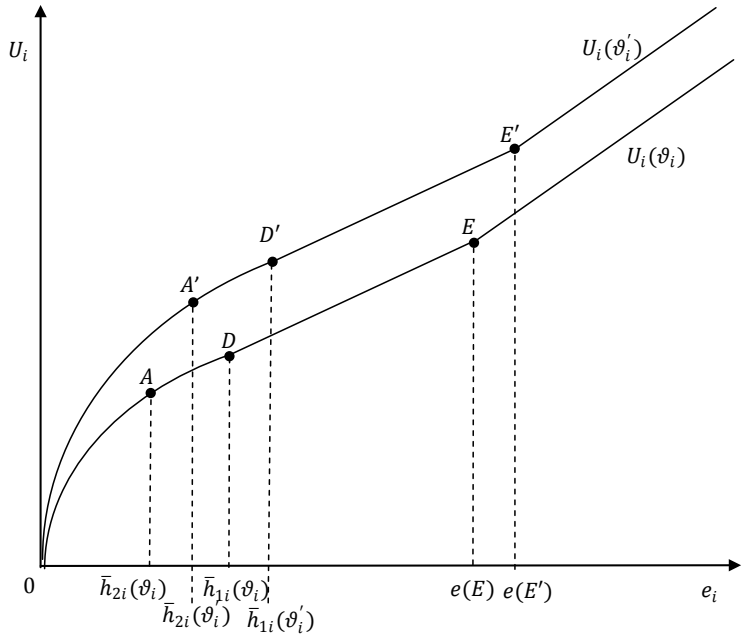


But the farmer has another option as well: to produce food crop to be sold locally, *f*. Since selling in the local market has no fixed costs, when the marginal utility of producing *f* is equal to that of producing *h*, the household starts producing some *f*. That point corresponds to endowment level $\bar{h}_{1i}$ and point D. From point D up to point E the farmer will produce $e - \bar{h}_{1i}$units of *f*. Point E represents the point in which the higher price the farmer receives for exporting the good compensates the fixed costs the farmer must incur to sell in that market, compared to selling in the local market. After point E, the farmer stops producing *f* and switches to *c* , producing $e - \bar{h}_{2i}$ of it.

To recapitulate, the relevant farmer's i utility is represented in the graph by $ODEG$, and its value, as well as his decision of what to produce, will depend on the endowment e_i at his disposal. As argued above, several factors affect the farmer's decision for a given e_i. Next, we explore graphically the effects of a change in the main parameters of the model.

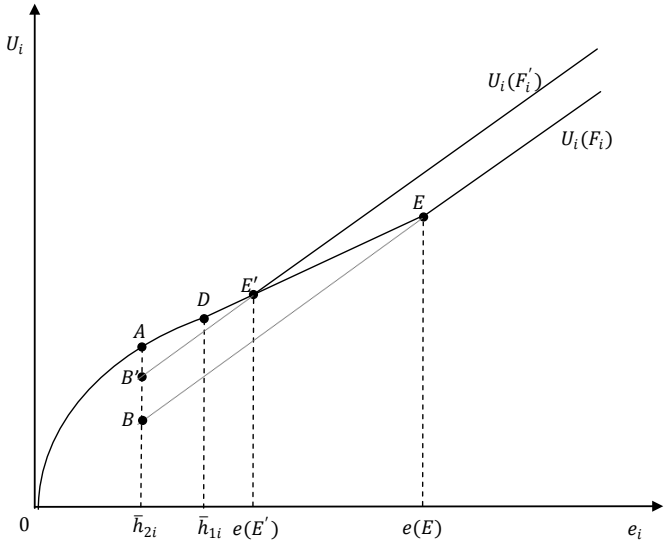
The parameter ϑ_i accounts for the household´s preference to auto-consumption. A larger ϑ_i will increase the marginal utility of producing h for each e, therefore increasing the values of $\bar{h}_{1i}$ and $\bar{h}_{2i}$, as is shown in Figure 2.2. Farmers that were originally producing f can switch to h if their endowment is between the points $D$and $D´$, and some farmers with endowment between E and $E´$ will switch from producing some c to produce some f. In the end, farmers originally producing f or c will increase h. In addition, farmers producing *c* will further switch to *f* and thus reduce their production of $c$in $\bar{h}_{2i}(\vartheta´_i) - \bar{h}_{2i}(\vartheta_i)$. In the end, the market supply of c will surely by reduced. The supply of f could either increase or decrease depending on whether or not the farmers switching from form c to f offset the switchers from f to h and the lower f production between $D´$ and E.

Figure 2.2: An increase in ϑ_i(from $\vartheta_i$to ϑ'_i)



We now analyze the effects of the change in *F* in Figure 2.3. A smaller F_i will reduce the gap AB to AB', affecting the decisions of the farmers with e between E' and E. These farmers will switch from f to h, and they will also reduce h in the amount $\bar{h}_{1i} - \bar{h}_{2i}$. Therefore, lower fixed costs imply a reduction in the total market supply of f and in the production of h, and an increase in the market supply of c. Note that it could be possible to find a F_i small enough so that the farmer will not produce f for any value of e_i. This makes sense: given that $(p^c - m^c) > \left(p^f - m^f\right)$, if F_i is low enough, farmers may not produce f at all.

Figure 2.3: A Reduction in Fixed Costs F_i (from $F_i$to F'_i)



Lastly, we analyze the impacts of changes in the values of t_i and the prices p^c and p^f in Figures 2.4 and 2.5. These parameters affect the slope of the curves P and O and, consequently, determine the endowment thresholds $\bar{h}_{1i}$ and $\bar{h}_{2i}$, and the points in with the curves H, P and O intercept each other. The effect of an increase in p^c is presented in Figure 4.4. When the price of c increases from p_0^c to p_1^c it changes the thresholds $\bar{h}_{2i}$to $\bar{h}'_{2i}$ and $\bar{F}_{2i}$to $\bar{F}'_{2i}$, which implicitly determine point E, shifting it to E'. The switch leads to more production of *f* for those farmers that were already producing it ($e > e(E)$) by the amount $\bar{h}'_{2i} - \bar{h}_{2i}$. There will also be switchers, farmers that will adopt the cash exports crops. This is capture by the switch from f to c, when e_i is between $e(E')$ and $e(E)$. These farmers were producing $e_i - \bar{h}_{1i}$ of f and now produce $e_i - \bar{h}'_{2i}$ of c. As expected, thus, an increase in p^c increases the market supply of c.

As shown in Figure 2.5, an increase in the price of p^f from p_0^f to p_1^f will have opposite effects. Now, point D moves to D' and EtoE'. Those farmers between D and D' will switch from h to f, and those between E and E', from c to f. Farmers already producing f will increase their production by $\bar{h}_{1i}(p_1^f)$ - $\bar{h}'_{1i}(p_0^f)$. The market supply of f is increasing in p^f.

Figure 2.4: An Increase in Cash Crop Price p^c(from $p_0^c$to p_1^c)

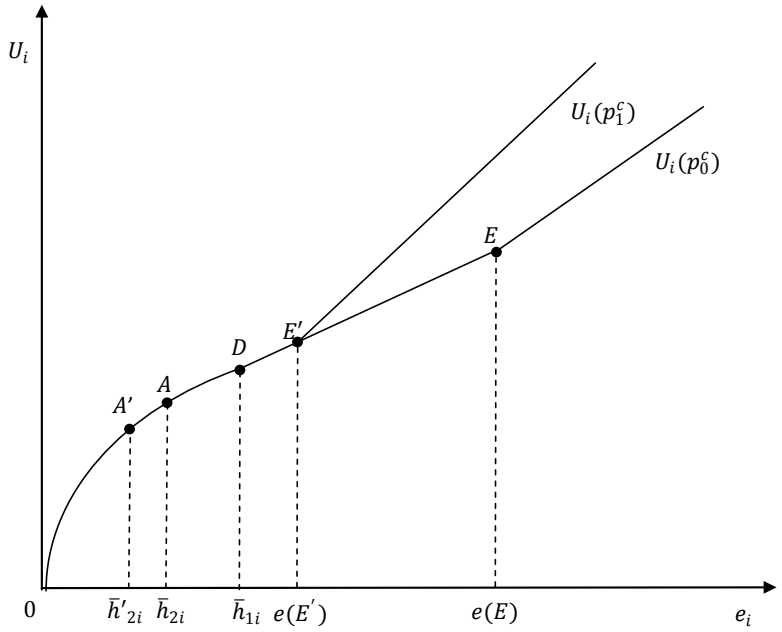
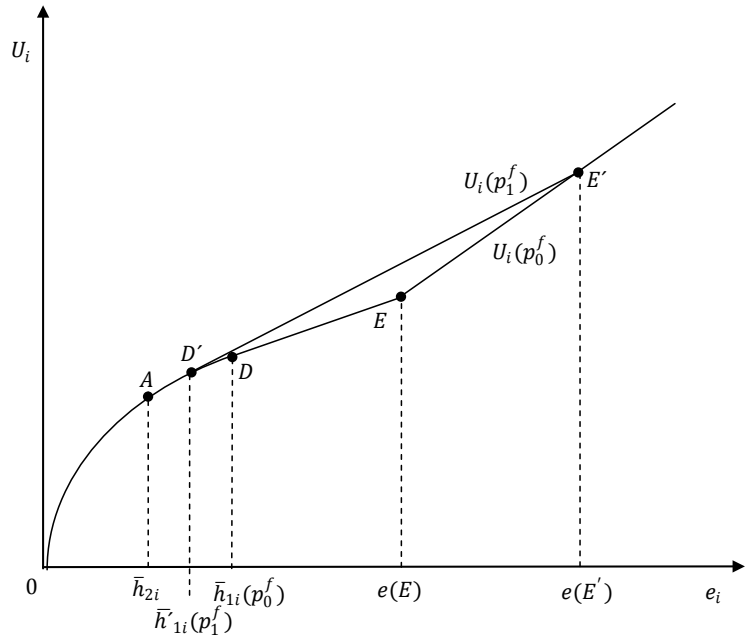


Figure 2.5: An Increase in Food Sales Prices p^f (from p_0^f to p_1^f)



The Farmer Supply of Cash Export Crop

The main purpose of the model is to allow us to derive the supply function of cash export crops. This function will later be combined with a demand for cash export crops to determine equilibrium prices.

To derive the supply, recall that farmers are heterogeneous in potentially many dimensions. We consider four sources of heterogeneity: endowments (e_i), preferences for auto-consumption (ϑ_i), accessibility to markets (t_i), and fixed costs of producing c (F_i). For each of these variables, the heterogeneity is captured by an inherent distribution function. We define $G(e, \vartheta, t, F)$ as the joint distribution of farmers over the different values of e, ϑ, t and F, without any specific functional form assumption (for the moment), with $\int dG(e, \vartheta, t, F) = L$. Using G, we can define $\Omega^{\mathrm{c}}(\mathrm{G}, \mathrm{p^c}, \mathrm{p^f})$, $\Omega^{\mathrm{f}}(\mathrm{G}, \mathrm{p^c}, \mathrm{p^f})$ and $\Omega^{\mathrm{h}}(\mathrm{G}, \mathrm{p^c}, \mathrm{p^f})$ as the farmers that produce crops for export, for the local food market and for auto consumption, respectively.

The supply of cash crop is equal to the sum of the production of all farmers that satisfy conditions 3 or 4 stated above ($e_i < \bar{h}_{1i}$, $e_i > \bar{h}_{2i}$, and $F_i < \bar{F}_{2i}$; $e_i > \bar{h}_{1i}$ and $F_i < \bar{F}_{1i}$):

$$S^c(p^c) = \int_{\Omega^{\mathrm{c}}(\mathrm{G},\mathrm{p^c})} \left(e - \bar{h}_{2i}(p^c)\right) \mathrm{dG}.$$

The supply of food is equal to the sum the farmers' productions who meet condition 5 ($e_i > \bar{h}_{1i}$ and $F_i > \bar{F}_{1i}$):

$$S^f\left(p^f\right) = \int_{\Omega^{\mathrm{f}}(\mathrm{G},\mathrm{p^f})} \left(e - \bar{h}_{1i}\left(p^f\right)\right) \mathrm{dG}.$$

Note that

$$\frac{dS^c(p^c)}{d\Omega^c}, \frac{\partial \Omega^c}{\partial p^c}; \ \frac{\partial \bar{h}_2}{\partial p^c}, \frac{dS^c(p^c)}{dp^c} \geq 0.$$

Similarly,

$$\frac{dS^f(p^f)}{d\Omega^f}, \frac{\partial \Omega^f}{\partial p^f}, \frac{\partial \bar{h}_1}{\partial p^f}, \frac{dS^f(p^f)}{dp^f} \geq 0.$$

The total production of *h* (denoted by *H*) is equal to

$$H(p^c, p^f) = \int_{\Omega^{\mathrm{h}}} e \, \mathrm{d\,G} + \int_{\Omega^{\mathrm{f}}} \bar{h}_{1i} \mathrm{d\,G} + \int_{\Omega^{\mathrm{c}}} \bar{h}_{2i} \mathrm{d\,G}.$$

It is easy to see that

$$S^c(p^c) + S^f(p^f) + H(p^c, p^f) = \int e \, \mathrm{d\,G}.$$

Exporters

We now turn to the export sector. There are n exporters who sell the crop c at an international price P^c. It is convenient to think about these exporters as firms that do some processing to the farm product. This processing may not necessarily entail complex operations (such as producing high-quality chocolate from cacao). It can be drying coffee beans, cutting tobacco leaves, spinning cotton seeds, or packaging tea leaves or cocoa beans. Exporters buy from farmers at the internal market price of p^c. We assume they operate as Cournot oligopsonists. They choose how much quantity to demand from the market at the prevailing price p^c, and they understand and correctly anticipate that their own demand behavior affects p^c.

The problem faced by an exporter is then to maximize profits:

$$\pi(P^c, p^c, u_j^c) = \max_{c_j} (P^c - p^c - u_j^c).c_j,$$

where c_j and $u_j^c$are, respectively, the demanded quantity and the unit cost of production of exporter j of the good$c$. In principle, exporters may face different marginal costs and this determines the equilibrium market shares.

We look for the equilibrium for the exporters' oligopsony game. Exporters correctly understand and anticipate that the market price p^cdepends on their own actions, other exporters' actions, and aggregate supply behavior from farmers. Let$D^c \equiv \sum_{j=1}^{n} c_j$denote aggregate demand from exporters, then a given exporter faces the following problem:

$$\pi(c_{k \neq j}, P^c, u_j^c) = \max_{c_j} (P^c - p^c - u_j^c).c_j$$

$$s.t. \ D^c \ \equiv \ c_j + \sum\nolimits_{k \neq j} c_k$$

The state variables are the international price P^c, and other exporters' actions $c_{k\neq j}$. It can be shown that a sufficient condition for the problem to be concave is that the aggregate supply function $S^c(p^c)$ be concave as well, so that $S^{c\prime\prime}(p^c) < 0$. When the aggregate supply function is concave, the exporters' profit maximization problem will be concave in their choice variable. If the aggregate supply function is not concave, then the problem may not be concave as well. Of course, if the problem is concave then the first order condition $\frac{\partial \pi}{\partial c_j} = 0$ will be necessary and sufficient. Moreover, by the Maximum Theorem under convexity (Stokeyand Lucas, 1989; Sundaram, 1996), the function $c_j(D^{*c})$ is well defined and continuous.

We now turn to the first order conditions. With n exporters, we have

$$c_j^* = \left(P^c - p^c(S^c) - u_j^c\right)\frac{\partial p^c(S^c)}{\partial c},$$

$$D^{*c}(p^c) = \sum\nolimits_j c_j^*.$$

The equilibrium quantity and price for the export cash crop are determined by the equality of demand and supply, $S^c(p^c) = D^{*c}(p^c)$. The equilibrium is thus characterized by:

$$\int_{\Omega^{\mathrm{c}}(\mathrm{G},\mathrm{p}^{\mathrm{c}})} \left(e - \bar{h}_{2i}(p^c)\right) \mathrm{d\,G} = D^{*c}(p^c) = \left(nP^c - np^c(S^c) - \sum\nolimits_{j=1}^{n} u_j^c\right)\frac{\partial p^c(S^c)}{\partial c}.$$

2.2. Net Food Exports

Here, we adapt the model to study the case of a food crop that is exported by the country. The structure of the model is the same as before. Farmers can produce self-sufficiency food, food crops for sales, and export cash crops. There are intermediaries that buy food from these farmers and sell internationally. The intermediaries compete a-la-Cournot. The model is the same as before. The main difference is that we need to model the local demand for exported food. We begin recapitulating production choices and we then move to demand.

Production

In this model, the price of cash crops for exports is assumed to remain constant and we focus our attention on the determination of the price of food for sale (marketable food). Given a price for food sales, the farmer can sell his produce for domestic consumption or for exports. We assume arbitrage and price equalization. To determine equilibrium prices, we need the aggregate net farm supply of food to food exporters. Aggregate gross supply was derived in the previous section and it is given by:

$$S^f\left(p^f\right) = \int_{\Omega^{\mathrm{f}}(\mathrm{G},\mathrm{p}^{\mathrm{f}})} \left(e - \bar{h}_{1i}\left(p^f\right)\right) \mathrm{dG}.$$

Domestic Demand

Since we are working with the case of net food exports, we assume that rural consumers satisfy their own food demand with home food production and thus the rural aggregate supply is just the excess rural production over consumption (net of the resources allocated to the cash export crop). In other words, there is no net food demand in rural areas. This is a clearly a simplification but it allows us to succinctly represent the equilibrium in rural food markets.

Aggregate food demand is the sum of urban food demand and of rural food demand. These are slightly different. We begin with urban food demand. We model this as a standard utility maximization problem since we rule out the crop allocation decision. The utility function of the urban consumer i is Cobb-Douglas:

$$U_{ui} = f^{\beta} g^{1-\beta}.$$

Utility if maximized subject to the following budget constraint:

$$f p^{f} + g p^{g} = d_i \,,$$

where g stands for consumption of non-food stuff (goods) with price p^{g} and d_i is the income of urban households, which is unrelated to agricultural activities (as thus considered exogenous as in the standard utility maximization problem). Individual food demand is $\beta d_i / p^{f}$. Therefore, the urban demand of food is equal to

$$D_u^{f}\left(p^{f}\right) = \frac{\beta}{p^{f}} \int dM(d),$$

where $M(d)$ is the distribution function of income across the urban population.

To model the market food demand of rural consumers, note that the utility for rural households can be written as:

$$U_{ri} = \vartheta_i h_i^{\alpha} + f^{\beta} g^{1-\beta}.$$

In this formulation, we assume that food purchases are different from food own-consumption. This could be because these are totally different products (onions and peas in one case, tomatoes and sorghum in another, etc.) or because market foodstuffs comprise different varieties of food. This is clearly a simplification but it allows for a succinct and realistic representation of food markets. The optimum individual consumption of market food f for farmer i is $\beta \frac{d_i}{p^{f}}$. Recall that money *m* can take three values: $(1-t_i)\left(p^{f}-m^{f}\right) * f_i$, if the farmer produces food for sale; $(1 - tipc - mc * ci - Fi$, if the farmer produces cash crops; and *0,* if the farmer only produces auto-consumption. Thus, the aggregate demand for food in rural areas is:

$$D_r^{f}\left(p^{f}\right) = \frac{\beta}{p^{f}} \frac{\beta}{p^{f}} (1-t_i)\left(p^{f}-m^{f}\right) \int_{\Omega^{c}(\mathrm{G},\mathrm{p}^{c})} \left(e - \bar{h}_{2i}(p^{c})\right) \mathrm{dG} + \frac{\beta}{p^{f}} (1-t_i)\left(p^{f}-m^{f}\right) \int_{\Omega^{f}(\mathrm{G},\mathrm{p}^{f})} \left(e - \bar{h}_{1i}\left(p^{f}\right)\right) \mathrm{dG}.$$

Note that farmers producing market staples sell their product in the market at price p^f, and then buy a fraction β at the same price. In our empirical analysis, we will not refer to this process as auto-consumption. This is because our data actually mask heterogeneous goods: the goods the farmers buy are not the same they sell in reality, even if they fit the same category in our taxonomy. Production for the market and consumption from the market with a net exchange of zero is qualitatively very different to auto consumption.

Net Aggregate Supply

At each p^f, there is an urban demand for food, a rural demand for food and an aggregate farm production of food. The gap between demand and supply can be positive or negative, and the difference is absorbed by the external market. If demand is larger than supply, the country is a net importer of a good. Instead, if supply is larger than demand the country is a net exporter of it.

In both cases, net aggregate supply can be defined as

$$NS^f = S^f - D_u^f - D_r^f,$$

so that

$$NS^f(p^f) = \left(1 - \frac{\beta}{p^f}(1-t_i)(p^f - m^f)\right)\int_{\Omega^{\mathrm{f}}(\mathrm{G},\mathrm{p}^{\mathrm{f}})}\left(e - \bar{h}_{1i}(p^f)\right)\mathrm{dG} - \frac{\beta}{p^f}(1-t_i)(p^c - m^c)\int_{\Omega^{\mathrm{c}}(\mathrm{G},\mathrm{p}^{\mathrm{c}})}\left(e - \bar{h}_{2i}(p^c)\right)\mathrm{dG} - \frac{\beta}{p^f}\int dM(d).$$

It is clear that $\frac{\partial NS^f}{\partial p^f} > 0$, since $\frac{\partial D_u^f}{\partial p^f} < 0$, $\frac{\partial D_r^f}{\partial p^f} < 0$ and $\frac{\partial S^f}{\partial p^f} > 0$.

In the case of net food exports, we have that $NS^f(p^f) > 0$. The country produces more than it consumes and the excess production is exported. This is done by intermediaries, who buy excess food from farmers and are in charge of the commercialization aboard (and in urban areas). These intermediaries may behave as an oligopoly (as in the case of cash exports). To simplify the reading and the description of the model, we reproduce below the main features of the oligopolistic game.

As before, there are n exporters who sell marketable food f at a fixed international price P^f. They buy from farmers at the internal market price p^f. The oligopoly game is Cournot. Firms (exporters) choose how much quantity to demand from the market at the prevailing price p^f, and they understand and correctly anticipate that their own demand behavior affects p^f.

The problem faced by a food exporter is to maximize profits:

$$\Pi\left(P^f, p^f, u_j^f\right) = \max_{f_j}\left(P^f - p^f - u_j^f\right).f_j$$

where $f_j$is the quantity of food demanded by exporter j, and u_j^f is the unit cost of production of this exporter (representing, for instance, packaging or processing costs). In principle, exporters may face different marginal costs and this determines the equilibrium market shares. Let $D^{*f} \equiv \sum_{j=1}^{n} f_j$denote the aggregate food demand from the exporters. A given exporter solves the following problem:

$$\Pi\left(f_{k\neq j}, P^f, u_j^f\right) = \max_{f_j}\left(P^f - p^f - u_j^f\right).f_j$$

$$s.t.\ D^{*f} \equiv f_j + \sum\nolimits_{k\neq j} f_k$$

The state variables are the international price P^f, and other exporters' actions $f_{k\neq j}$. It can be shown that a sufficient condition for the problem to be concave is that the aggregate **net** supply function $NS^f(p^f)$ be concave as well, so that $NS^{f\,''}\left(p^f\right) < 0$. If the problem is concave then the first order condition $\frac{\partial \pi}{\partial f_j} = 0$ will be necessary and sufficient. Moreover, by the Maximum Theorem under convexity (Stokey and Lucas, 1989; Sundaram, 1996), the function $f_j(D^f)$ is well defined and continuous.

We now turn to the first order conditions. With n exporters, we have

$$f_j = \left(P^f - p^f\left(S^f\right) - u_j^f\right)\frac{\partial p^f\left(S^f\right)}{\partial f}$$

$$\Rightarrow D^{*f}(p^f) = \left(nP^f - np^f\left(S^f\right) - \sum\nolimits_{j=1}^{n} u_j^f\right)\frac{\partial p^f\left(S^f\right)}{\partial f}$$

The equilibrium price is determined by the equality of the exporters demand and the farmers net supply of food, $NS^f\left(p^f\right) = D^{*f}(p^f)$.

2.3. Net Food Imports

The model is the same as in Section 2.2. The only difference is that in the case of food imports, demand is greater than supply, $D_u^f + D_r^f > S^f$. There is an excess food demand which is satisfied with food imports from abroad.

Production and Domestic Demand

Total food supply is, as before, given by:

$$S^f\left(p^f\right) = \int_{\Omega^f(G,p^f)} \left(e - \bar{h}_{1i}\left(p^f\right)\right) \mathrm{dG}.$$

In turn, urban demand and rural food demands are given by:

$$D_u^f\left(p^f\right) = \frac{\beta}{p^f}\int dG(d)\,;$$

$$D_r^f(p^f) = \frac{\beta}{p^f}(1-t_i)(p^c - m^c)\int_{\Omega^c(G,p^c)}\left(e - \bar{h}_{2i}(p^c)\right)\mathrm{dG} + \frac{\beta}{p^f}(1-t_i)\left(p^f - m^f\right)\int_{\Omega^f(G,p^f)}\left(e - \bar{h}_{1i}(p^f)\right)\mathrm{dG}.$$

Net demand is defined as

$$ND^f = D_u^f + D_r^f - S^f$$

$$ND^f(p^f) = \frac{\beta}{p^f}\int dM + \frac{\beta}{p^f}(1-t_i)(p^c - m^c)\int_{\Omega^c(G,p^c)}\left(e - \bar{h}_{2i}(p^c)\right)\mathrm{dG} - \left(1 - \frac{\beta}{p^f}(1-t_i)\left(p^f - m^f\right)\right)\int_{\Omega^f(G,p^f)}\left(e - \bar{h}_{1i}(p^f)\right)\mathrm{dG}.$$

It is clear that $\frac{\partial ND^f}{\partial p^f} < 0$, since $\frac{\partial D_u^f}{\partial p^f} < 0$, $\frac{\partial D_r^f}{\partial p^f} < 0$ and $\frac{\partial S^f}{\partial p^f} > 0$.

As we mentioned above, in this model the country demands more food than it produces. The difference is covered with imports. Imports are brought into the country by intermediaries who buy internationally and sell locally in a potential setting of imperfect competition.

To model this, as before, we assume that there are n importers who buy the food f at an international price P^f. They sell to domestic farmers and urban households at an internal market price p^f. These are Cournot oligopolists. The problem faced by an importer is then to maximize revenues:

$$\Pi\left(p^f, P^f, u_j^f\right) = \max_{f_j}\left(p^f - P^f - u_j^f\right).f_j$$

Where f_j is the quantity of food sold by importer j and u_j^f is the unit cost of production (e.g., packaging, distribution, etc.). In principle, importers may face different marginal costs and this determines the equilibrium market shares. Let $S^f \equiv \sum_{j=1}^n f_j$ denote aggregate supply from importers. A given importer solves:

$$\Pi\left(f_{k\neq j}, P^f, u_j^f\right) = \max_{f_j}\left(p^f - P^f - u_j^f\right).f_j$$

$$s.t.\ S^f \equiv f_j + \sum\nolimits_{k\neq j} f_k$$

With n importers, the first order conditions are:

$$f_j = \left(p^f\left(ND^f\right) - P^f - u_j^f\right)\frac{\partial p^f\left(ND^f\right)}{\partial f}$$

$$\Rightarrow S^f(p^f) = \left(n\,p^f\left(ND^f\right) - nP^f - \sum\nolimits_{j=1}^n u_j^f\right)\frac{\partial p^f\left(ND^f\right)}{\partial f}$$

In equilibrium,

$$S^f(p^f) = ND^f(p^f).$$

2.4. The Solution

The model presented here must be solved numerically. Once a solution is obtained, the equilibrium can be shocked to generate comparative static results that we use in the below in the welfare analysis. In this section, we explain how we calibrate the main parameters of the model and we describe the algorithm used to solve it. As an illustration, we work with the net food export model of section 2.2.

Farmers choose a production allocation and a food demand bundle. Urban households also choose how much to consume of food. There are *n* Cournot oligopsonist firms that buy food crops from the farmers and sell the surplus in the international market. As we stated before, we need to find the equilibrium where the net domestic supply of food equals the companies' demand: $NS^f(p^f) = D^{*f}(p^f)$.

The first step in the solution of the model is to numerically simulate the allocations of a large number of farmers, based on common and heterogeneous characteristics. The parameters that are common to all farmers are: $\alpha_r; \alpha_u; m^f; m^c; p^c; P^f$. The share of food consumed in urban and rural areas is retrieved from the household surveys. Using data from exports and imports, we calculate export and import quantities as well as measure of exports and import prices. These are combined with the information documented in section 2 to calculate the ratio of domestic prices to the international price of cash crops. Note that in the case of the net food exporter model of section 2.2 and of the net food imported model of section 2.3, we consider p^cas a fixed parameter that is not affected by change in the market of f. In this sense, our results capture partial equilibrium effects. As it was also explained in section 2, the margin analysis of each crop allows us to compute measures of the price wedges (with respect to international prices) for food crops and thus measures of relative prices.

The heterogeneous parameters that vary across farmers are the endowment (e_i), the transport cost (t_i), the fixed cost F_i and the preference for auto-consumption (ϑ_i). We also need to consider the incomes of urban households (d), used only to obtain the urban demand of f. Endowments in rural areas and income in urban areas are taken from the household surveys. Transport costs are inferred from supplementary information. The preference for autoconsumption is computed from the share of auto-consumption in total household expenditures. Fixed costs are arbitrarily set to the share of producers in the data.

With all these parameters, we can compute $\bar{h}_{1i}$,$\bar{h}_{2i}$,$\bar{F}_{1i}$, and $\bar{F}_{2i}$ for each p^f. These quantities are then used to determine self-sufficiency food consumption $h_i(p^f)$, market food demand $f_i(p^f)$ and cash crop production $c_i(p^f)$. Next, we calculate aggregate food supply $S^f(p^f)$ and the domestic demands $D_u^f(p^f)$and $D_r^f(p^f)$. Net supply ($NS^f(p^f)$) is equal to $S^f(p^f) - D_u^f(p^f) - D_r^f(p^f)$.

We now need to compute the total food demanded by the oligopsony enterprises j. We have information about the share that each firm has in the market, and we need to compute their marginal cost (u_j^f). For that purposes, we use export and import records to assess the total quantity demanded (D^{*f}) and we use this to solve for the original equilibrium price and the farmer marginal costs using $S^f(p^f) = D_u^f(p^f) + D_r^f(p^f) + D^{*f}$.

Then, we calculate the marginal cost of company j as

$$u_j^f = P^f - p^f(NS^f) - f_j \frac{\partial NS^f(p_0^f)}{\partial p^f}$$

Note that $\frac{\partial NS^f(p^f)}{\partial p^f(ND^f)}$ can be easily calculated since we have already estimated the aggregate net supply $NS^f(p^f)$. We do all this to calibrate the u_j^f compatible with the shares from data and the aggregate demand $D^{*f}(p^f)$.

Given the solution to the model, we can simulate the impacts, especially on prices, of changes in several parameters. This is done by solving the model under the changed parameter configuration to find a price p^f such as $S^f(p^f) = D_u^f(p^f) + D_r^f(p^f) + D^{*f}(p^f)$. As a result, we obtain the equilibrium quantities $h(p^f)$ and $c(p^f)$ produced by the farmers and the $f(p^f)$ consumed by rural and urban households.

The cash export model in section 2.1 is slightly different: we take the value of p^f as fixed and there is no need of estimate the domestic demands for f. We solve for the marginal costs of cash crop production based on the information on price ratios and on the solution of the equality of export supply and demand (given trade flows). Then, we calibrate the marginal cost of the n exporters using

$$u_j^c = P^c - p^c(S^c) - f_j \frac{\partial S^c(p_0^c)}{\partial p^c}$$

With all the calibrated parameters and with the solution to the model, we perform simulations by computing the new equilibrium from $S^c(p^c) = D^{*c}(p^c)$. For the food import demand model of section 2.3, we solve $S^f(p^f) + M = D_u^f(p^f) + D_r^f(p^f)$, or $M = ND^f(p^f)$ and the equation that calibrates the marginal cost of the importers is

$$u_j^f = p^f(ND^f) - P^f - f_j \frac{\partial ND^f(p_0^f)}{\partial p^f}$$

Finally, the results from the simulations follow from solving $S^f(p^f) + S^{*f}(p^f) = D_u^f(p^f) + D_r^f(p^f)$.

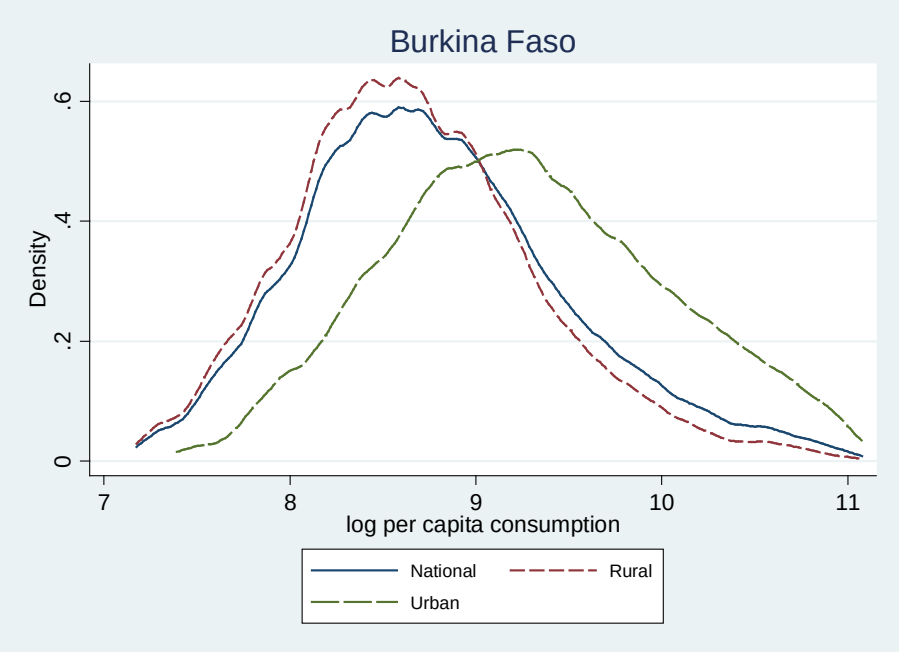
3. Welfare effects of domestic market structure and household constraints: The case of Burkina Faso

3.1. The Household Survey Data

The household data comes from the 2005 “Enquête annuelle sur les conditions de vie des ménages” of Burkina Faso. The dataset contains information on 8,500 households. Around one third of these households reside in urban areas and two-thirds in rural areas. As it is often the case in Africa, the Burkina population is young: 45.3 percent of the sample is less than 15 years old and over 96 percent is under 65 years old. There are slightly more females (51.1 percent) than males (48.9 percent). However, only 8.1 percent of the households are headed by females. On average, household size is 6.3 members per family. In turn, households in rural areas are bigger than in urban areas (6.6 versus 5.2 members per family respectively). Only 1.12 percent in the survey declares to be a wage earner, while 31.41 percent is self-employed, and 67.24 percent is a family worker. In our study, Burkina Faso is the country with the largest share of people declaring to be working in agriculture with 88.1 percent of the people in the survey.

Figure 3.1 shows the distribution of income. The graph shows the estimated density function of the logarithm of household per capita expenditure at the national level and for urban and rural regions separately. As expected, the density for urban areas lies to the right of the density for rural areas, thus indicating that urban households enjoy, on average, a higher level of expenditure per capita than the rural households. Since the rural sample is bigger, the national distribution of income lies close to the rural density.

Figure 3.1: The Distribution of Income
Density of (log) per capita household expenditure



Source: Burkina Faso Household Survey (2005).

We turn now to a description of sources of income and patterns of consumption across households. In Table 3.1, we report consumption patterns for urban and rural households. We report cash expenditures and the value of auto-consumption, as a share of total expenditures. As expected, the share of auto-consumption is much larger in rural areas than in urban areas. In fact, for urban households, 92.5 percent of their expenditure is cash spending. For rural households, cash expenditures account for 62.1 percent of the total budget, while home-produced expenditures account for the remaining 37.9 percent. Since we are interested in food consumption, we can take a close look at aggregate food expenditure, that is food cash expenditure and food auto-consumption. At the national level, 62.4 percent of the Burkinabé household budget is allocated to food. This share is larger for rural households (64.8 percent) than for urban households (51.3 percent). This observation fits with the idea that urban people are richer, who thus spend more on other goods and services than on food. Among food item, the most significant crop in consumption is sorghum. On average, sorghum represents 11.8 percent of Burkina's household expenditure (13.7 percent of rural expenditure and the 2.9 percent of urban expenditure). Millet accounts for 11.4 percent of the budget. Maize (4.3) and rice (4.4) are also important, with higher shares among urban households (7.7 vis-à-vis 3.7 percent in the case of rice). Livestock, in turn, accounts for 2.8 percent of expenditures, and this percentage is similar in rural and urban areas.

Table 3.1: Budget Shares

Burkina Faso	Total	Rural	Urban
Total consumption per capita	**100,0**	**100,0**	**100,0**
Expenditures	**67,5**	**62,1**	**92,5**
Food	35,0	32,8	45,2
Manufactures	15,5	13,9	23,3
Services	8,6	6,4	19,1
Others	8,3	9,0	4,9
Auto-consumption	**32,5**	**37,9**	**7,5**
Auto-consumption food	27,4	32,0	6,1
Auto-consumption others	5,1	5,9	1,4
Total Food consumption	**62,4**	**64,8**	**51,3**
Total crops	**38,4**	**41,2**	**25,2**
Maize	4,3	3,9	6,2
Rice	4,4	3,7	7,7
Poultry	1,6	1,8	0,7
Livestock	2,8	2,8	2,9
Sorghum	11,8	13,7	2,9
Millet	11,4	13,1	3,3
Cowpea	1,9	2,0	1,2
Yam	0,2	0,2	0,3
Cotton	0,0	0,0	0,0

Source: Burkina Faso Household Survey (2005).

In Table 3.2, we show different sources of income. As expected, rural households have lower shares of cash income (49.9 percent), because their gross income comes mostly from auto-consumption. On the other hand, urban cash income represents 79.6 percent of total income. Looking at agriculture income, livestock is the most important source of income. It represents 17.8 percent of rural household income and 4 percent of urban household income. Sorghum (14 percent) and millet (12.5 percent) are also relatively important sources of income in rural areas, but not so much in urban areas (3.2 and 3.3 percent respectively).

Table 3.2: Income Shares

Burkina Faso	Total	Rural	Urban
Total Income per capita	**100,0**	**100,0**	**100,0**
Incomes	**54,5**	**49,9**	**79,6**
Food (agriculture)	27,0	30,3	8,8
Wage	3,3	3,3	3,1
Enterprises	11,3	8,1	28,9
Transfers	12,9	8,2	38,8
Auto-consumption	**45,5**	**50,1**	**20,4**
Auto-consumption food	36,7	40,5	15,4
Auto-consumption others	8,8	9,5	5,0
Total Food income and AC	**63,7**	**70,9**	**24,2**
Total crops	**53,1**	**59,9**	**15,4**
Maize	4,2	4,5	2,2
Rice	1,3	1,4	0,6
Poultry	4,4	5,1	1,0
Livestock	15,7	17,8	4,0
Sorghum	12,3	14,0	3,2
Millet	11,1	12,5	3,3
Cowpea	2,4	2,7	0,8
Yam	0,2	0,3	0,1
Cotton	1,4	1,6	0,2

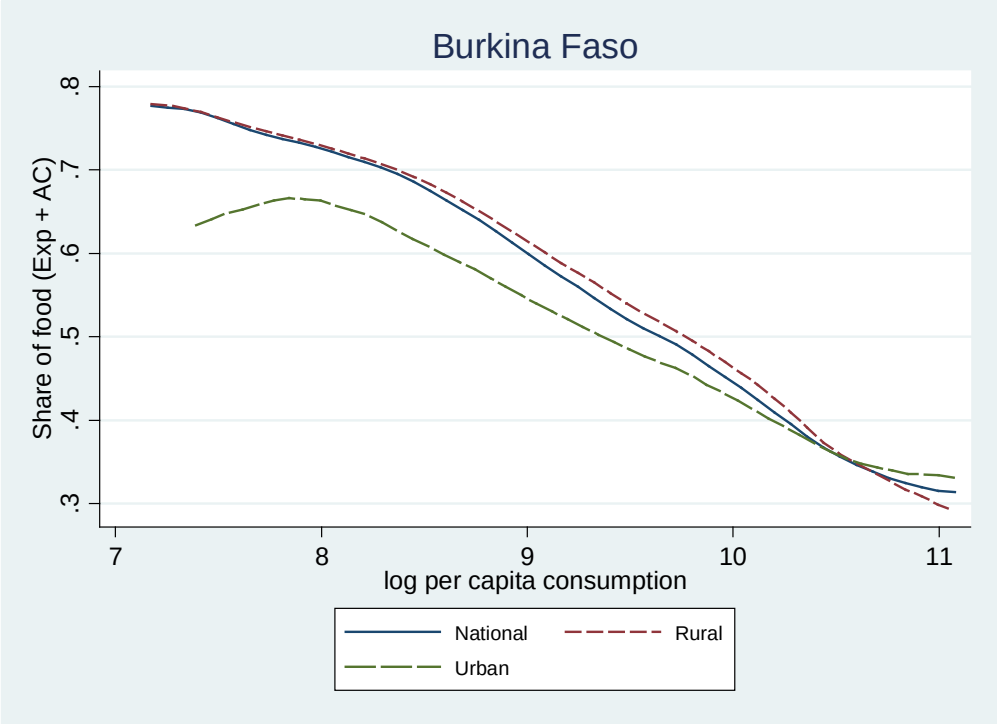
Source: Burkina Faso Household Survey (2005).

To explore the poverty and welfare impacts of changes in the prices of these commodities, it is important to describe first the patterns of income sources of expenditure shares across the income distribution. We characterize the distribution of income with the (log) of per capita household expenditure (log pce) and we plot estimates of non-parametric regressions of income and budget shares on log pce.

We begin in Figures 3.2 and 3.3 with average share of food expenditure (cash expenditure plus auto-consumption) and share of income food (cash agricultural plus auto-consumption). The food share profile slopes steeply downward. In fact, at the bottom of the distribution, almost 80 percent of the budget is allocated to food, while at the top, only about 30 percent is allocated to food. The fact that the curves in Figure

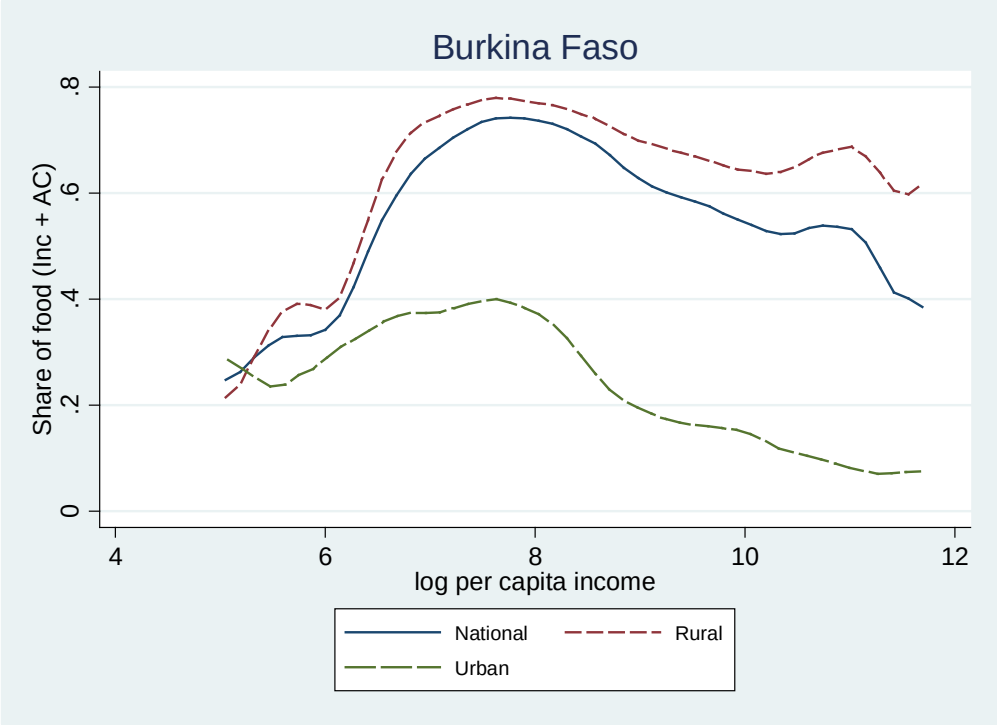
3.2 slope downward is no more than a manifestation of Engel´s law, or its food equivalent that the share of the budget spent on food declines as living standards rise. At the very bottom of the expenditure distribution, rural expenditure is greater than urban expenditure. It noteworthy, however, that as households get richer, these shares converge (and are in fact slightly larger for urban households). Figure 3.3 shows shares of food production on the logarithm of household per capita expenditure. The income share of rural agricultural production is always greater than the urban share, except for the poorest household. Unlike expenditures, income shares increase first with the level of livelihood to up to almost 80% (for rural households in the middle of the income distribution) to decrease later to around 60% (for the richest rural households). From these two figures, we can draw preliminary conclusions about the welfare effects of food price changes. Looking at consumption patterns, price declines will improve welfare conditions relatively more for poor people than for rich people. Looking at Figure 3.3, lower price will hurt richer (rural) households proportionately more than poor households. This illustrates potential differences in the distributional impacts of price changes.

Figure 3.2: Total Food Budget Share across the Income Distribution



Source: Burkina Faso Household Survey (2005).

Figure 3.3: Total Food Income Share across the Income Distribution

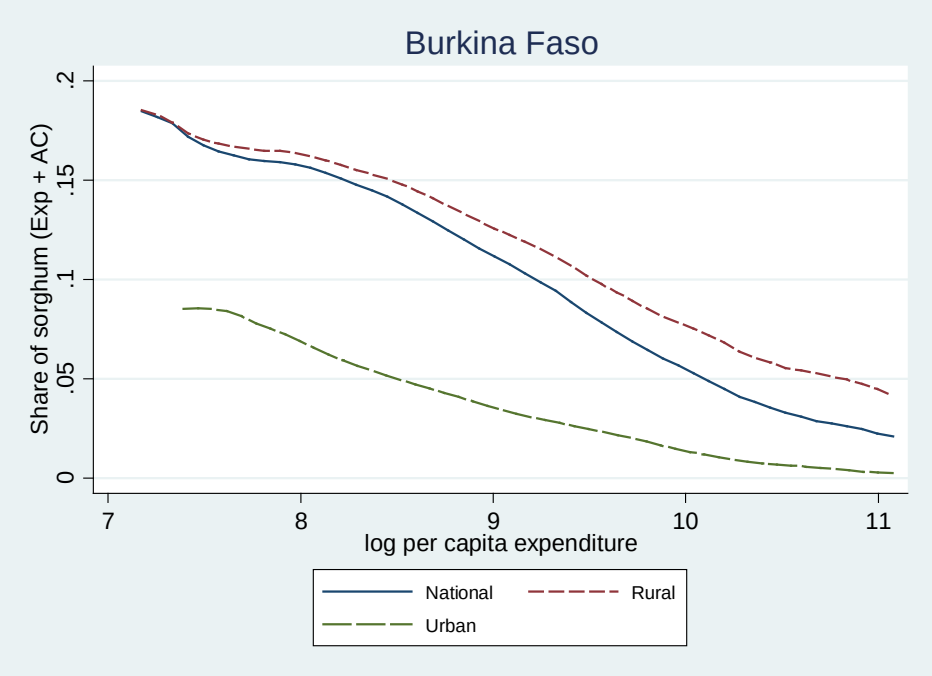


Source: Burkina Faso Household Survey (2005).

We now take a closer look at the patterns of income and budget shares across the income distribution for the main crops under study in Burkina Faso (Figures 3.4-3.9).

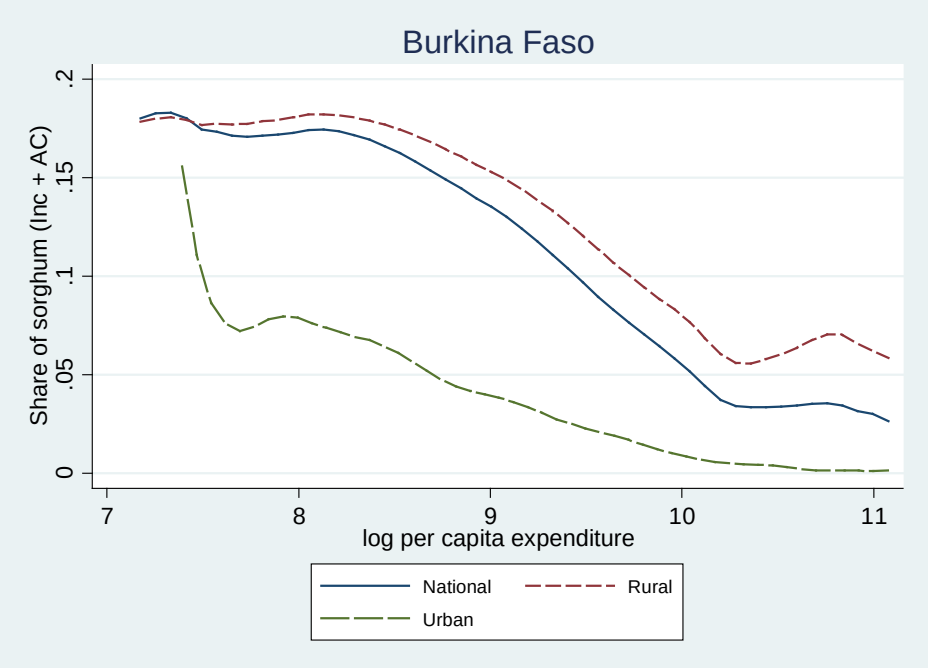
Figure 3.4 displays the household budget share spent on sorghum for different levels of livelihoods. The pattern is similar to the aggregate food expenditure shown in Figure 3.2, the share of the budget spent on sorghum declines with the level of per capita expenditure and the share is always larger for rural than urban households. The poorest rural households spend around 18 percent of their income while the richest urban households spend less than 1 percent of their income on sorgum. Figure 3.5 shows the share of income household get from sorghum. Unsurprisingly the pattern and levels are similar to those in Figure 3.4. This is the case because a large part of sorghum production in Burkina Faso is for auto-consumption and therefore producers and consumers are the same. Only the richest rural households in Burkina Faso have on average a net production of sorghum that they sell in the market.

Figure 3.4: Sorghum Budget Share across the Income Distribution



Source: Burkina Faso Household Survey (2005).

Figure 3.5: Sorghum Income Share across the Income Distribution

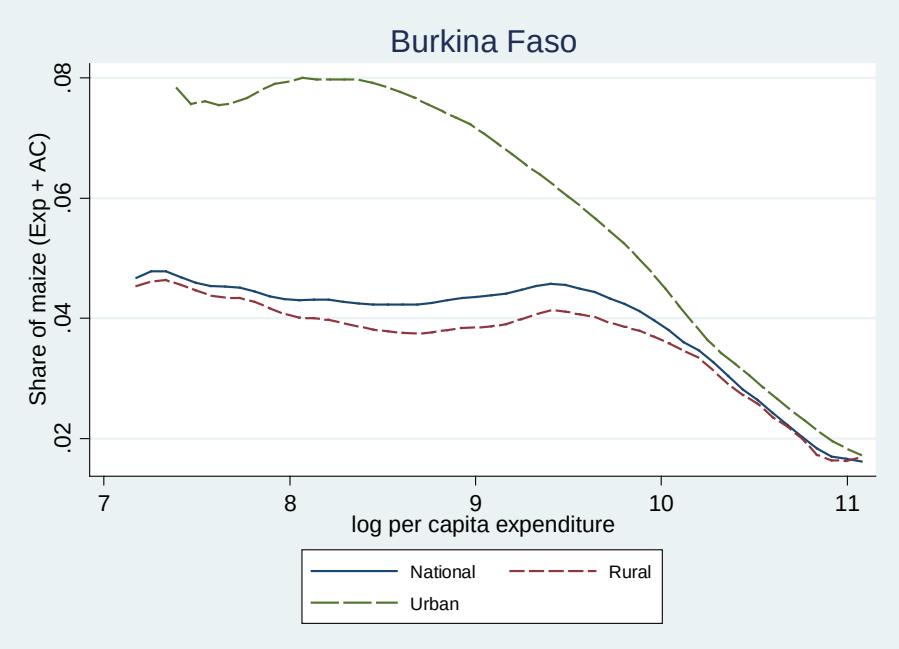


Source: Burkina Faso Household Survey (2005)

Figure 3.6 and 3.7 show the budget and income shares of maize for different levels of livelihood. The amount poor urban household spend on maize almost double the share spent on maize by poor rural households (8 versus 4.5 percent). However, this initial difference declines with the level of per capita expenditure converging to around 1 percent of the budget for the richest urban and rural households in Burkina Faso. The share of income households get from maize in urban areas is similar to their budget maize share. However, the picture is quite different for rural households. Indeed, the share of income rural household acquire from maize increases with the level of income from 2 to 7 percent.

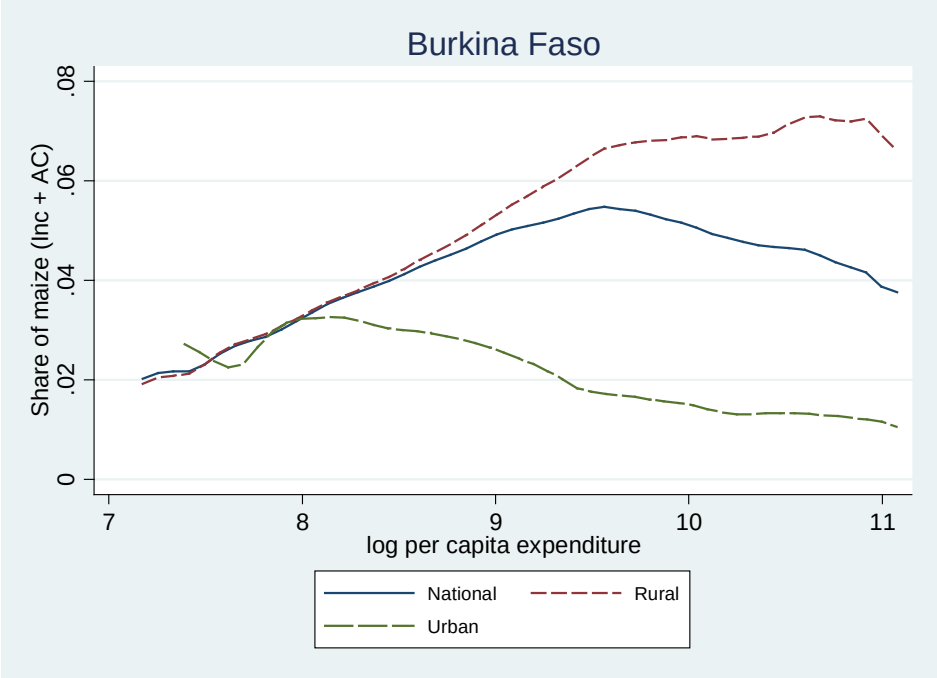
Finally we show the nonparametric regression of livestock budget and income shares for different levels of livelihood for rural and urban households in Burkina Faso. The first thing to notice is that the budget shares of livestock are lower than for other crops despite the fact that many households, in particular those in rural areas, produce livestock. This shows that an important part of the livestock production is to sell in the market, including regional markets. The share in consumption of livestock is larger for rural poor household than the urban counterpart. While the budget share only slightly increases with the level of income for rural households, it sharply increases for urban households. Rural and urban households in the middle of the income distribution spend a similar share of their budget in livestock (between 2.5 and 3 percent). Figure 3.9 shows that livestock is an important source for income in rural areas both the poorest and richest households. The livestock income is on average larger than in the case of sorghum that has an important auto-consumption component that seems to be missing in the case of livestock.

Figure 3.6: Maize Budget Share across the Income Distribution



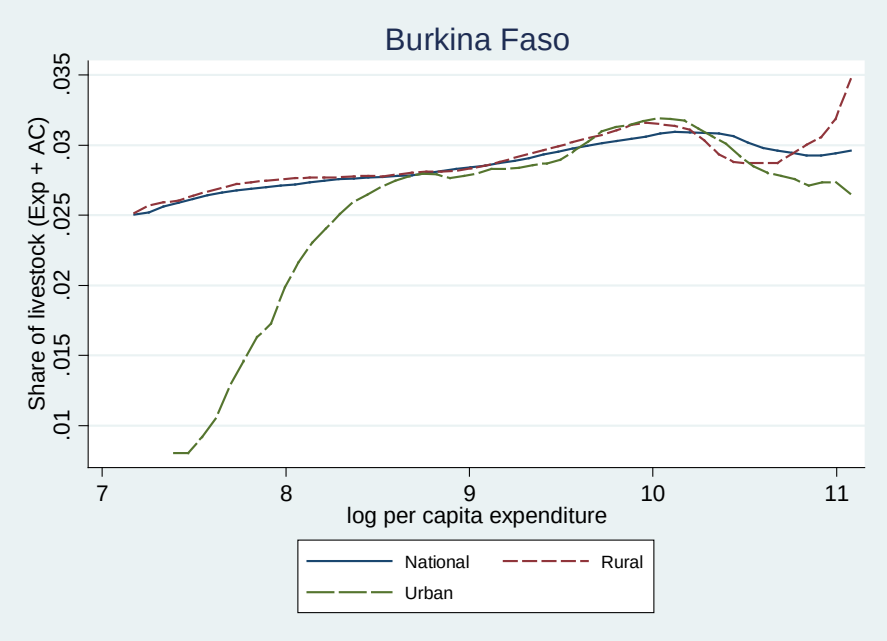
Source: Burkina Faso Household Survey (2005).

Figure 3.7: Maize Income Share across the Income Distribution



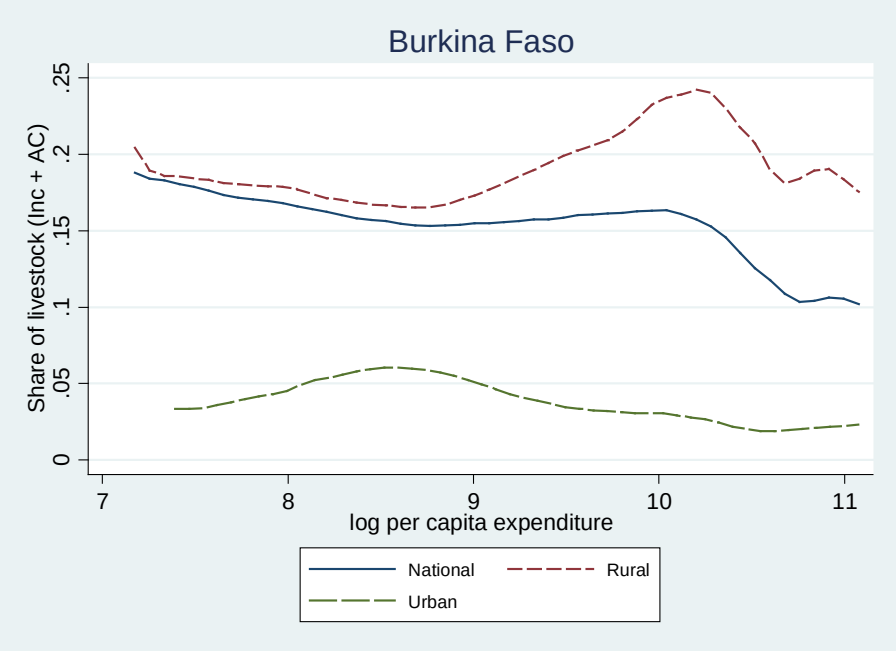
Source: Burkina Faso Household Survey (2005).

Figure 3.8: Livestock Budget Share across the Income Distribution



Source: Burkina Faso Household Survey (2005).

Figure 3.9: Livestock Income Share across the Income Distribution



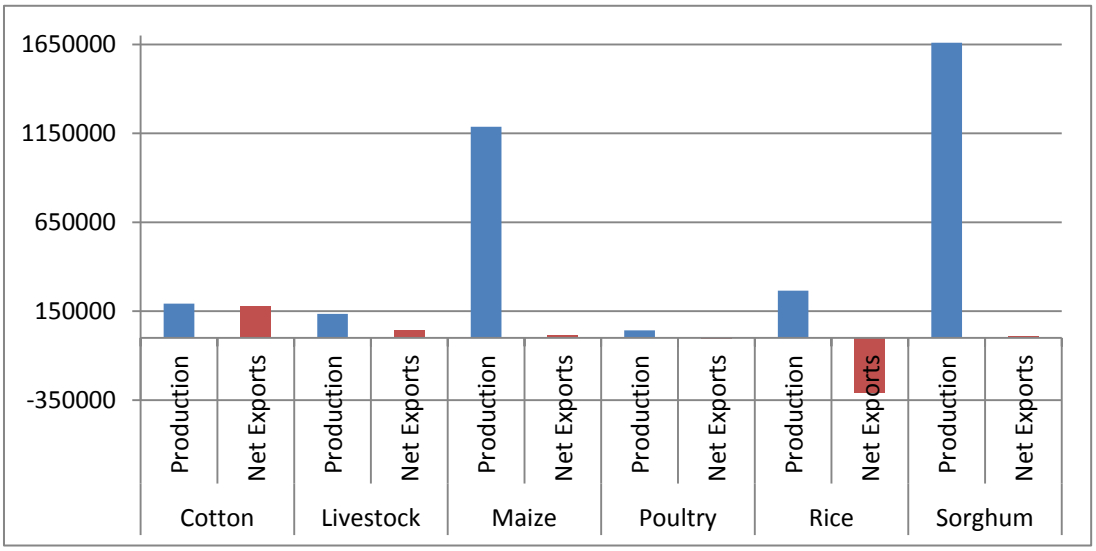
Source: Burkina Faso Household Survey (2005).

3.2. Cash and Food Crops in Burkina Faso

For the past forty years, agriculture has been the second largest contributor to Gross Domestic Product (GDP) in Burkina Faso averaging around 30% of GDP. Roughly 80% of the active population in Burkina Faso depends on agriculture for their livelihood. This indicates the importance of agriculture for the country's development.

The majority of Burkinabe farmers are smallholders residing in rural areas and practicing subsistence farming. This means that their productivity is low and thus there is a need to find ways of raising it if agriculture is to contribute fully its transforming potential. In this report we focus on the crops and livestock that are crucial for the Burkinabe agriculture. Sorghum is the most commonly produced food crop in the country with 1.7 million tons in 2011. However, in terms of market penetration, sorghum is small especially when it is compared to maize and rice (marketing rates in 2006-07 were 6% versus 95% and 41%, respectively, MAHRH 2008). Millet (not covered in this study), maize and rice are also important crops. While the country exports modest amounts of maize, it is a heavier rice importer. Livestock, in particular cow, is also an important economic sector accounting for around 40% of the agriculture GDP and it is an important regional export product. The livestock sector occupies 900,000 workers full time and between 60,000 and 90,000 in the transformation and marketing activities linked to the sector. Cotton plays an overwhelmingly important role among export goods in Burkina Faso. About 35% of the country's GDP comes from the cotton sector, and about 18% of the people live on cotton farming.

Figure 3.10: Crops and Livestock Production and Net Exports in Burkina Faso (in tons, 2011)



Source: FAO.

For the food crops and livestock operate in a relative free market where the forces of demand and supply determine the price at which they are to be traded. In some instances, especially in times of crisis the government intervenes to control the price. But this is only in very rare instances. This is not the case of cotton where the price is determined every year before the seasons begins by a consortium made up cotton companies, cotton farmers organization, under the auspices of the government. For cereal crops, the market is in general much atomized with the largest company controlling less than 16% of the market (Table 3.3). However, this is not the case for the livestock and poultry sector where a few players control the market. The structure of the cotton sector is characterized by the existence of three companies, namely SOFITEX, Faso Cotton, and Societe Cotoniere de Gourma (SOCOMA), with each company operating in a different region of the country. Although each company maintains the same type of “one-stop” cotton farming system, cotton prices are now negotiated among the principal stakeholders within the cotton sector in the country. Cotton producers have had an influencing voice in determining the price levels through the Union Nationale des Producteurs de Cotton du Burkina Faso (UNPCB) since 1999 and own a 30% share of the ginning sector. All three companies therefore purchase cotton at the same price and follow a pan-territorial pricing scheme.

Table 3.3: Market Shares in Burkina Faso

Cotton		**Livestock**		**Maize and Sorghum**	
Company	*Shares*	*Company*	*Shares*	*Company*	*Shares*
Sofitex	85%	l'Abattoir frigorifique de Ouagadougou (AFO)	52%	Sodepal (Société d'Exploitation des Produits Alimentaires)	2%
Socoma	10%	l'abattoir de Ouahigouya	12%	Sitrac (Société industrielle pour la transformation et la commercialisation de céréales)	11%
Faso Coton	5%	Abattoir frigorifique de Bobo-dioulasso	22%	Mels (Meunerie et d'emballage de légumes secs)	8%
		Abattoir de Dedougou	15%	Minoterie du Faso	16%
				Large number of smaller processors	63%
Poultry		**Rice**			
Company	*Shares*	*Company*	*Shares*		
Ferme MOABLAOU	71.5%	Sahel Farm	4.43%		
Ferme Kuna	6.3%	Grenier Faso	6.96%		
Ferme Konkobo	12.7%	Zakane Mahoumoud	9.49%		
Ferme Samora	9.5%	Kouama Industries	12.66%		
		Bikinga	4.43%		
		TRAORE Koflan	7.59%		
		KOUSSE Koussé	4.43%		
		Wend-yam de Kodemi	7.59%		
		SANKERE et DIAKITE	12.03%		
		Société de Décorticage de Riz	8.23%		
		ETSAF	4.43%		
		KY Albert	5.06%		
		LAFIASCO	12.66%		

3.3. Simulation results

In this section, we use the model to perform various simulations. These simulations are in fact comparative static results that stem from the model. Among the parameters of the model, we consider two sets of exercises. Following Porto, Depetris and Olarreaga (2011), we shock the market structure of the supply chain. To this end, we consider (arbitrary) changes in the number of firms and in their market shares to capture both increases and decreases in the extent of competition in the supply chain. We study the cases of Leader split, Leaders merge, Exit of the largest firm, equal market shares, and a limit case of perfect competition. We also consider comparative static results from changes in key parameters affecting the production decision of the farmers. We explore (arbitrary) changes international prices, costs of production, transaction costs, endowments, risk and food security aversion. We are interested in price changes of the agricultural goods produced in Burkina Faso. The ultimate goal of these simulations is to feed the results to the household survey data to assess the welfare and poverty impacts.

We investigate six case studies for Burkina Faso: cotton, maize, sorghum, and cow (exportables) and poultry and rice (importables). Given the complexity of the scenarios, we simplify the analysis by working with a sequence of partial equilibrium models so that each case study is dealt with separately. This just means that, in the case of cotton for instance, we keep all the other markets unmodeled.

In what follows, we describe in detail the results for the case of cotton. We later list the major findings for the other case studies, highlighting differences and specific results. Cotton is a cash crop exported by Burkina Faso and we thus use the cash crop export model. The price changes from the simulation results are presented in table 3.4. The first row shows the impacts of changes in competition. As expected, increases in competition raise farm gate cotton prices, while decreases in the extent of competition reduce prices. In the case of Leaders merge and Exit of the largest, prices decline by 0.51 and 4.02 percent respectively. In contrast, the splits of the leader would increase prices by 3.67 percent, a move to an oligopsony with equal market shares, by 6.24 percent, and a move to a limit case of perfect competition, by 13.39 percent. Note that all these effects are moderate, except the extreme move to competition.

The role of household constraints is explored in column 1 of Table 3.4, starting in row 2. This is the baseline model, where the structure of the market chain is not shocked. Different rows correspond to different comparative static results. International prices have large impacts on farm gate prices. In the margin, after a price increase of 10 percent, for example, farm gate prices would increase by 16.62 percent. This implies a pass-through rate of 1.66. This is consistent with findings in Porto, Depetris, and Olarreaga (2011), on which our model builds, but it is a large elasticity. This result is due in part by a steep farmers supply curve. The many constraints farmers face imply that quantities do not respond strongly to price changes. In this model changes in international prices are equivalent to changes in transport cost, and more generally to changes in trading costs.

Increases in the marginal cost and in the fixed cost of producing cotton lead to increases in farm gate prices (rows 3 and 4). This is a very intuitive result because higher costs imply a shift up in the farm aggregate cotton supply and a consequent increase in equilibrium prices. Note that the response of prices is, however, cushioned to a very large extent by the market structure: marginal cost increases of 10 percent lead to price changes of less than 4 percentage points. The increase in the endowment has the opposite effect (row 5). An exogenous increase in endowment means more resources for the farmers. They can thus more easily satisfy any food security needs and leave more resources available for the production of the cash crop. This implies an increase in farm cotton supply and a lower equilibrium price. Note, once again, that the impacts are cushioned by imperfect competition among processors. The implications of these results are straightforward. Cost reductions (increases) in cotton production benefit (hurt) farmers but the general equilibrium effects via prices may hurt (benefit) them. Nevertheless, the price effects are scaled down by the competition between exporters so that the direct effect appears to dominate.

The model also predicts that increases in household risks that lead to higher demands for food security positive affect equilibrium cash crop prices (row 6). This is an interesting result. The intuition works along the same lines as before. Imagine shocks to farmers that induce them to want to better cover their food needs via subsistence activities. This could be caused by more erratic food market conditions, a higher health risk for productive household members, and so on. In this scenario, households react by retracting to autoconsumption and by allocating more resources to auto-consumption and thus lower resources to cotton. In the end, cotton farm supply is lower, and cotton prices may increase in equilibrium. This can benefit cotton farmers. As we will show below, this result suggests that negative and unwanted shocks to food producers (in rural areas, for example) may end up benefiting cotton producers. This may exacerbate inequality between farmers and increase relative poverty impacts, for example.

An important element in our model is that it allows us to explore, at least to some extent, the spillovers and interrelationships between cash crop production and food markets. In the cotton export model, farmers take the prices of competing marketable foods as given, but the level of these prices clearly affects production and consumption decision. Similarly, the marginal cost of producing food can also affect cotton production choices. In our simulations, we find that increases in the prices of competing food crop prices because an increase in cotton prices (row 7). Alternatively, an increase in the cost of producing those goods can lead to general equilibrium declines in cotton prices (row 8). Consider an increase in the price of marketable food. This induces farmers to produce more food and less cotton and the price of cotton increases as a result. The opposite would happen if the cost of producing the marketable food increases. It is important to emphasize these results. They highlight the role of stressing the feedback effects between food production and cash crop export production. These feedbacks are seldom studied in the literature but our model shows they can be sizeable.

Our model allows us also to study the effect of transaction on farm gate prices. In row 9 we analyze the effect of a 10 percent increase in the transaction cost of the crop production and in row 10 a similar increase in the transaction cost on inputs. The price effect of the increase in the transaction cost associated with production (7.15 percent) is larger than in the case of inputs (1.13 percent). The former affects processors who transmit the shock to farmers via the demand for crops. The latter affects directly farmers and therefore plays a direct role in the production decision of the farmer.

To end, we examine complementarities between shocks to the structure of competition among exporters and shocks to household constraints. The idea is to uncover potential synergies between different types of policies or shocks. For instance, an increase in competition among exporters brings farm gate cotton prices up. The same happens when the international price increases. Complementarities would occur if the change in farm gate price due to the increase in competition is boosted by a concurrent increase in international prices (net of the direct effect of these higher prices). It is not easy to establish these complementarities quantitatively. Our approach here is to simulate the impacts of the joint shocks and to compare these numbers with the sum of the impacts of each individual shock. Table 3.4 reports the joint effect. The sum of the separate effects can be easily calculated from the competition policies shocks (row 1) with the baseline complementary policy results (column 1).

Our model features complementarities, and substitutabilities. It is difficult to generalize the results, however. Complementarities show up when the joint effect is larger than the sum of the separate effects. Consider, for instance, the case of leader split and preference parameter. The joint effect of those two shocks would be an increase in farm gate prices of 4.89 percent. Instead, the sum of the separate effects is smaller, 4.42 percent. In this case, the complementarity exists and it is significant (equivalent to roughly 10 percent of the joint effect). In other cases, the complementarity is much smaller and in others much larger. The intuition is that the increase in competition causes prices to increase and this increase is larger if, concurrently, there is an increase in the risk of food security.

Consider now the case of equal market shares together with an increase in the marginal cost of producing the cash crop. The result of the joint shock would be an increase in cotton farm gate prices of 8.21 percent. Instead, the sum of the separate shocks would bring prices up by 10.13 percent. This is a “substitutability” effects that implies a difference of 23 percent, approximately. In this case, the increase in the marginal cost induce farmers to reallocate resources out of cotton and into food crops, thus reducing cotton supply and increasing cotton prices. When this happens in the presence of more competition, which in itself implies higher prices, the reallocation of resources is ameliorated and the price increase is therefore smaller.

As we mentioned above, while the model delivers complementarities and substitutabilities, it is difficult to generalize and to find clear patterns in the results. Sometimes, shocks and policies go in the same direction, sometimes they oppose each other. Sometimes the joint effects are big, sometimes they are small. The important lesson from these exercises,

beyond the quantification of the special cases considered in the simulations, is that these complementarities exist and need to be taken seriously in the design of agricultural policies.

The other exportable good that we study for Burkina Faso is livestock. Results are reported in Table 3.5. Given the nature of competition in the supply chain, which is concentrated but more competitive than in the case of cotton, changes in the structure of the market has also important impact on livestock farm gate prices. This can be seen in the first row of Table 3.5. As in the case of cotton, changes in international prices have large impacts on livestock prices.

It is noteworthy that shocks to complementary factor seem to have moderate effects on livestock prices. We can divide these factors in two sets. On the one hand, there are factors that affect directly the production of livestock, such as household risks and livestock production costs. On the other hand, recall that our food export model includes a farm production decision that allows farmers to choose between livestock and a competing cash crop (e.g., cotton). This means we can look at feedbacks and spillovers from cash crop markets to food (exportable) markets.

In the case of livestock, we find that changes in production costs of the cash crop generate reduction in the price of livestock. This is because higher costs of producing cash crops induce a shift of resources out of the cash crop and into the competing food export crop, thus increase livestock supply. The magnitudes are moderate. The impact of changes in marginal costs is -2 percent (row 3) and the impact of changes in fixed costs is -1.39 percent (row 4). An increase in the price of the cash crop, in turn raises livestock prices because it induces farms to produce more cash crop and supply less livestock.

Factors that affect livestock production directly also have moderate impacts. In row 8, for instance, a 10 percent increase in the marginal cost of producing livestock raises livestock equilibrium prices by only 1.79 percent. Similarly, an increase in household total resources does not affect prices much (row 5). Similarly, changes in household risks that raise autoconsumption have a positive effect on livestock prices. The magnitudes are small, but still larger than for other complementary shocks (row 6). For instance, in the baseline, the price change caused by an increase in household risk would be of 1.96 percent. The price effects of transaction cost associated with crop production on the other hand have a sizable effect. A 10 percent increase in transaction cost of crop production (row 9) increases farm gate prices more than 6 percent.

We now turn to the case of sorghum (Table 3.9), rice (Table 3.8) and maize (Table 3.6), three important food commodities in Burkina Faso. Sorghum is the most important of the three both in terms of production and consumption. Sorghum and maize production is mostly for domestic consumption and only a negligible surplus is exported. Rice on the other hand is an importable food commodity where the local production only covers about half of the domestic demand. As it was shown in Table 3.3, the market for these three crops is dominated by a large number of traders and intermediaries. Analytically, these

markets behave very competitively and, as a result, the shocks to market structure imply negligible impacts on prices (row 1 in the respective tables). Note that in the case of rice we are dealing with an importable commodity and thus the market is represented by an oligopoly. In consequence, increases in competition in the rice sector should bring prices down (see for example, the price decline of 2.2 percent in the limit case of perfect competition).

Increases in international prices are transmitted to the local economy, in part due to the nature of competition (row 2). In the case of rice, the pass-through is less than 100 percent. In general, complementary factors affecting household constraints and resources have also small impacts on prices. Only an increase in the cash crop price (of 10 percent, row 8), which is in principle more profitable, elicits a supply response that increases maize, rice, and sorghum prices by 0.90, 1.33, and 1.14 percent respectively. These results imply that these markets are in general inelastic to the shocks considered in our exercises. This is because, even though these crops are important food staples, the marketable fraction of production is typically small. Moreover, given the appropriate conditions, the model implies that the cash export crop is more profitable and, consequently, farmers prioritize resource reallocation to these crops.

An interesting novel results (albeit a weak one) that arise in the case of maize and rice but not in sorghum if the following. When the endowment is higher, the price of maize and rice increases (slightly). A higher endowment allows households to produce more of all crops, including maize and rice. Ceteris paribus, this should lead to price declines because of a larger supply. However, the price of maize and rice increases. This could happen if the increase in household resources is such that cash crop production becomes, at the margin, profitable to a larger number of farmers and this creates incentives to move some resources out of maize and rice and into the export cash crop. It is difficult to establish this result more generally, but it is another interesting finding that highlights feedback and spillovers across markets and household activities and decisions.

Finally, results for poultry are presented in Table 3.7. Overall, the simulations for poultry resemble qualitatively the results for rice, because poultry is also an imported commodity although the imports are far less important in terms of magnitudes. Also the competition effects for the price pf poultry are somewhat larger because poultry is a more concentrated market. The role of complementary factors is also weak. Apart from changes in border prices, which transmit to the local economy in a fashion similar to rice, all the other parameters of the model generate very small prices changes.

Table 3.4: Simulation Results for Cotton

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	3,67	-0,51	-4,02	6,24	13,39
Increase of 10% in:						
International Price	16,62	20,58	14,47	9,51	24,21	33,39
Marginal Cost of Producing Cash Crop	3,89	6,51	3,89	0,44	8,21	13,39
Fixed Cost of Producing Cash Crop	0,18	3,94	-0,28	-3,76	6,44	13,39
Endowment	-0,66	2,62	-1,34	-4,55	5,37	13,39
Preference Paremeter	0,75	4,89	0,47	-3,29	7,18	13,39
Food Crop Price	2,44	5,27	2,44	-0,31	7,15	13,39
Marginal Cost of Producing Food Crop	-0,27	3,46	-0,92	-4,71	6,15	13,39
Transaction Costs on Crop Production	7,15	8,85	6,22	4,09	10,41	14,36
Transaction Costs on Inputs	1,13	1,89	1,13	0,13	2,38	13,39
Non-Farmer demand	0,00	3,67	-0,51	-4,02	6,24	13,39

Source: simulation results from the model of Section 2.

Table 3.5: Simulation Results for Livestock

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	1,63	-0,99	-2,26	3,93	10,88
Increase of 10% in:						
International Price	14,36	16,85	12,10	10,77	17,99	32,11
Marginal Cost of Producing Cash Crop	-2,00	-0,17	-3,31	-4,55	1,74	10,84
Fixed Cost of Producing Cash Crop	-1,39	0,44	-2,55	-3,83	2,56	10,84
Endowment	0,84	2,31	0,08	-1,19	4,60	10,84
Preference Paremeter	1,96	3,19	1,51	0,37	5,56	10,84
Cash Crop Price	4,39	5,37	4,36	2,97	8,36	10,84
Marginal Cost of Producing Food Crop	1,79	3,14	1,23	0,03	5,57	10,84
Transaction Costs on Crop Production	6,18	7,25	5,20	4,63	7,74	13,81
Transaction Costs on Inputs	0,52	0,91	0,36	0,01	1,62	10,84
Non-Farmer demand	0,18	1,74	-0,82	-2,09	4,00	10,84

Source: simulation results from the model of Section 2.

Table 3.6: Simulation Results for Maize

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	0,14	-0,10	-0,15	1,35	2,36
Increase of 10% in:						
International Price	13,20	13,38	13,03	12,98	14,50	16,65
Marginal Cost of Producing Cash Crop	-0,45	-0,29	-0,58	-0,62	0,89	2,36
Fixed Cost of Producing Cash Crop	-0,29	-0,14	-0,40	-0,45	1,05	2,36
Endowment	0,16	0,28	0,08	0,03	1,49	2,36
Preference Paremeter	0,45	0,56	0,38	0,34	1,77	2,36
Cash Crop Price	0,90	0,98	0,85	0,81	2,24	2,36
Marginal Cost of Producing Food Crop	0,40	0,51	0,33	0,29	1,75	2,36
Transaction Costs on Crop Production	5,68	5,75	5,60	5,58	6,24	7,16
Transaction Costs on Inputs	0,12	0,15	0,10	0,08	0,51	2,36
Non-Farmer demand	0,05	0,18	-0,04	-0,09	1,40	2,36

Source: simulation results from the model of Section 2.

Table 3.7: Simulation Results for Poultry

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	-0,66	0,19	1,02	-2,07	-3,94
Increase of 10% in:						
International Price	8,09	7,72	7,80	8,59	6,02	5,96
Marginal Cost of Producing Cash Crop	-1,04	-1,52	-1,12	-0,35	-3,05	-3,94
Fixed Cost of Producing Cash Crop	-0,52	-1,10	-0,48	0,34	-2,57	-3,94
Endowment	0,49	-0,24	0,79	1,63	-1,58	-3,94
Preference Paremeter	1,22	0,38	1,70	2,51	-0,79	-3,94
Cash Crop Price	1,84	0,83	2,53	3,44	-0,33	-3,94
Marginal Cost of Producing Food Crop	1,30	0,44	1,77	2,56	-0,68	-3,94
Transaction Costs on Crop Production	3,48	3,32	3,36	3,69	2,59	2,56
Transaction Costs on Inputs	0,38	0,13	0,51	0,74	-0,20	-3,94
Non-Farmer demand	0,16	-0,54	0,38	1,21	-1,92	-3,94

Source: simulation results from the model of Section 2.

Table 3.8: Simulation Results for Rice

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	-0,06	0,26	0,26	-0,66	-2,20
Increase of 10% in:						
International Price	7,35	7,29	7,42	7,42	6,63	6,39
Marginal Cost of Producing Cash Crop	-1,38	-1,44	-1,31	-1,31	-2,08	-2,30
Fixed Cost of Producing Cash Crop	-0,28	-0,42	-0,13	-0,13	-1,01	-2,30
Endowment	0,20	0,03	0,39	0,39	-0,54	-2,30
Preference Paremeter	0,74	0,54	0,98	0,98	-0,02	-2,30
Cash Crop Price	1,33	1,07	1,63	1,63	0,54	-2,30
Marginal Cost of Producing Food Crop	0,86	0,65	1,11	1,11	0,10	-2,30
Transaction Costs on Crop Production	3,16	3,13	3,19	3,19	2,85	2,75
Transaction Costs on Inputs	0,25	0,19	0,32	0,32	0,03	-2,30
Non-Farmer demand	0,11	-0,05	0,30	0,30	-0,63	-2,30

Source: simulation results from the model of Section 2.

Table 3.9: Simulation Results for Sorghum

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	0,12	-0,08	-0,12	1,19	2,11
Increase of 10% in:						
International Price	10,41	10,56	10,27	10,23	11,62	13,22
Marginal Cost of Producing Cash Crop	-0,85	-0,69	-1,00	-1,04	0,35	2,11
Fixed Cost of Producing Cash Crop	-0,18	-0,06	-0,29	-0,33	0,99	2,11
Endowment	-0,01	0,10	-0,11	-0,15	1,18	2,11
Preference Paremeter	1,21	1,26	1,19	1,15	2,41	2,11
Cash Crop Price	1,14	1,19	1,12	1,08	2,33	2,11
Marginal Cost of Producing Food Crop	0,33	0,42	0,26	0,21	1,51	2,11
Transaction Costs on Crop Production	4,48	4,54	4,42	4,40	5,00	5,69
Transaction Costs on Inputs	0,09	0,12	0,07	0,06	0,44	2,11
Non-Farmer demand	0,01	0,12	-0,07	-0,11	1,20	2,11

Source: simulation results from the model of Section 2.

3.4. Welfare impacts

We end our analysis for Burkina Faso with a discussion of the poverty impacts of the comparative static results presented above. Ultimately, we are interested in the role of the supply chain in agriculture on household well-being, on whether the poor are affected more or less than the non-poor, and on whether the complementarities between the structure of markets and household constraints can inform policy about ways to boost or ameliorate those poverty impacts. This is the goal of this section.

The analysis is done using standard techniques in the literature. We adopt the first order approximation analysis of Deaton (1989, 1997). This implies we can approximate the impact of a price change using income shares and budget shares as measures of exposure. The first order approximation works well if the price changes are small and if there are limited supply and consumption responses. It is, in general, a very powerful and useful tool to evaluate the welfare effects of price changes.

The welfare impacts of the price changes are reported in Tables 3.10 to 3.15 for the cases of cotton, livestock, maize, poultry, rice and sorghum. We show the impacts of shocks to the market structure. To illustrate the complementarities, we show results for a combination of shocks to market structure and international prices (we comment on the results for other complementarities at the end). We also report average results for the total population, the poor, and the non-poor, and separate results for producers.

Some regularities can be detected in the simulation results. Increased competition and complementary policies in cotton show positive welfare impacts across households. The impacts are obviously larger for cotton producers. Competition among exporters in a cash export crop implies higher farm-gate prices and, consequently, higher farm income from cotton production. Since raw cotton is only produced and not consumed directly by the households, real farm income is in the end higher. Increases in competition and international prices in livestock have overall positive welfare impacts in Burkina Faso, with the effect being larger for non-poor households. Even though there is net production of sorghum, competition and higher prices create (small) welfare losses because of the distribution of consumption shares among both producers and consumers. In addition, higher maize and rice prices (due to lower competition in the supply chain) create welfare losses because these are staple crops.

To a large extent, the welfare impacts are small for all groups of households. For most crops, shocks, and affected population, the welfare impacts of the proposed simulations are less than 1 percent of total household expenditures. The only exception is the impact on livestock and on cotton producers where some sizeable impacts can be established.

Table 3.10: Cotton Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	0,20	-0,03	-0,22	0,34	0,73
International Price	0,90	1,12	0,79	0,52	1,31	1,81
Poor						
Competition Policy	0,00	0,15	-0,02	-0,16	0,25	0,53
International Price	0,66	0,81	0,57	0,38	0,96	1,32
Non Poor						
Competition Policy	0,00	0,28	-0,04	-0,31	0,48	1,02
International Price	1,27	1,57	1,11	0,73	1,85	2,55
Producers						
Competition Policy	0,00	1,79	-0,25	-1,96	3,04	6,52
International Price	8,10	10,03	7,05	4,64	11,80	16,27

Note: first order impact on household welfare.

Table 3.11: Livestock Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	0,49	-0,30	-0,68	1,18	3,26
International Price	4,30	5,05	3,62	3,22	5,39	9,61
Poor						
Competition Policy	0,00	0,39	-0,24	-0,54	0,93	2,58
International Price	3,41	4,00	2,87	2,56	4,27	7,63
Non Poor						
Competition Policy	0,00	0,64	-0,39	-0,88	1,54	4,27
International Price	5,63	6,61	4,74	4,22	7,05	12,59
Producers						
Competition Policy	0,00	0,42	-0,25	-0,58	1,00	2,78
International Price	3,67	4,31	3,09	2,75	4,60	8,21

Note: first order impact on household welfare.

Table 3.12: Maize Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	0,00	0,00	0,00	-0,01	-0,03
International Price	-0,14	-0,14	-0,14	-0,14	-0,16	-0,18
Poor						
Competition Policy	0,00	0,00	0,00	0,00	-0,01	-0,02
International Price	-0,13	-0,13	-0,13	-0,13	-0,14	-0,16
Non Poor						
Competition Policy	0,00	0,00	0,00	0,00	-0,02	-0,03
International Price	-0,16	-0,16	-0,16	-0,16	-0,18	-0,20
Producers						
Competition Policy	0,00	0,02	-0,02	-0,03	0,24	0,42
International Price	2,38	2,41	2,34	2,34	2,61	2,99

Note: first order impact on household welfare.

Table 3.13: Poultry Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	-0,01	0,00	0,02	-0,05	-0,09
International Price	0,18	0,17	0,18	0,19	0,14	0,13
Poor						
Competition Policy	0,00	-0,01	0,00	0,01	-0,03	-0,05
International Price	0,10	0,10	0,10	0,11	0,08	0,08
Non Poor						
Competition Policy	0,00	-0,02	0,01	0,04	-0,08	-0,15
International Price	0,30	0,29	0,29	0,32	0,22	0,22
Producers						
Competition Policy	0,00	-0,07	0,02	0,11	-0,21	-0,41
International Price	0,84	0,80	0,81	0,89	0,62	0,62

Note: first order impact on household welfare.

Table 3.14: Rice Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	0,00	-0,01	-0,01	0,02	0,06
International Price	-0,21	-0,21	-0,21	-0,21	-0,19	-0,18
Poor						
Competition Policy	0,00	0,00	-0,01	-0,01	0,02	0,07
International Price	-0,25	-0,25	-0,25	-0,25	-0,23	-0,22
Non Poor						
Competition Policy	0,00	0,00	-0,01	-0,01	0,01	0,05
International Price	-0,15	-0,15	-0,16	-0,16	-0,14	-0,13
Producers						
Competition Policy	0,00	-0,01	0,05	0,05	-0,12	-0,40
International Price	1,32	1,31	1,34	1,34	1,19	1,15

Note: first order impact on household welfare.

Table 3.15: Sorghum Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	0,00	0,00	0,00	-0,02	-0,03
International Price	-0,16	-0,16	-0,15	-0,15	-0,17	-0,20
Poor						
Competition Policy	0,00	0,00	0,00	0,00	-0,02	-0,03
International Price	-0,17	-0,17	-0,17	-0,17	-0,19	-0,21
Non Poor						
Competition Policy	0,00	0,00	0,00	0,00	-0,01	-0,03
International Price	-0,13	-0,13	-0,13	-0,13	-0,15	-0,17
Producers						
Competition Policy	0,00	0,01	-0,01	-0,01	0,13	0,22
International Price	1,11	1,13	1,10	1,09	1,24	1,41

Note: first order impact on household welfare.

These results are expected, given the nature of the exercised considered here, and they are also comparable to the literature on the topic (see the review in Lederman and Porto, 2014). There are various elements that need to be taken into account. First, the income shares and budget shares used in the first order approximation are typically small (recall the household survey analysis of Section 3.1). Some crops are relevant separately on both the production side and on the consumption side. But a price change affects households as consumers and as producers, and thus the net effect tends to be small in general. Second, in some of the crops considered here, the market was already characterized by some degree of competition, thus leaving small room for sizeable price changes. The combination of small price changes with small net benefit ratios (Deaton, 1997) implies small impacts.

The fact that the impacts are typically small does not mean they are not important. As we argued above, small results are expected in this literature. They are expected given the context (household survey data and baseline market structure) but are reasonable. We are just assessing the short-run impacts of price changes caused by changes in exporters' market power and the combination with complementary factors. It is important to note that the complementary factors have an independent effect on household welfare that we are not attempting the measure here. If, for instance, the cost of crop production declines due to improvement in infrastructure, access to cheaper and better inputs, access to knowledge or credit, etc., there will be a direct impact on welfare and an indirect one via the combination with changes in market structure. Here, we are measuring this additional impact only. It turns out that these additional impacts are small but, since they do not carry additional costs (for example fiscal costs if the complementarities are funded by the government), they only generate benefits.

4. Welfare effects of domestic market structure and household constraints: The case of Ghana

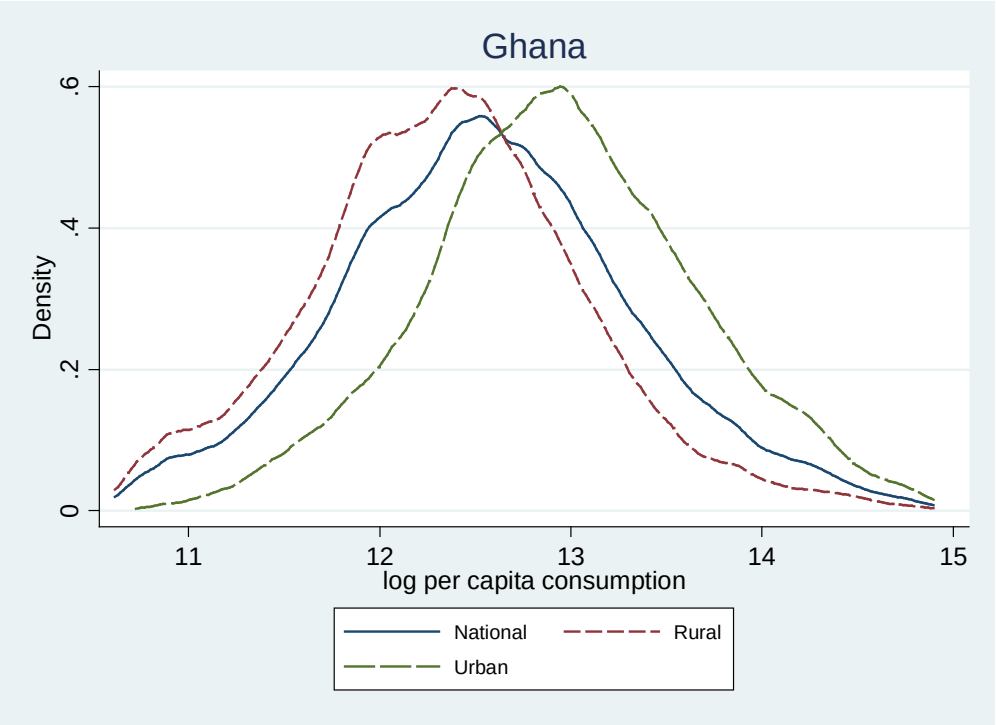
4.1. The Household Survey Data

The household data in the analysis comes from the 2005 "Ghana Living Standard Survey 5". The dataset contains information on 8,687 households. Households residing in rural areas accounted for 58.7%. The results show that Ghana's population is still young. Children under 15 years account for about 40 percent of the population, while the aged persons (65 years and older) form 4.7 percent. Based on this structure, the survey reveals a dependency ratio of 82 compared to 96 as per the GLSS 4 survey. The proportion of children in rural areas (43.3%) is higher than in Accra (30.7%) and other urban (36.4%).Females form 51.5 percent of the population. Almost 30 percent of the households are headed by females. On average, household size is 4 members per family compared to 5.1 in 2000. As expected, households in rural areas are bigger than in urban areas (4.4 versus 3.4 members per family respectively). Self-employed are almost half of the sample (49.84 percent) followed by those declaring to be family worker (31.8 percent)

and wage earners (14.81 percent). People working in agriculture are 60.6 percent of the sample.

Figure 4.1 shows the distribution of income. The graph shows the estimated density function of the logarithm of household per capita expenditure at the national level and for urban and rural regions separately. As expected, the density for urban areas lies to the right of the density for rural areas, thus indicating that urban households enjoy, on average, a higher level of expenditure per capita than the rural households.

Figure 4.1: The Distribution of Income
Density of (log) per capita household expenditure



Source: Ghana Living Standard Survey 5 (2005).

We turn now to a description of sources of income and patterns of consumption across households. In Table 4.1, we report consumption patterns for urban and rural households in Ghana. We report cash expenditures and the value of auto-consumption, as a share of total expenditures. As expected, the share of auto-consumption is much larger in rural areas than in urban areas. In fact, for urban households, 92.8 percent of their expenditure is cash spending. For rural households, cash expenditures account for 66.9 percent of the total budget, while home-produced expenditures account for the remaining 33.1 percent. Since we are interested in food consumption, we can take a close look at aggregate food expenditure. At the national level, 58.6 percent of the average Ghanaian household budget is spent on food. This share is larger for rural households (65.1 percent) than for

urban households (46.5 percent). This observation fits with the idea that urban people are richer, who thus spend more on other goods and services than on food. Among food item, the most significant crops in consumption are maize, yam, cassava, and rice. On average, maize represents 6 percent of Ghanaian household expenditure (7.5 percent of rural expenditure and 3.3 percent of urban expenditure). Yam and cassava account for 4 percent of the budget each with larger incidence in rural than in urban areas. Rice (3.5) and livestock (3.1) are also important food staples in Ghana, in particular in urban areas where they account for 3.9 and 4.3 percent of the average household.

Table 4.1: Budget Shares

Ghana	Total	Rural	Urban
Total consumption per capita	**100,0**	**100,0**	**100,0**
Expenditures	**75,9**	**66,9**	**92,8**
Food	35,9	33,3	40,9
Manufactures	19,4	17,2	23,6
Services	16,4	12,9	23,0
Others	4,2	3,6	5,3
Auto-consumption	**24,1**	**33,1**	**7,2**
Auto-consumption food	22,7	31,8	5,6
Auto-consumption others	1,4	1,3	1,6
Total Food consumption	**58,6**	**65,1**	**46,5**
Total crops	**26,1**	**30,2**	**18,4**
Maize	6,0	7,5	3,3
Rice	3,5	3,2	3,9
Poultry	1,5	1,6	1,3
Livestock	3,1	2,5	4,3
Cassava	4,0	4,8	2,5
Sorghum	1,6	2,4	0,2
Millet	1,8	2,7	0,2
Cowpea	0,5	0,6	0,3
Yam	4,0	4,9	2,4
Cocoa	0,0	0,0	0,0

Source: Ghana Living Standard Survey 5 (2005).

In Table 4.2, we show different sources of income for Ghanaian households. As expected, rural households have lower shares of cash income (66.9 percent), because a significant part of their income comes from auto-consumption. On the other hand, urban cash income represents 89.5 percent of total income of which one tenth is associated with agricultural income. Looking at agriculture income, maize, cassava, and yam are the most important source of income in rural areas. These three crops taken together account for almost one fifth of all income in rural areas but less than 6 percent for household in urban areas. Sales

of cocoa account for only 2.9 percent of rural income but its incidence may be higher when we consider wages paid in the sector.

Table 4.2: Income Shares

Ghana	Total	Rural	Urban
Total Income per capita	**100,0**	**100,0**	**100,0**
Incomes	**72,3**	**63,3**	**89,5**
Food (agriculture)	27,0	36,8	8,2
Wage	14,6	6,9	29,1
Enterprises	25,0	15,7	42,6
Transfers	5,8	3,8	9,5
Auto-consumption	**27,7**	**36,7**	**10,5**
Auto-consumption food	25,3	34,9	7,3
Auto-consumption others	2,3	1,9	3,2
Total Food income and AC	**52,3**	**71,7**	**15,5**
Total crops	**24,8**	**33,9**	**7,6**
Maize	6,3	8,2	2,6
Rice	1,0	1,4	0,2
Poultry	0,9	1,2	0,2
Livestock	1,6	2,1	0,5
Wheat	0,0	0,0	0,0
Cassava	4,7	6,2	1,8
Sorghum	1,8	2,6	0,2
Millet	2,2	3,3	0,1
Cowpea	0,5	0,8	0,1
Yam	3,8	5,0	1,4
Cocoa	2,1	2,9	0,6

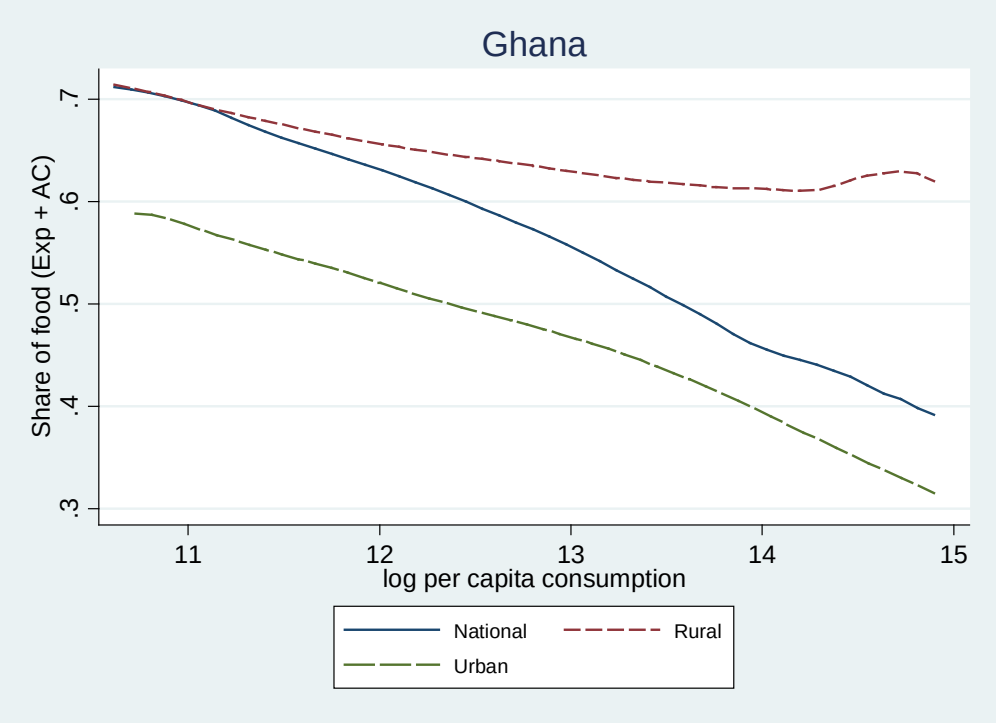
Source: Ghana Living Standard Survey 5 (2005).

The objective of this study is to explore the poverty and welfare impacts of changes in the prices of agricultural commodities. For that reason it is important to describe first the patterns of income sources of expenditure shares across the income distribution. We characterize the distribution of income with the (log) of per capita household expenditure (log pce) and we plot estimates of non-parametric regressions of food income and budget shares on the log pce.

We begin in Figures 4.2 and 4.3 with average share of food expenditure (cash expenditure plus auto-consumption) and share of income food (cash agricultural plus auto-consumption). The food budget share profile slopes steeply downward for urban household and smoothly declines in the case of rural households. In effect, at the bottom

of the distribution, more than 70 percent of the budget is allocated to food, while at the top, only about 40 percent is allocated to food. The fact that the curves in Figure 4.2 slope downward is no more than a manifestation of Engel´s law, or its food equivalent that the share of the budget spent on food declines as living standards rise. The proportion of food expenditures is larger for rural than urban households across the whole income distribution. This gap increases with the level of livelihood in Ghana, the opposite to what we saw in the case of Burkina Faso where as the households get richer, these shares converge.

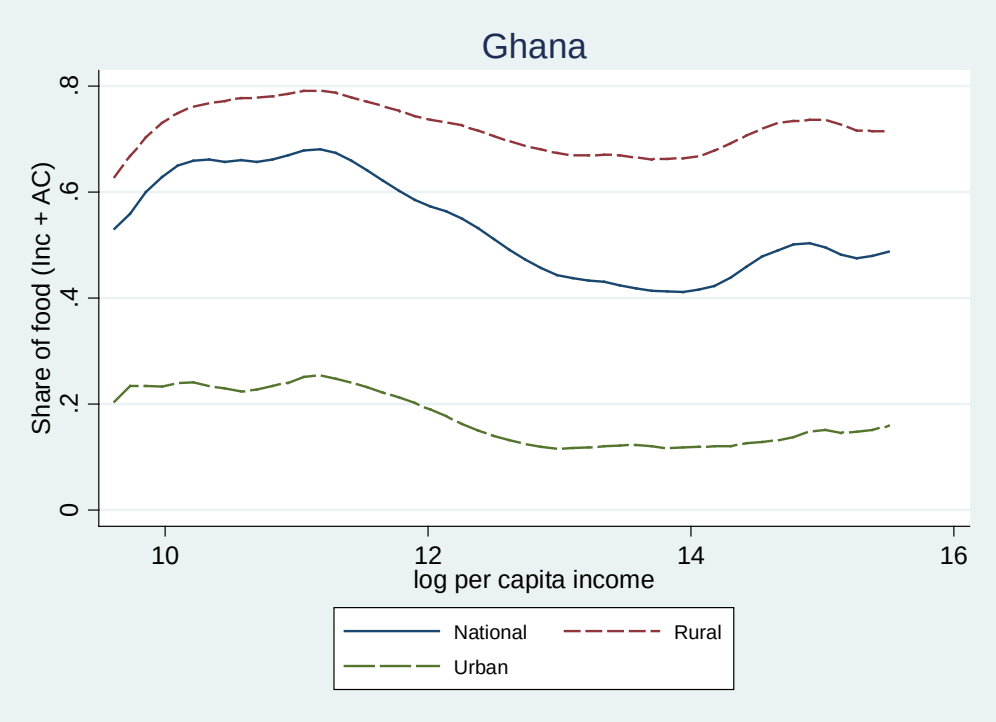
Figure 4.2: Total Food Budget Share across the Income Distribution



Source: Ghana Living Standard Survey 5 (2005).

Figure 4.3 shows the shares of food production in total income on the logarithm of household per capita expenditure. The income share of rural agricultural production is always greater than the urban share and the difference seems to increase with the level of per capita expenditure of the household. The income shares increase first with the level of livelihood to up to almost 80% for rural households and 25 percent for the urban houses to later decrease. From these two figures, we can draw preliminary conclusions about the welfare effects of food price changes. Looking at consumption patterns, price declines will improve welfare conditions relatively more for poor people in urban areas than those in rural areas. In rural the price change of food staples may have an ambiguous effect as agricultural products are both an important source of income and expenditure for the Ghanaian household.

Figure 4.3: Total Food Income Share across the Income Distribution

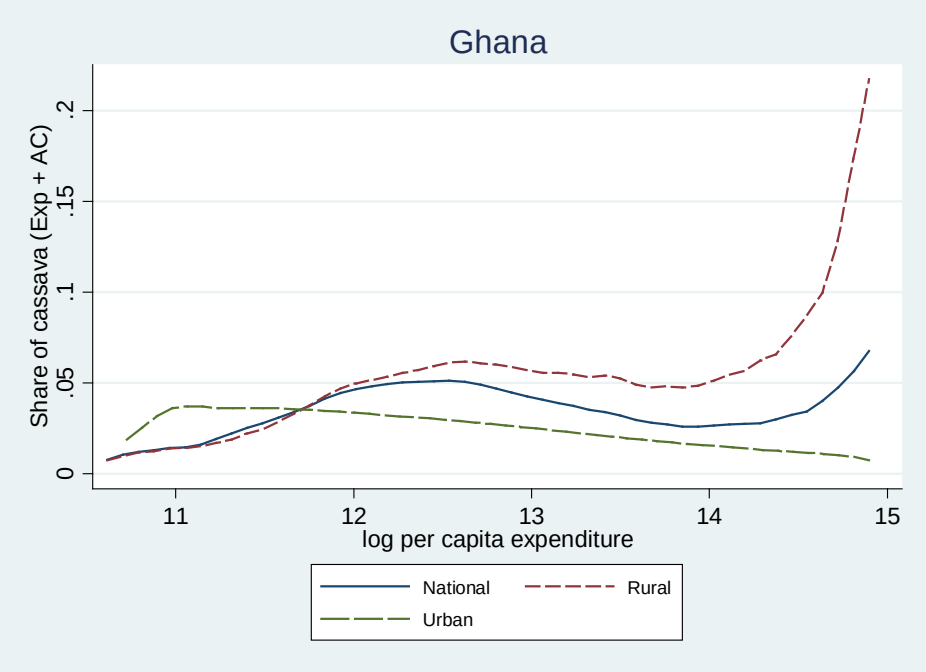


Source: Ghana Living Standard Survey 5 (2005).

We now take a closer look at the patterns of income and budget shares across the income distribution for three of the crops under study in Ghana (Figures 4.4-4.9).

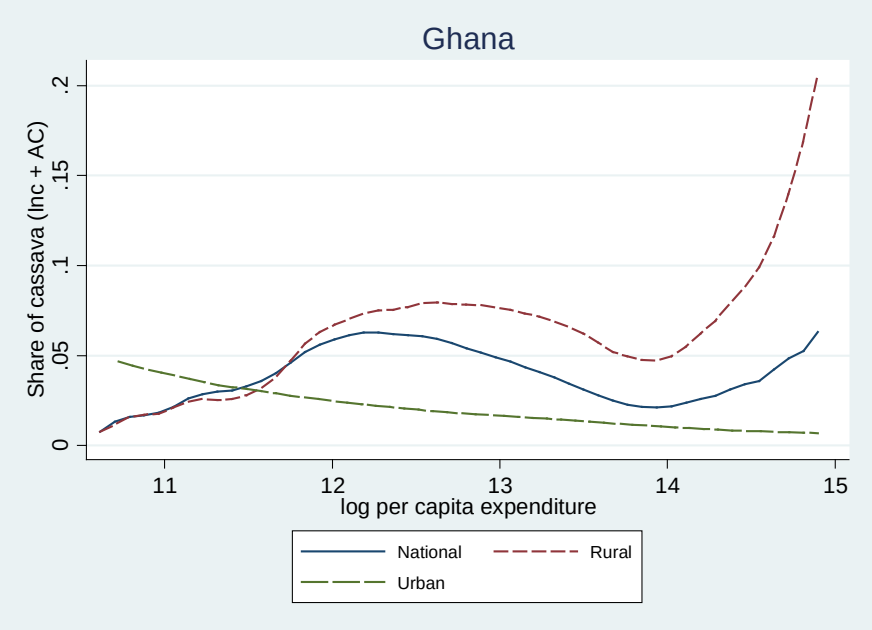
Figure 4.4 and 4.5 show the non parametric regression of cassava budget and income shares with respect to log per capita income for household in urban and rural areas in Ghana. The similarity of the level and the relationship with the level of livelihood for budget and income shares of cassava suggests a strong auto-consumption component for this crop. For poorer household the budget and income shares of cassava is larger for urban than rural households. However, while these shares smoothly decline with the level of income for urban households, it increases significantly for rural households. In rural areas the richest households on average spend (earn) up to 20 percent of their budget (income) while the poorest only spend (earn) around 2 percent in cassava.

Figure 4.4: Cassava Budget Share across the Income Distribution



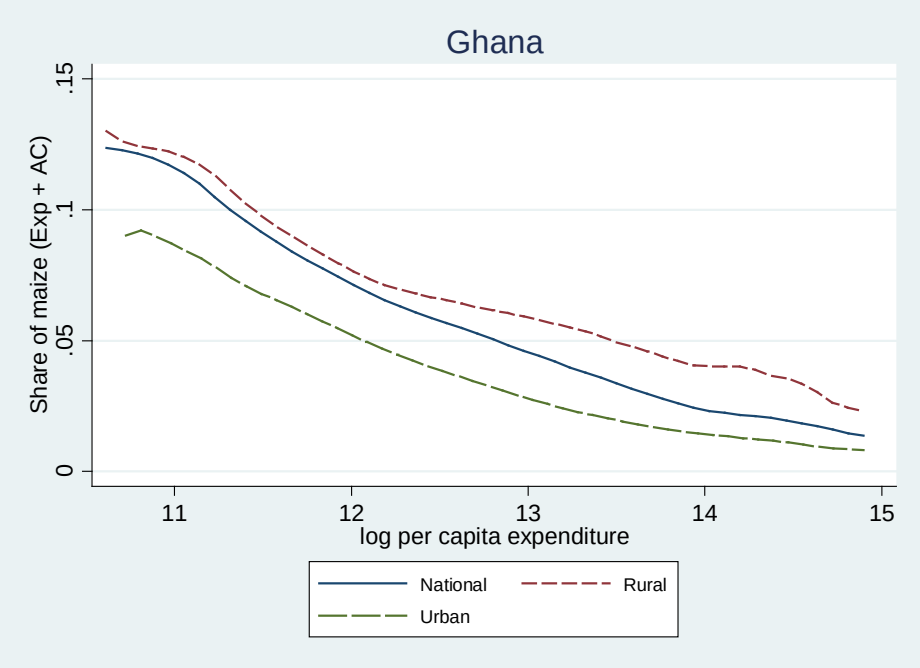
Source: Ghana Living Standard Survey 5 (2005).

Figure 4.5: Cassava Income Share across the Income Distribution



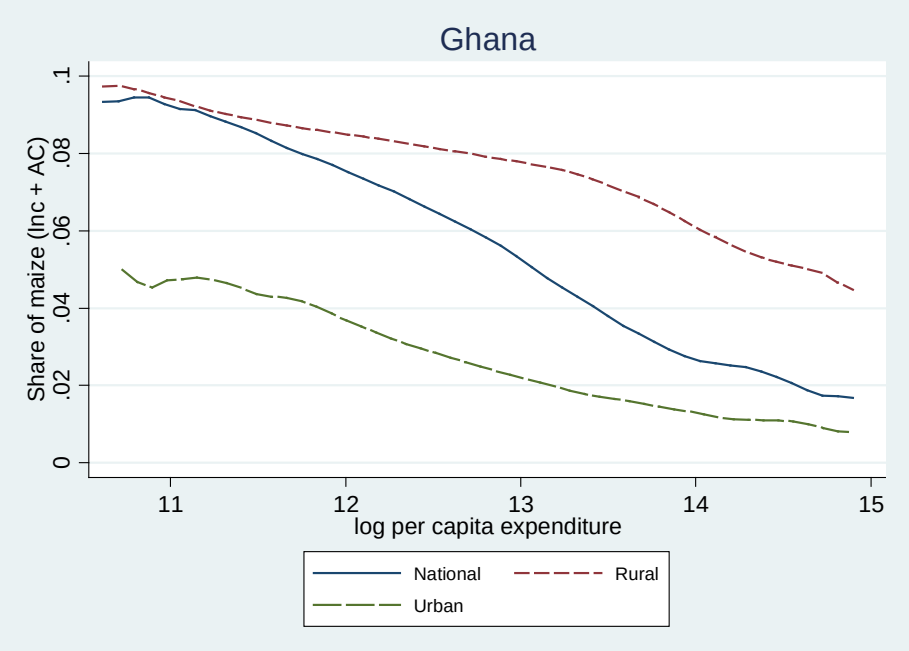
Source: Ghana Living Standard Survey 5 (2005).

Figure 4.6: Maize Budget Share across the Income Distribution



Source: Ghana Living Standard Survey 5 (2005).

Figure 4.7: Maize Income Share across the Income Distribution

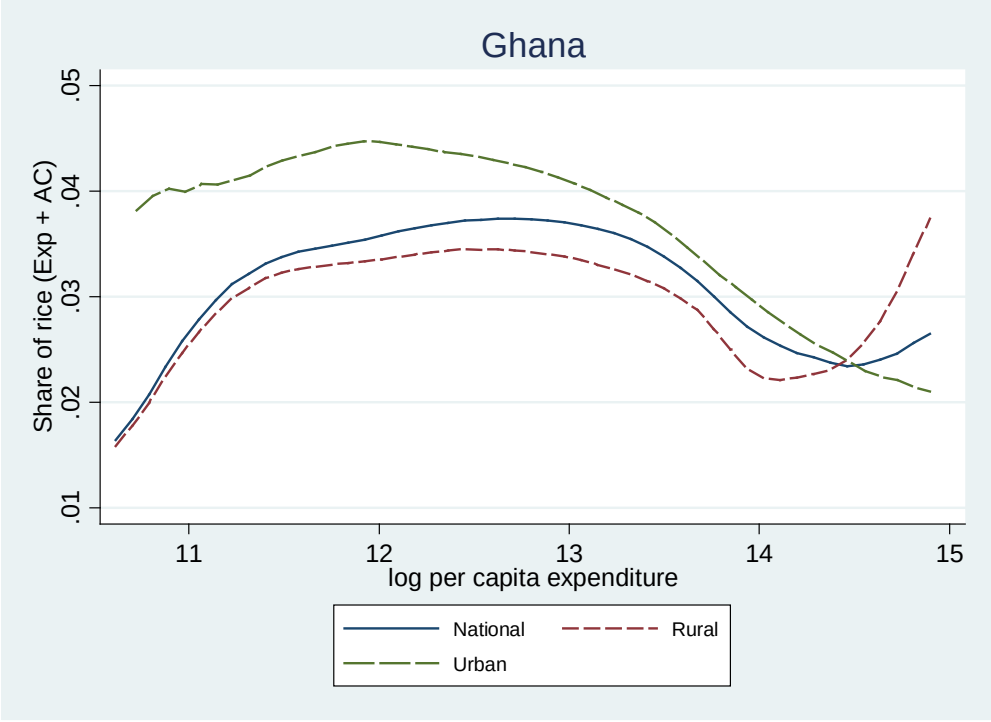


Source: Ghana Living Standard Survey 5 (2005).

The relationship with maize budget share and the level of livelihood of Ghanaian household is display in figure 4.6. The importance of maize in the households' budget declines with the level of income both for rural and urban households, with the incidence larger on average for rural households for all levels of per capita expenditure. While the poorest rural households spend almost 14 percent of their income on maize, the poorest urban households spend around 9 percent. These shares decline to around 3 and 1 percent for the richest rural and urban households respectively. The income share of maize (Figure 4.7) also declines with the level of livelihood and we would expect it is larger for rural than urban households. While auto consumption seems also important in the case of maize, the comparison of both figures shows that maize is also widely traded in Ghana.

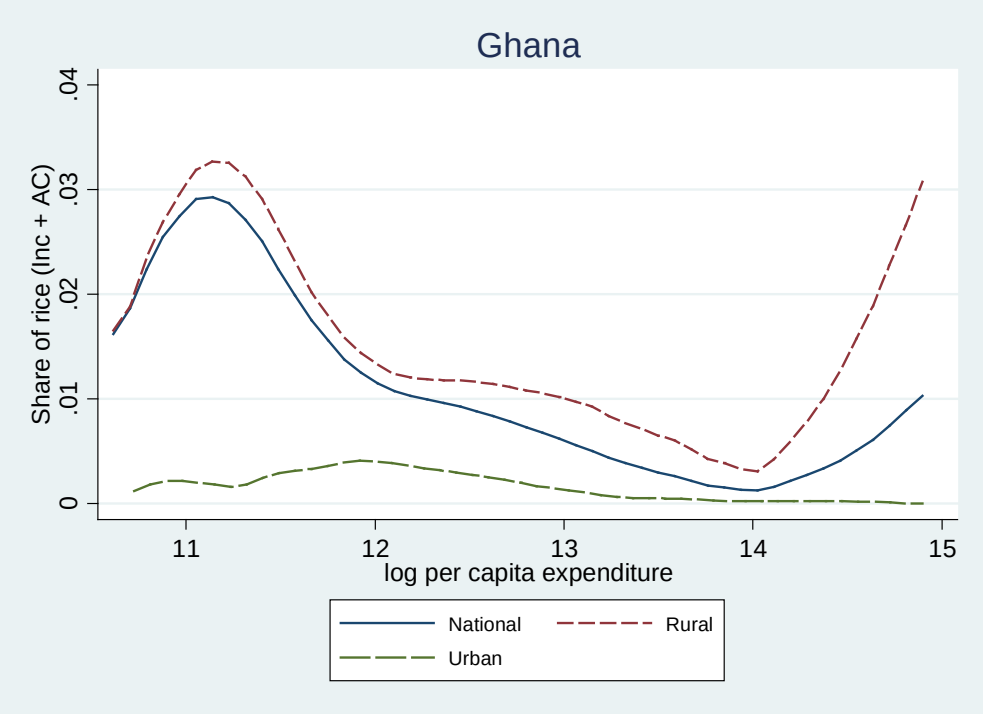
Finally, Figures 4.8 and 4.9 show the relationship between budget and income shares of rice with the level of livelihood. Rice is widely consumed in Ghana and local production often satisfies less than 50 percent of local demand with the deficit been covered by imports. Except for the richest households, the incidence of rice on households' budget is larger for urban than rural households. The share of rice on expenditures first increases with income, to later decrease (except for the wealthiest rural households). Rice income shares show a similar pattern with urban households declaring a smaller share of their income coming from rice than farmers, except again for the wealthiest farmers.

Figure 4.8: Rice Budget Share across the Income Distribution



Source: Ghana Living Standard Survey 5 (2005).

Figure 4.9: Rice Income Share across the Income Distribution



Source: Ghana Living Standard Survey 5 (2005).

4.2. Cash and Food Crops and Poultry in Ghana

The relative importance of the agricultural sector in Ghana in the country´s GDP has been declined as it accounted for 60 percent of GDP in 1980, 39.4% in 2000 and 22.7% in 2012. Despite this decline, the sector is one of the main sources of employment and it is of particular importance for food security. The main staple crops produced in Ghana are maize, cassava, yam, and plantain. In general, these crops are produced and consumed across the country. Farming is dominated by smallholder production, estimated to contribute over 90 percent of national food production with the majority of these small-holder producers being among the poorest households in Ghana.

Maize is one of the most important cereal crops in Ghana and the major staple crop. It is grown by the vast majority of rural households in all parts of the country except for the Sudan savannah zone of the far north. It is an important source of carbohydrate in the tropics and a major staple crop for most inhabitants in Ghana in addition to being an important poultry feed and for industrial uses (Morris, 2001; Pingali and Pandey, 2001; FAO, 2007). Accordingly to estimates, more than 70 percent of the maize produced in Ghana is reportedly either consumed at the farm level or informally traded. The local production often satisfies the domestic demand with small surpluses been exported and any deficit due to a bad crop covered by regional imports.

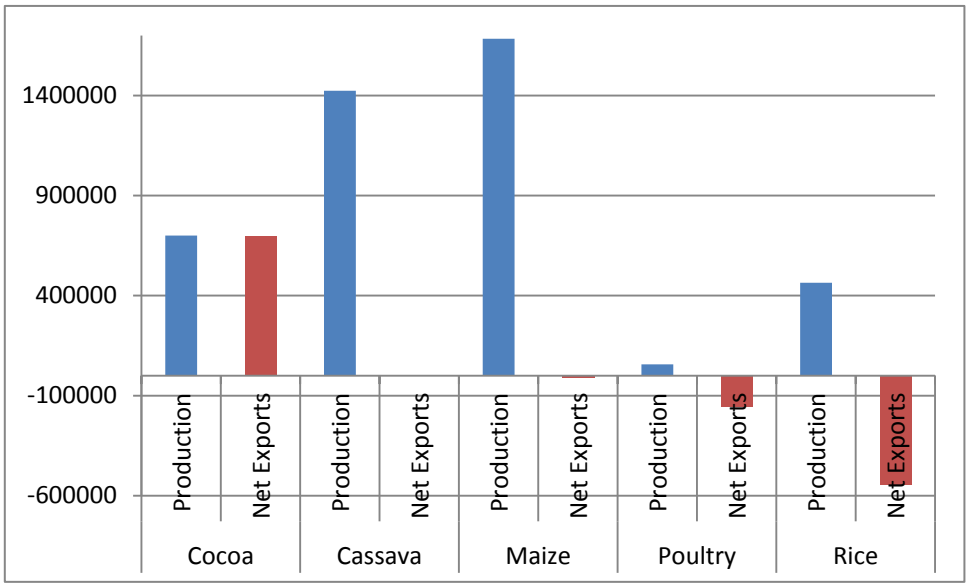
Cassava, which can grow well on marginal lands, is one of the most important staple foods in Ghana. The majority of cassava is grown by small-scale farmers with small landholdings. At that scale production, harvesting, and post-harvest handling are carried out with limited chemical and technical inputs. It is grown in all regions of Ghana but is particularly abundant in Central, Eastern, Brong Ahafo, Volta, and Ashanti regions. Cassava has traditionally been regarded as 'poor man's food' but increasingly its utilities as a cash crop are being recognized. Opportunities exist for earning incomes from processed cassava products, but significant constraints also continue to place restrictions on some opportunities. For instance traditional processing methods are time-consuming and labor intensive and the technology for processing modern industrial cassava products are often not available to most low income cassava producers and processors. All the domestic production is consumed domestically. There have been plans to add value to cassava by exporting starch to the international market but so far the results have been modest.

Rice has become a major staple food in Ghana and consumption of the commodity is increasing. Rice is cultivated in Ghana both as a food crop and a cash crop and it is undertaken in three different ecologies: lowland rain-fed ecology, which includes rice planted in the receding waters of the Volta and other rivers accounts for 78 percent of production; upland rain-fed ecology (6 percent), and irrigated ecology (16 percent). The greater part of local rice production is cultivated in the Upper East, Northern, and Volta Regions of Ghana which account for about 70 percent of production with 30 percent going to the rest of the seven regions. Rice consumption largely surpassed domestic demand with the surplus covered by imports. The importers tend to purchase through the international trade, but they may also deal direct with mills in Thailand. There are a large number of smaller importers who will bring in rice by the container load as the opportunity arises.

Poultry meat is also important in the Ghanaian diet. However the domestic sector is not competitive, in particular in broiler meat where imported poultry products tend to be 30-40 percent cheaper than locally produced chicken. This is due primarily to the high cost of production (feed, drugs), inefficient production methods, limited knowledge of modern poultry management, and lack of processing facilities. Commercial poultry production in Ghana can be categorized into large-scale (over 10,000 birds), medium-scale (5,000-10,000 birds) and small-scale (50-5,000) enterprises. Currently there are less than twenty large-scale commercial poultry operators, producing mainly eggs with limited production of broilers (meat). Broiler birds produced by some commercial poultry farmers are targeted at festive seasons (Christmas, Easter), when Ghanaians would normally buy live chickens. The large commercial poultry farms are privately owned by individuals or a family. Most operate their own feed-mills. There are over 1,500 small- to medium-scale poultry producers comprising over 95 percent of the poultry sector and they rely on hatcheries for their day-old chicks and on feed mills for their feed. The medium-scale category also produces primarily eggs. The small-scale category (including backyard poultry producers) mainly produces broiler birds.

The last crop we cover for Ghana is cocoa. The country is the second largest producers of cocoa beans after its neighbor Ivory Coast, and captures about 20% of the $9 billion international cocoa beans market. Cocoa is a significant crop for the Ghanaian economy, accounting for about 10% of GDP, generating about 25% of total export earnings, and generating employment for about 800,000 smallholder farms. Cocoa production in Ghana occurs in the forested areas of the country, namely the Ashanti, Brong-Ahafo, Central, Eastern, Western and Volta Regions. Since 2001, the volume of cocoa produced in the country has grown at unprecedented rates (at a yearly average of about 11 per cent between 1994 and 1999 and 16 per cent in the following 2000–03 interval). Many actors involved in the sector have attributed this production boom to the increase in fertilizer use and the introduction of a government sponsored mass-spraying exercise beginning in 2001. Today, Ghana cocoa production is slightly below 700,000 MT of cocoa beans per year, of which almost all is exported.

Figure 4.10: Crops and Poultry Production and Net Exports in Ghana (in tons, 2011)



Source: FAO.

The cassava and poultry market are relatively free with supply and demand establishing the market price. In the case of cassava there are many small processing units with any of them holding a significant share of the market (Table 4.3). The largest one, DATCO processing, holds 8.45 percent of the market. Instead for poultry meat, the two largest companies (Servistar and Silver Platter) hold 50 percent of the market, and the largest four companies account for 81 percent of the market. For rice and maize, the Ghana buffer stock company guarantees a minimum price to farmers and therefore market forces do not always determine the effective transaction price. The Ghanaian rice market is increasingly segmented and dominated by high priced premium rice which is mostly served by imports. There are, however, a few major buyers of local rice who sell under various brand names. It is believed that these distributors have contract farming arrangements with famers to

produce to their specification. Locally produced improved aromatic varieties are sold through traders and wholesalers into Accra and Kumasi to compete with imported rice. The maize processing industry is rather competitive with the two main processors controlling together only around 11 percent of the processing capacity as illustrated in table 4.3. The rest is controlled by a large number of small scale hammer and motorized mill scattered around the country.

The cocoa beans sector in Ghana is heavily regulated. COCOBOD plays a key role across the Ghanaian supply chain, providing subsidized inputs and guaranteeing purchase prices to farmers, and directly managing all exports through its wholly owned subsidiary, the Cocoa Marketing Company (CMC). COCOBOD grants licenses to companies to buy cocoa beans from producers at no less than announced prices and deliver them to Cocoa Marketing Company Limited (CMC), while adhering to quality standards that are stipulated by the Quality Control Company (QCC). These Licensed Buying Companies (LBCs) can be divided into four groups. The first category comprises the former subsidiary of COCOBOD, the PBC who controls 32.82% of the market. The second category of LBCs consists of domestically owned companies and control 44.76% of the market. The third type of companies is the farmer-based fair trade cooperative KuapaKokoo who controls 5.91% of the market share. The last category of LBCs comprises the two international companies, Olam and Armajaro who control 16.41% of the market. As a result of the regulations, Ghanaian farmers have far more price stability than in free-market oriented regimes such as Cote d'Ivoire, although recent producer prices as a share of the world spot price appear comparable.

4.3. Simulation results

In this section, we use the model to perform various simulations. These simulations are in fact comparative static results that stem from the model. Among the parameters of the model, we consider two sets of exercises. The first exercise is to shock the market structure of the supply chain. To this end, we consider (arbitrary) changes in the number of firms and in their market shares to capture both increases and decreases in the extent of competition in the supply chain. We also consider comparative static results from changes in key parameters affecting the production decision of the farmers. We explore (arbitrary) changes international prices, costs of production, endowments, risk and food security aversion.

We investigate five case studies for Ghana: cocoa, cassava, maize, poultry, and rice. Cocoa is a cash crop that is mostly exported. Cassava and maize are produced for the domestic market with little international trade. On the other hand, rice and poultry are both produced domestically and heavily imported. As before, given the complexity of the scenarios, we simplify the analysis by working with a sequence of partial equilibrium models so that each case study is dealt with separately.

Table 4.3: Market Shares in Ghana

Cocoa		**Cassava**		**Maize**	
Company	*Shares*	*Company*	*Shares*	*Company*	*Shares*
PBC	32.83%	St. Bassa Processing	1.69%	Premium Food	10%
Akuapo	11.97%	Caltech Ghana Ltd	1.13%	Yedent Agro Food Processing	1.1%
Olam	10.71%	JosmaGari Processing	1.35%	Others (>100 small scale ones)	88.9%
Adwumapa	8.62%	Ayensu Starch company	5.41%		
Fed	7.04%	DATCO processing	8.45%		
KuapaKokoo	5.91%	Praise Export Ghana Limited	0.28%		
Transroyal	5.72%	Processing Associations (>30)	33.80%		
Armajaro	5.70%	Small Scale Artisanal Processors (>50)	56.34%		
Coco Gh	3.17%				
Diaby	2.70%				
Others	5.63%				

Poultry		**Rice**	
Company	*Shares*	*Company*	*Shares*
Silver Platter	22%	Prairie Volta	13.48%
Servistar	28%	Brazil Agro	6.96%
Francopat Co	17%	Worawora	2.61%
Succatrde Ltd	14%	Nasia	3.91%
Cocas Impex	7%	Lolandi	2.17%
Swift Com	5%	Avnash	29.5%
AdomMbroso	3%	Amsig	1.3%
K.R. Ent	3%	Kpong Irrigation Project	1.56%
Other	1%	Small scale mills (more than 100 scattered around country)	38.51%

We first consider the case of cocoa displayed in Table 4.4. As expected increases in competition would increase the price paid to the farmers and reduction in competition will decreased it (row 1). However, the effect is only large when we consider the limit cases of equal market shares (farm gate prices would increase 17.91 percent) and perfect competition (prices would increase 27.34 percent). In column 1, starting in row 2 we can see the effects of shocks to the farmers constraint. As it was the case in other cash crops, we find that the pass through of the international price to the farmers is more than 100 percent. An increase of ten percent in either the marginal and fixed cost of producing cocoa would contract the supply of cocoa but the price received by farmers would only increase 0.38 and 0.36 percent respectively in the baseline scenario. An increase of 10% in the endowment of the farmer (row 5) would increase the resources available for both food and cash crops and the increase in the supply of cocoa would reduce the price paid to the farmer by slightly more than 1 percent point. The model also predicts that increases in household risks that lead to higher demands for food security positive affect equilibrium cocoa prices (row 6). We can also study the spillovers and interrelationships between cash crop production and food markets. In the cocoa export model, Ghanaian farmers take the prices of competing marketable foods as given, but the level of these prices clearly affects production and consumption decision. Similarly, the marginal cost of producing food can also affect cocoa production choices. In our simulations, we find that increases in the prices of competing food crop prices marginally increases the price paid to cocoa farmers (row 7). Alternatively, an increase in the cost of producing those goods would lead to no change in cocoa prices (row 8). These feedbacks that are rather small in the case of cocoa can be sizeable as we will shown later in other simulations. On the other hand, a 10 percent increase in the transaction cost associated with the production of cocoa beans will have a 5 percent increase in its farm gate price (row 9).

Another interesting feature of our model is that we can examine complementarities between shocks to the structure of competition among exporters and processing companies and shocks to household constraints. The idea is to uncover potential synergies between different types of policies or shocks. Our approach here is to simulate the impacts of the joint shocks and to compare these numbers with the sum of the impacts of each individual shock (competition policies shocks in row 1 and complementary policy results column 1). Complementarities show up when the joint effect is larger than the sum of the separate effects. For instance, an increase of international price of cocoa of 10 percent and an increase in competition where all the processing cocoa firms have the same market share would lead to a price increase of 29.95 percent when the sum of the individual effects would amount to 29.65 percent. On the other hand, if we consider the combination of an increase of the food crop and equal market shares, the joint effect on the price of cocoa (17.94 percent) is lower than the sum of the individual effects (18.09). In this case, the two policies are substitutes.

We turn now to the analysis of the simulations for the case of cassava displayed in Table 4.5. In the last decade Ghana has imported some cassava and therefore we decided to model the sector as an importing food crop even though almost all domestic demand is satisfied by local production. This implies that the domestic price is the

international price plus a domestic markup and therefore more competition will reduce the domestic price. Unsurprisingly, given that there is already a lot of competition in this market, the effects of competition policy shocks are very small. Only the extreme case of perfect competition among cassava importers would reduce cassava farm gate prices by 6.75 percent. On the other hand, changes in the constraint affecting farmers have relatively important effects on the price of cassava. For instance, increases in the production costs of the cash crop generate reduction in the price of cassava because cash some crop farmers would switch to cassava and increase its supply. The magnitudes are not irrelevant. The impact of changes in marginal costs is -3.22 percent (row 3) and the impact of changes in fixed costs is -1.17 percent (row 4). An increase of ten percent in the price of the cash crop, in turn raises cassava prices by 4.37 percent (row 7) because it induces farms to produce more cash crop and supply less cassava.

Factors that affect cassava production directly have relatively small impacts on the cassava farm gate price. In row 8, for instance, a 10 percent increase in the marginal cost of producing cassava raises cassava equilibrium prices by only 1 percent. Similarly, changes in household risks that raise autoconsumption have a positive effect on cassava prices but the effect is small (0.65 percent). An increase of 10 percent in transaction cost of cassava would increase its farm gate price by almost 3 percent because of its negative effect on supply (row 9). An interesting result is that an increase in the endowment does not reduce the price of cassava but increases it. A higher endowment allows households to produce more of all crops, including cassava. Ceteris paribus, this should lead to price declines because of a larger supply. However, the price of cassava increases 1.35 percent. This could happen if the increase in household resources is such that cash crop production becomes, at the margin, profitable to a larger number of farmers and this creates incentives to move some resources out of cassava and into the export cash crop.

Maize, poultry, and rice are also modeled as food importing sectors. Maize imports are relatively small but poultry meat and rice imports are often larger than domestic production. The market for maize processing is relatively competitive and therefore the price impacts of changes in the level of competition are rather modest. For instance, in the case of leader split, the price of maize would decrease by only 0.10 percent, while the same simulation in poultry and rice would decrease their prices 0.42 and 0.50 percent respectively. As in cassava, the international to domestic price pass through is incomplete. A ten percent increase in the international price of the food crop would increase the domestic farm gate price of maize, poultry meat, and rice by 3.57, 4.48, and 1.85 percent respectively. An increase of 10 percent in the marginal cost of the competing export cash crop sector would only reduce the price of maize and poultry meat by less than 1 percent but it would reduce the price of rice by 3.62 percent. The rice price is also more sensitive to changes in the price of the export cash crop. An increase in ten percent in the cash crop would switch resources away from rice what would imply an increase in its price of around 4.5 percent. Changes in the endowment have positive but small price effect in the three food staples. Variations in transaction costs both for the final product and production inputs seem to have a minor farm gate price effect.

Table 4.4: Simulation Results for Cocoa

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	2,04	-0,83	-2,38	17,91	27,34
Increase of 10% in:						
International Price	11,74	13,90	10,70	9,12	29,95	40,32
Marginal Cost of Producing Cash Crop	0,38	2,40	-0,48	-1,99	18,11	27,34
Fixed Cost of Producing Cash Crop	0,36	2,43	-0,48	-2,00	18,23	27,34
Endowment	-1,17	0,94	-2,15	-3,63	16,48	27,34
Preference Paremeter	1,35	3,48	0,59	-0,96	19,27	27,34
Food Crop Price	0,18	2,20	-0,66	-2,17	17,94	27,34
Marginal Cost of Producing Food Crop	0,00	2,03	-0,85	-2,39	17,91	27,34
Transaction Costs on Crop Production	5,05	5,98	4,60	3,92	12,88	17,34
Transaction Costs on Inputs	0,11	0,70	-0,14	-0,58	5,25	27,34
Non-Farmer demand	0,00	2,04	-0,83	-2,38	17,91	27,34

Source: simulation results from the model of Section 2.

Table 4.5: Simulation Results for Cassava

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	-0,20	0,28	0,28	0,00	-6,75
Increase of 10% in:						
International Price	6,80	6,64	6,95	6,95	6,80	2,34
Marginal Cost of Producing Cash Crop	-3,22	-3,36	-3,09	-3,09	-3,22	-6,75
Fixed Cost of Producing Cash Crop	-1,17	-1,36	-0,95	-0,95	-1,17	-6,75
Endowment	1,35	1,03	1,68	1,68	1,35	-6,75
Preference Paremeter	0,65	0,40	0,93	0,93	0,65	-6,75
Cash Crop Price	4,37	3,97	4,84	4,84	4,37	-6,75
Marginal Cost of Producing Food Crop	1,00	0,70	1,30	1,30	1,00	-6,75
Transaction Costs on Crop Production	2,92	2,85	2,99	2,99	2,92	1,00
Transaction Costs on Inputs	0,29	0,20	0,38	0,38	0,29	-6,75
Non-Farmer demand	0,49	0,22	0,77	0,77	0,49	-6,75

Source: simulation results from the model of Section 2.

Table 4.6: Simulation Results for Maize

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	-0,10	0,11	0,11	0,00	-2,30
Increase of 10% in:						
International Price	3,57	3,49	3,66	3,66	3,57	1,70
Marginal Cost of Producing Cash Crop	-0,95	-1,00	-0,88	-0,88	-0,95	-2,30
Fixed Cost of Producing Cash Crop	-0,68	-0,75	-0,61	-0,61	-0,68	-2,30
Endowment	0,66	0,53	0,80	0,80	0,66	-2,30
Preference Paremeter	0,46	0,35	0,59	0,59	0,46	-2,30
Cash Crop Price	1,86	1,68	2,06	2,06	1,86	-2,30
Marginal Cost of Producing Food Crop	0,14	0,04	0,26	0,26	0,14	-2,30
Transaction Costs on Crop Production	1,54	1,50	1,57	1,57	1,54	0,73
Transaction Costs on Inputs	0,04	0,01	0,07	0,07	0,04	-2,30
Non-Farmer demand	0,17	0,06	0,29	0,29	0,17	-2,30

Source: simulation results from the model of Section 2.

Table 4.7: Simulation Results for Poultry

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	-0,42	0,46	0,60	-0,89	-3,30
Increase of 10% in:						
International Price	4,48	4,29	4,60	4,73	3,59	2,95
Marginal Cost of Producing Cash Crop	-0,70	-1,02	-0,39	-0,31	-1,59	-3,30
Fixed Cost of Producing Cash Crop	-0,53	-0,88	-0,19	-0,08	-1,43	-3,30
Endowment	0,59	0,11	1,14	1,26	-0,32	-3,30
Preference Paremeter	1,15	0,58	1,73	1,85	0,23	-3,30
Cash Crop Price	2,96	2,16	4,02	4,13	2,05	-3,30
Marginal Cost of Producing Food Crop	0,70	0,14	1,24	1,36	-0,28	-3,30
Transaction Costs on Crop Production	1,93	1,85	1,98	2,03	1,54	1,27
Transaction Costs on Inputs	0,20	0,04	0,36	0,40	-0,08	-3,30
Non-Farmer demand	0,20	-0,24	0,73	0,87	-0,71	-3,30

Source: simulation results from the model of Section 2.

Table 4.8: Simulation Results for Rice

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	-0,50	0,40	0,56	-3,22	-6,14
Increase of 10% in:						
International Price	1,85	1,40	2,21	2,37	-1,36	-3,71
Marginal Cost of Producing Cash Crop	-3,62	-3,79	-3,54	-3,39	-6,66	-6,14
Fixed Cost of Producing Cash Crop	-0,64	-1,10	-0,29	-0,14	-3,88	-6,14
Endowment	0,40	-0,10	0,84	1,01	-2,78	-6,14
Preference Paremeter	1,98	1,29	2,60	2,78	-1,48	-6,14
Cash Crop Price	4,51	3,61	5,40	5,56	1,11	-6,14
Marginal Cost of Producing Food Crop	0,67	0,12	1,17	1,33	-2,59	-6,14
Transaction Costs on Crop Production	0,80	0,60	0,95	1,02	-0,58	-1,59
Transaction Costs on Inputs	0,19	0,03	0,34	0,39	-0,75	-6,14
Non-Farmer demand	0,27	-0,24	0,69	0,82	-2,97	-6,14

Source: simulation results from the model of Section 2.Welfare impacts

We conclude the analysis for Ghana with an analysis of the poverty impacts resulting from the price simulations of the previous section. The analysis is done using the standard first order approximation analysis of Deaton (1989, 1997). This implies we can approximate the impact of a price change using income shares and budget shares as measures of exposure. The first order approximation works well if the price changes are small and if there are limited supply and consumption responses.

The welfare impacts of the price changes are reported in Tables 4.9 to 4.13 for the cases of cocoa, cassava, maize, poultry, and rice. We show the impacts of shocks to the market structure in the first row and to illustrate the role played by complementarities, we show results for a combination of shocks to market structure and international prices. We show average results for the total population, the poor, and the non-poor, and separate results for household that declare to be a producer of the crop under consideration.

Some regularities can be detected in the simulation results. Increased competition and complementary policies in cocoa show positive welfare impacts across households. The impacts are obviously larger for cocoa producers but are overall modest except for extreme cases such as moving to perfect competition. Competition among exporters in a cash export crop implies higher farm-gate prices and, consequently, higher farm income from cocoa production. Since cocoa is only produced and not consumed directly by the households, real farm income is in the end higher. For the food crops, the overall welfare effects are very small because the net benefit ratios are very small (income shares are compensated by expenditure shares of the same order of magnitude). The overall effect of more competition is not clear as household (in particular in rural areas) tend to be both producers and consumers of food staples.

Table 4.9: Cocoa Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	0,07	-0,03	-0,08	0,58	0,89
International Price	0,38	0,45	0,35	0,30	0,97	1,31
Poor						
Competition Policy	0,00	0,07	-0,03	-0,08	0,64	0,97
International Price	0,42	0,50	0,38	0,33	1,07	1,44
Non Poor						
Competition Policy	0,00	0,06	-0,02	-0,07	0,50	0,76
International Price	0,33	0,39	0,30	0,25	0,83	1,12
Producers						
Competition Policy	0,00	0,38	-0,16	-0,45	3,36	5,12
International Price	2,20	2,61	2,01	1,71	5,61	7,56

Note: first order impact on household welfare.

Table 4.10: Cassava Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	-0,01	0,01	0,01	0,00	-0,28
International Price	0,28	0,28	0,29	0,29	0,28	0,10
Poor						
Competition Policy	0,00	0,00	0,01	0,01	0,00	-0,16
International Price	0,16	0,16	0,17	0,17	0,16	0,06
Non Poor						
Competition Policy	0,00	-0,01	0,02	0,02	0,00	-0,46
International Price	0,46	0,45	0,47	0,47	0,46	0,16
Producers						
Competition Policy	0,00	-0,03	0,04	0,04	0,00	-1,01
International Price	1,02	0,99	1,04	1,04	1,02	0,35

Note: first order impact on household welfare.

Table 4.11: Maize Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	0,00	0,00	0,00	0,00	-0,07
International Price	0,11	0,11	0,11	0,11	0,11	0,05
Poor						
Competition Policy	0,00	-0,01	0,01	0,01	0,00	-0,12
International Price	0,19	0,18	0,19	0,19	0,19	0,09
Non Poor						
Competition Policy	0,00	0,00	0,00	0,00	0,00	0,00
International Price	0,00	0,00	0,00	0,00	0,00	0,00
Producers						
Competition Policy	0,00	-0,01	0,01	0,01	0,00	-0,13
International Price	0,21	0,20	0,21	0,21	0,21	0,10

Note: first order impact on household welfare.

Table 4.12: Poultry Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	0,00	0,00	0,00	0,01	0,02
International Price	-0,03	-0,03	-0,03	-0,03	-0,02	-0,02
Poor						
Competition Policy	0,00	0,00	0,00	-0,01	0,01	0,03
International Price	-0,04	-0,04	-0,04	-0,04	-0,03	-0,03
Non Poor						
Competition Policy	0,00	0,00	0,00	0,00	0,00	0,01
International Price	-0,01	-0,01	-0,01	-0,01	-0,01	-0,01
Producers						
Competition Policy	0,00	0,00	0,00	0,01	-0,01	-0,03
International Price	0,04	0,04	0,04	0,05	0,03	0,03

Note: first order impact on household welfare.

Table 4.13: Rice Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	0,00	0,00	0,00	-0,01	-0,01
International Price	0,00	0,00	0,00	0,00	0,00	-0,01
Poor						
Competition Policy	0,00	0,01	-0,01	-0,01	0,06	0,11
International Price	-0,03	-0,02	-0,04	-0,04	0,02	0,06
Non Poor						
Competition Policy	0,00	-0,01	0,01	0,02	-0,10	-0,18
International Price	0,06	0,04	0,07	0,07	-0,04	-0,11
Producers						
Competition Policy	0,00	-0,03	0,02	0,03	-0,18	-0,35
International Price	0,10	0,08	0,12	0,13	-0,08	-0,21

Note: first order impact on household welfare.

5. Welfare effects of domestic market structure and household constraints: The case of Nigeria

5.1. The Household Survey Data

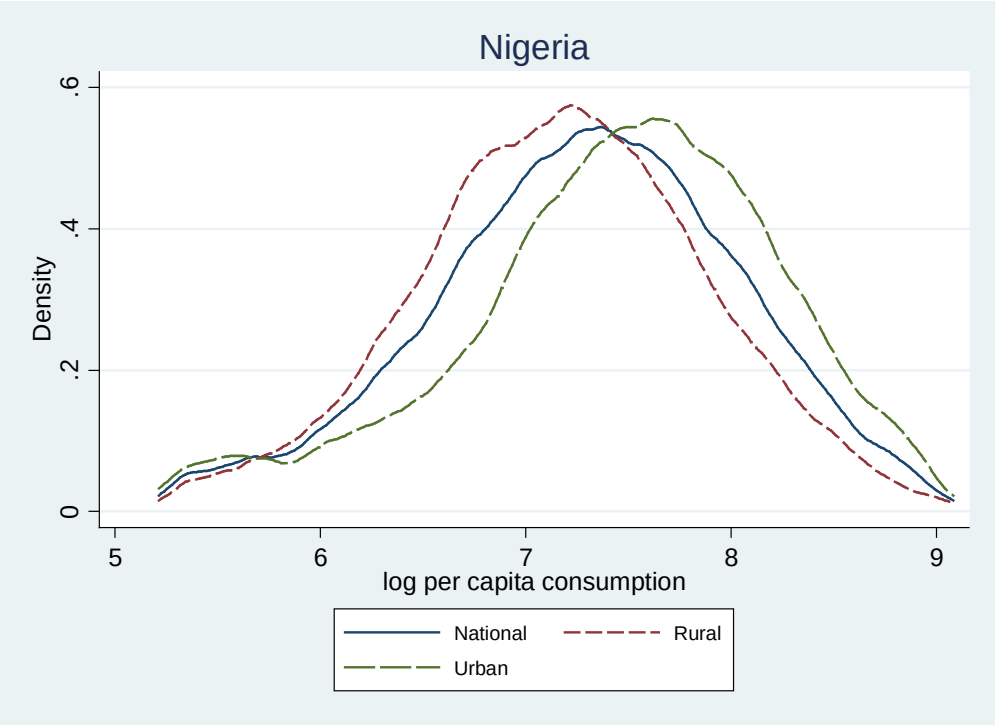
The household data in the analysis comes from the 2003-2004 "Nigeria Living Standards Survey". This survey is a stratified clustered survey with a sample size that allows representative statistics at state level; although the design sample size was somewhat larger, there are usable data on 19,158 households. The NLSS 2004 survey reveals that poverty in Nigeria is largely a rural phenomenon. There is a 20 percentage point gap between the poverty incidence of the urban and rural households. While 43 percent of urban households are poor, 63.8 percent of the rural households are poor. Further investigation of the poverty profile in the rural area reveals that about 44.4 percent cannot meet the food expenditure requirements while 19.38 percent of the households, although could meet the food expenditure requirements are unable to meet the minimum expenditure to cover other basic needs. The survey also shows that children constitute about half the population of Nigeria and female headed households are 15.9 percent of the total. Self-employed people are 47.04 percent of the sample, family workers 33.55 percent, and wage earners 16.2 percent. Almost half the people in the sample work in agriculture (48.9 percent).

The distribution of income in Nigeria is displayer in Figure 5.1 for the national level and for urban and rural regions separately. The density for urban areas lies to the right of the density for rural areas as on average they enjoy a higher level of expenditure per capita than the rural households.

Important determinants of living conditions of households and their members will be the economic activities in which they are engaged and the returns they are able to reap there from. For many households in Nigeria, especially in the rural areas, agriculture is the main activity, and previous and current analysis of poverty has shown that poverty is disproportionately concentrated among households whose primary livelihood lie in agricultural activities. For that reason we use household survey data to discuss the importance of agriculture and food both as a source of income and as expenditure for the households in Nigeria. In Table 5.1, we report consumption patterns for urban and rural households in Nigeria. The share of auto-consumption is much larger in rural areas than in urban areas but the auto-consumption shares are lower than we observe in other Sub-Saharan African countries. For urban households, 86 percent of their expenditure is cash spending. For rural households, cash expenditures account for 71.8 percent of the total budget, while home-produced expenditures account for the remaining 28.2 percent. Since we are interested in food consumption, we can take a close look at aggregate food expenditure. The incidence of food expenditures in the budget is very large. In fact, accordingly to the survey, 72.9 percent of the average Nigerian household budget is spent on food. This share is slightly larger for rural households (74.4 percent) than for urban households (70.9 percent). This observation fits with the idea that urban people are richer,

who thus spend more on other goods and services than on food. Among food item, the most significant crops in consumption are rice, yam, livestock, and millet. On average, rice represents 6.8 percent of Nigerian household expenditure while yam accounts for 5.9 percent, millet for 5.7 percent, and livestock 5.2 percent. The pattern of expenditures on food in urban and rural areas is similar except for some cereals like wheat (predominantly urban) and sorghum (with higher incidence in rural areas).

Figure 5.1: The Distribution of Income
Density of (log) per capita household expenditure



Source: Nigeria Living Standards Survey (2003).

In Table 5.2, we show different sources of income for urban and rural households in Nigeria. As anticipated, urban households have larger shares of cash income (90 percent), because a significant part of their income comes from wages and enterprises (often self employment in the informal sector). In contrast, rural cash income represents 58.7 percent of total income of which almost 60 percent is associated with agricultural income. Looking at agriculture income, sorghum, millet, maize, and cassava are the most important source of income in rural areas, followed by yam and livestock. Rice and wheat that were important in consumption are less so as a source of income as there two crops are heavily imported.

Table 5.1: Budget Shares

Nigeria	Total	Rural	Urban
Total consumption per capita	**100,0**	**100,0**	**100,0**
Expenditures	**78,0**	**71,8**	**86,0**
Food	50,9	46,2	56,9
Manufactures	17,8	17,6	18,0
Services	8,9	7,8	10,2
Others	0,4	0,1	0,8
Auto-consumption	**22,0**	**28,2**	**14,0**
Auto-consumption food	22,0	28,2	14,0
Auto-consumption others	0,0	0,0	0,0
Total Food consumption	**72,9**	**74,4**	**70,9**
Total crops	**37,5**	**37,6**	**37,3**
Maize	3,5	3,5	3,4
Rice	6,8	6,3	7,5
Poultry	0,6	0,7	0,4
Livestock	5,2	5,2	5,3
Wheat	3,0	1,9	4,5
Cassava	1,9	2,6	1,0
Sorghum	3,4	5,0	1,3
Millet	5,7	5,5	6,0
Cowpea	1,5	1,3	1,7
Yam	5,9	5,6	6,2

Source: Nigeria Living Standards Survey (2003).

Table 5.2: Income Shares

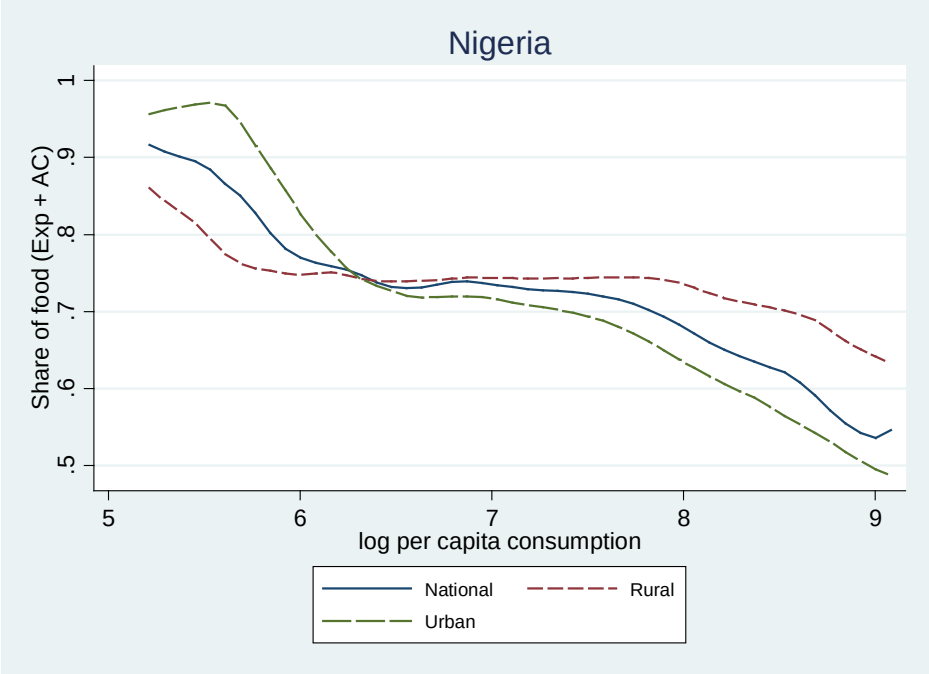
Nigeria	Total	Rural	Urban
Total Income per capita	**100,0**	**100,0**	**100,0**
Incomes	**72,1**	**58,7**	**90,0**
Food (agriculture)	24,4	34,3	11,2
Wage	19,0	9,2	32,2
Enterprises	24,0	11,0	41,4
Transfers	4,6	4,2	5,2
Auto-consumption	**27,9**	**41,3**	**10,0**
Auto-consumption food	27,9	41,3	10,0
Auto-consumption others	0,0	0,0	0,0
Total Food income and AC	**52,3**	**75,6**	**21,2**
Total crops	**30,5**	**45,9**	**9,9**
Maize	4,8	7,0	1,8
Rice	2,1	3,3	0,6
Poultry	0,9	1,3	0,4
Livestock	2,9	4,5	0,8
Wheat	0,1	0,1	0,1
Cassava	4,3	6,5	1,4
Sorghum	6,3	9,8	1,5
Millet	5,8	8,5	2,2
Cowpea	0,2	0,2	0,2
Yam	3,1	4,6	1,1

Source: Nigeria Living Standards Survey (2003).

We are interested in the poverty and distributional impact of changes in agricultural prices and therefore we need to describe the patterns of expenditure and income sources related to agriculture across the income distribution. In Figures 5.2 and 5.3 we plot estimates of non-parametric regressions of food budget share and income food shares on the logarithm of per capita expenditure of the households for the national sample and for households in rural and urban areas separately. The food budget share profile slopes steeply downward for poor urban household, then it smoothly declines for the urban household in the middle and upper part of the distribution. On the other hand, the share spent on food by rural households' declines moderately with the level of per capita expenditure. At the bottom of the distribution, urban households allocate more than 95 percent of their budget to food, while rural households spend around 85 percent. This clearly shows that extreme poverty and food safety is a concern for the Nigerian households in the bottom of the distribution. For households in the middle of the income distribution; the proportion of food expenditures is larger for rural than urban households and this gap increases with the level of livelihood in Nigeria. The richest urban households spend less than 50 percent of their

budget on food, while their rural counterparts spend close to two third of their budget on food.

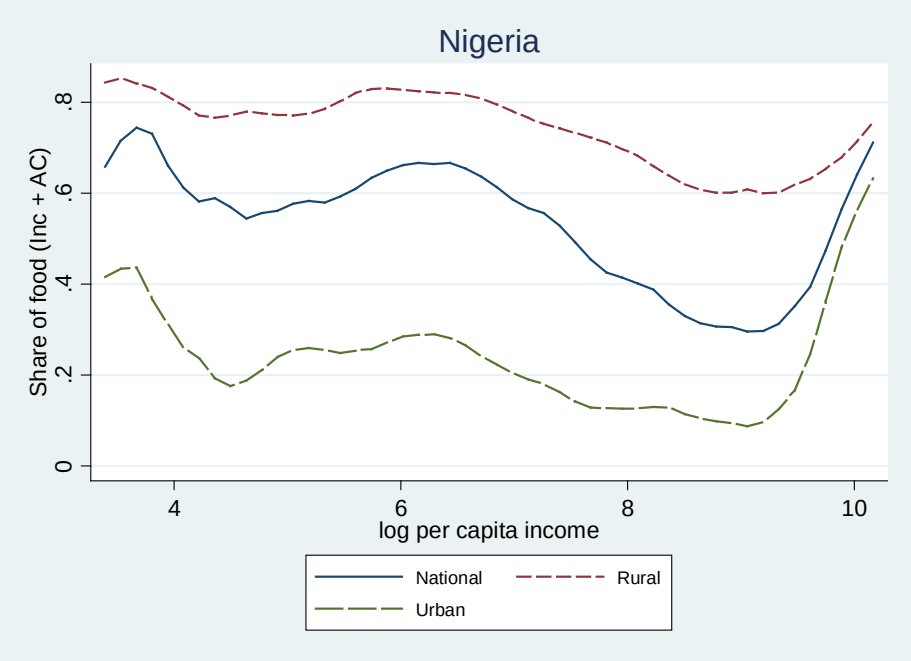
Figure 5.2: Total Food Budget Share across the Income Distribution



Source: Nigeria Living Standards Survey (2003).

Figure 5.3 shows the shares of food production in total income on the logarithm of household per capita expenditure. The income share of rural agricultural production is always greater than the urban share but the difference decreases for the upper section of the distribution where urban households get on average 60 percent of their income from agriculture against slightly more than 70 percent of the richest rural households. For rural households, the incidence of agriculture on total income oscillates between 82 and 60 percent, with the largest incidence observed for low and middle income rural households. From this figures, we can find the same pattern we found in Ghana for the likely welfare effect of a price change in agricultural commodities, price declines will improve welfare conditions relatively more for poor people in urban areas than those in rural areas. In rural the price change of food staples may have an ambiguous effect as agricultural products are both an important source of income and expenditure for the Nigerian household.

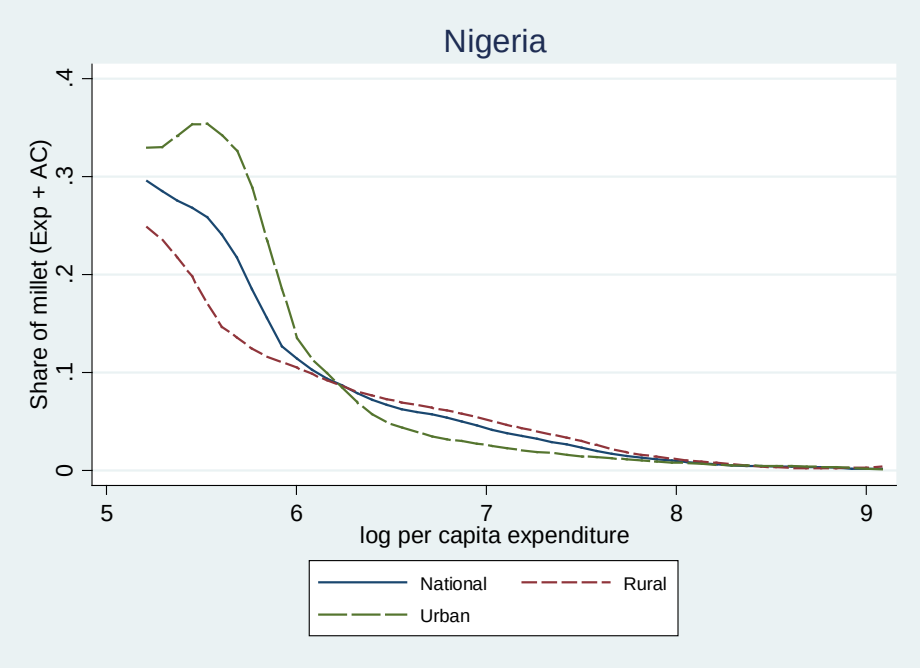
Figure 5.3: Total Food Income Share across the Income Distribution



Source: Nigeria Living Standards Survey (2003).

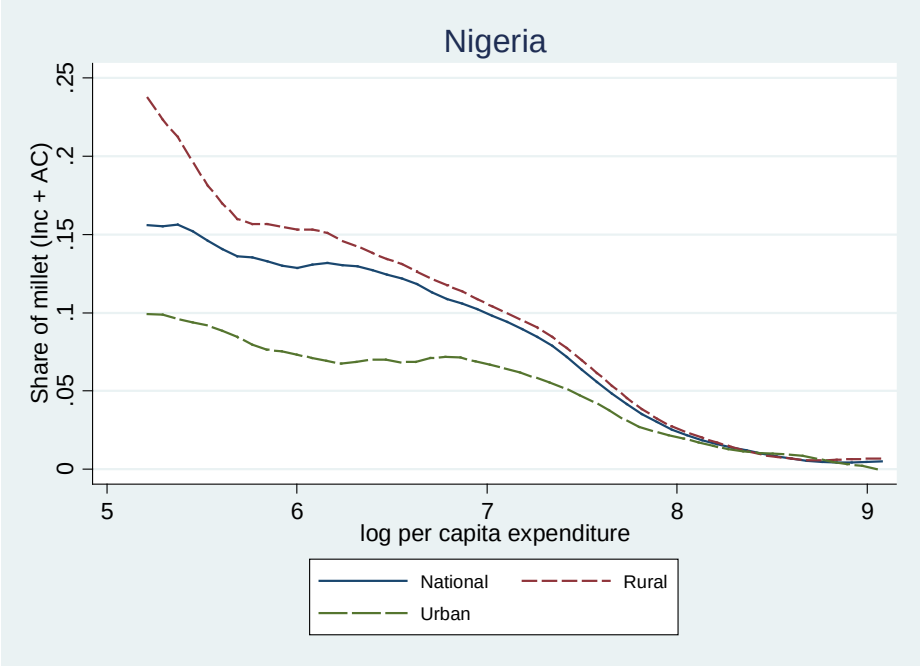
We now reproduce the same analysis for three of the individual crops in the study, namely millet, rice, and sorghum. Figure 5.4 and 5.5 show the non parametric regression of millet budget and income shares with respect to log per capita income for household in Nigeria. The shape and levels in the two graphs are similar, suggesting a non negible auto-consumption component for millet. For household in the bottom of the distribution, the budget and income shares of millet are larger for urban than for rural households. However, these shares declines abruptly with the level of income for urban households, while it does less so for rural households. The richest households both in rural and urban areas seem to not consume millet. In rural areas while the richest households do not produce millet, those in the middle of the distribution get on average 10 percent of their income from millet, and the poorest one 20 percent.

Figure 5.4: Millet Budget Share across the Income Distribution



Source: Nigeria Living Standards Survey (2003).

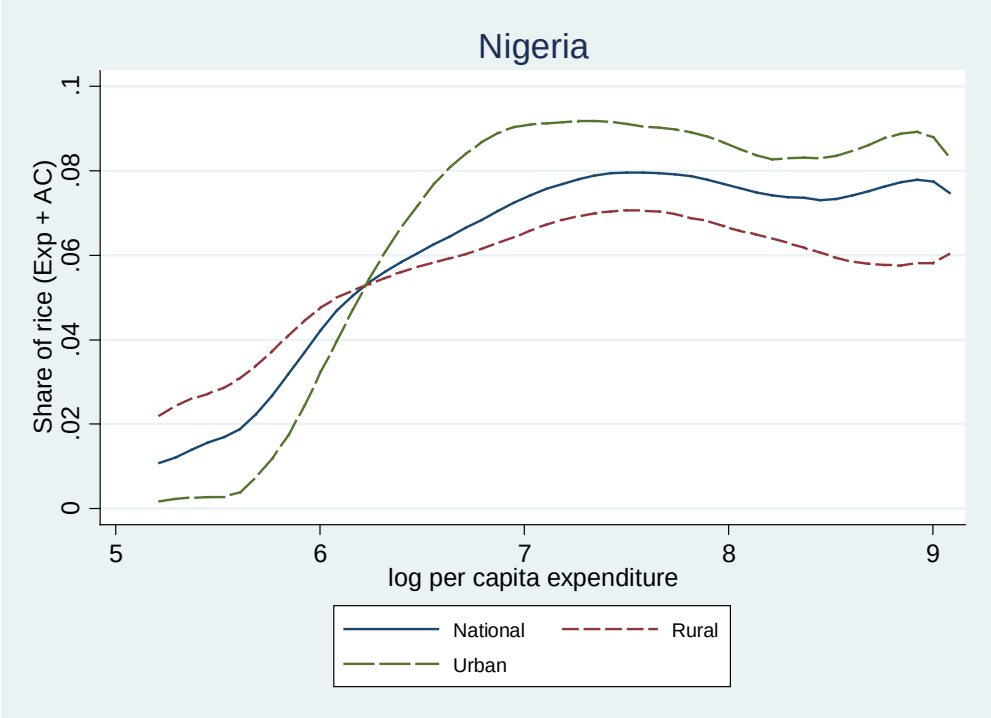
Figure 5.5: Millet Income Share across the Income Distribution



Source: Nigeria Living Standards Survey (2003).

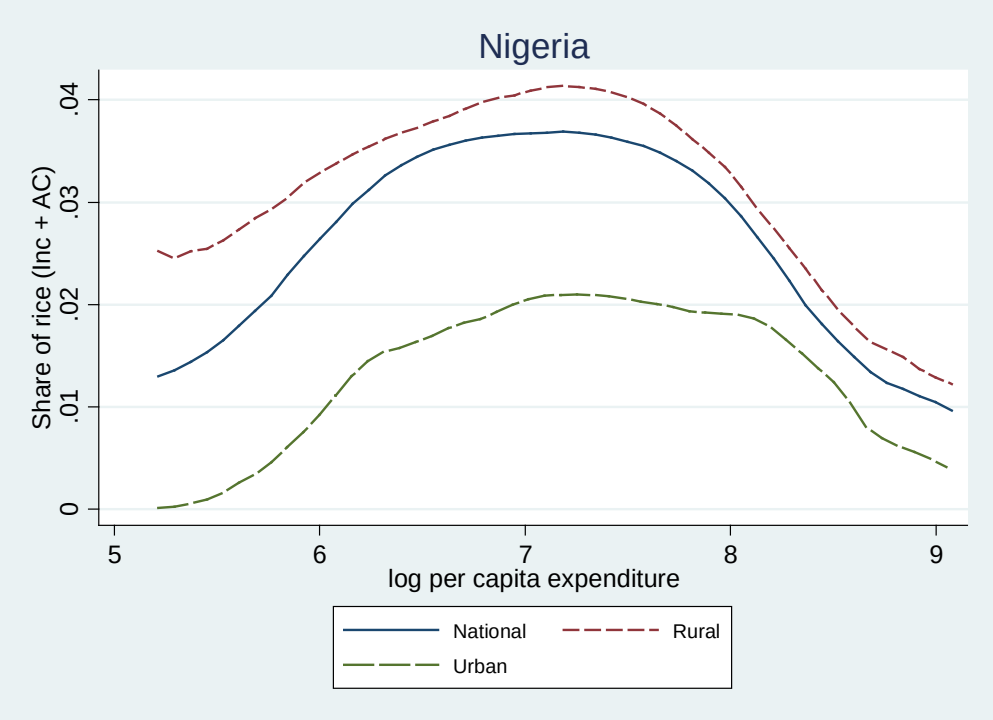
Figures 5.6 and 5.7 show the non parametric regression of rice budget and income shares with the level of livelihood in Nigeria. Rice is widely consumed in Nigeria, in particular by households in the middle and upper part of the income distribution. While local rice production is important and supported by the government, it often does not satisfy local demand. There is also a demand for premium rice that is satisfied by imports. Except for the poorest households, the incidence of rice on households' budget is larger for urban than rural households. The poorest urban households do not consume much rice (close to 0 percent of their budget is spent on rice), but the incidence of rice increases with the level of livelihood to above 8 percent of the total budget. In rural areas, the incidence of rice in the budget also increases with the level of income from around 2 percent to 7 percent for those in the middle of the distribution and 6 percent for those in the upper part. Households in urban areas have a larger share of their income coming from rice, except for the poorest household where the opposite is true. For rural household the importance of rice as a source of income first smoothly increases from 2 percent with the level of livelihood reaching 4 percent on average for households in the middle of the distribution and later decreases to below 2 percent. Smaller shares are generally reported in urban areas.

Figure 5.6: Rice Budget Share across the Income Distribution



Source: Nigeria Living Standards Survey (2003).

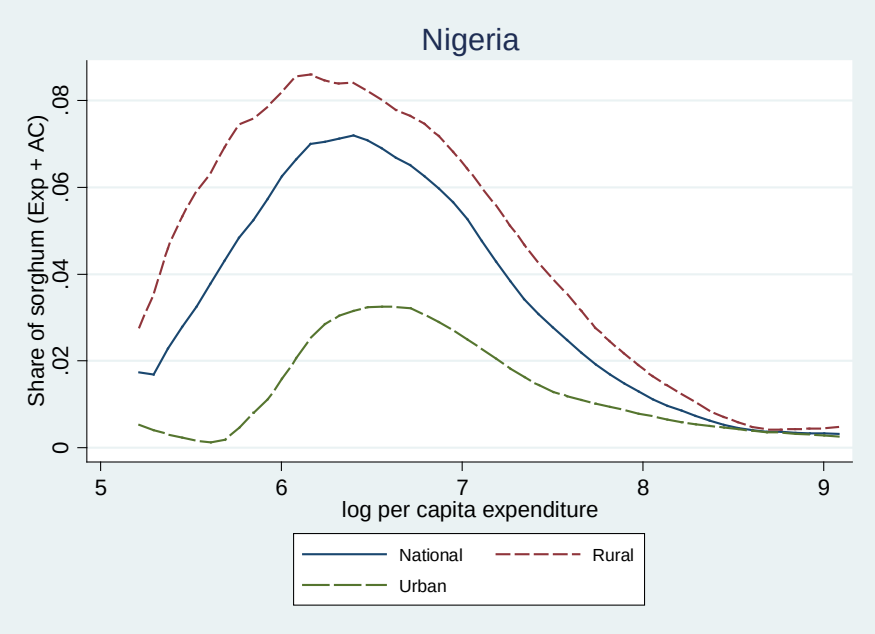
Figure 5.7: Rice Income Share across the Income Distribution



Source: Nigeria Living Standards Survey (2003).

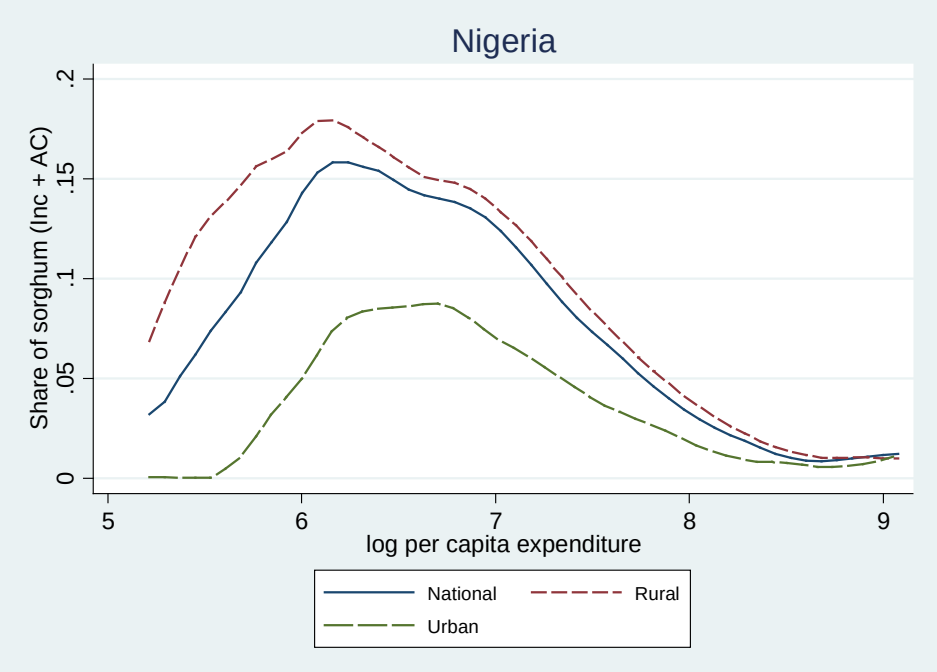
Finally, we analyze the relationship between sorghum consumption and income shares with the level of livelihood. As we showed before, sorghum in Nigeria is an important source of income, in particular in rural areas, but it is less important as a consumption crop. This is reflected in Figure 5.8 and 5.9 below where the level of income shares is higher than those of the budget shares. Both figures show a similar dynamics, sorghum is more important in rural than in urban areas both in consumption and income and its incidence first increases with income and later declines.

Figure 5.8: Sorghum Budget Share across the Income Distribution



Source: Nigeria Living Standards Survey (2003).

Figure 5.9: Sorghum Income Share across the Income Distribution



Source: Nigeria Living Standards Survey (2003).

5.2. Food Crops in Nigeria

In terms of employment, agriculture is by far the most important sector of Nigeria's economy, engaging about 70% of the labor force. Agricultural holdings are generally small and scattered; farming is often of the subsistence variety, characterized by simple tools and shifting cultivation. These small farms produce about 80% of the total food. About 30.7 million hectares (76 million acres), or 33% of Nigeria's land area, are under cultivation. Nigeria's diverse climate, from the tropical areas of the coast to the arid zone of the north, make it possible to produce virtually all agricultural products that can be grown in the tropical and semitropical areas of the world. The economic benefits of large-scale agriculture are recognized, and the government favors the formation of cooperative societies and settlements to encourage industrial agriculture. Large-scale agriculture, however, is not common. Despite an abundant water supply, a favorable climate, and wide areas of arable land, productivity is restricted owing to low soil fertility in many areas and inefficient methods of cultivation. Agriculture contributed 33.1% to GDP in 2012. However the predominance of oil in the economy has often diverted Nigeria policies' attention away from agriculture. Nigeria's became a net food importer in the late 1970's after petroleum oil became a main component of its exports. Over the past 15 years, food trade deficit has been growing by an average rate of 17.5 per cents per year.

Nigeria is the largest world producer of cassava accounting for almost one fifth of global output. Production reached 54 million tons in 2011 of which almost everything is processed and consumed domestically. The crop is produced and consumed mostly in the southern part of the country. Cassava is grown throughout the year, making it preferable to seasonal crops such as grains, peas and beans and other crops for food security. It displays an exceptional ability to adapt to climate change, with a tolerance to low soil fertility, resistance to drought conditions, pests and diseases, and suitability to store its roots for long periods. The requirements of labor and inputs are low compared to other crops. Cassava is rich in carbohydrates especially starch and consequently has a multiplicity of end uses including flour, starch, glucose, and animal feed. While there are well-established multiplication and processing techniques for food products and cattle feed from cassava, coordinating harvest and transport for large quantities of commercial grade cassava remain the greatest challenge for Nigeria to further increase processing of cassava. The government has been trying to promote the production and consumption of cassava over rice and wheat both promoting innovation in cassava production and through trade restrictions on competing crops.

Maize it is produced and consumed across the six geo-political zones of Nigeria but the major producing areas remain in the central region. Nigeria produced 9 million tons of maize in 2011. In the same years, imports of maize totaled only 800 tons despite the fact import ban on maize was lifted in 2008 and imports are now allowed at 5 percent tariff. Even though the import ban was removed, potential maize importers fear that Nigeria's customs agency would likely block maize imports in support of local producers. For many importers, the status of import ban on maize seems uncertain and no shipment of large quantity maize into the country has been recorded in the last few years (USDA, 2013).

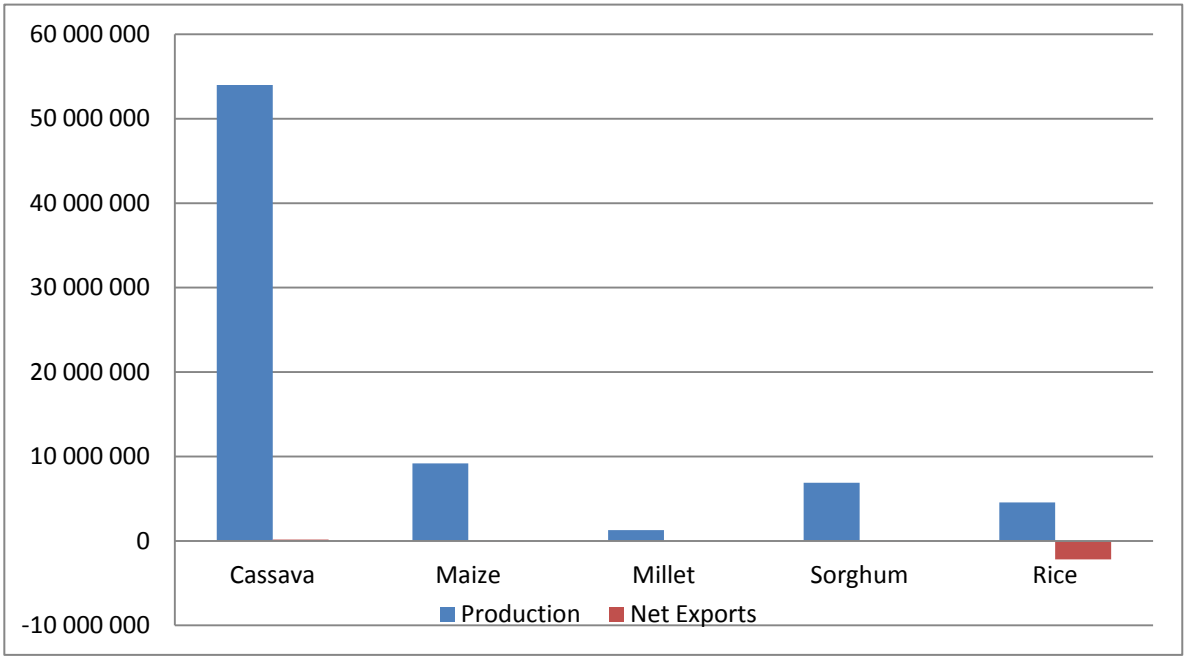
Smaller shipments cross in informal trade in many border locations. Potential buyers have been unusually hesitant about exploring this opportunity. Unofficial sources comment the reason for no major imports to be political reasons. Around 60% of Nigeria's production of maize is consumed by the industrial sector for production of flour, beer, malt drink, corn flakes, starch, syrup, dextrose and animal feeds.

Millet is predominantly produced and consumed in northern Nigeria made up of three geo-political zones including North-east, North-West and North-central. Nigeria is the second largest producer of millet in the world, accounting for 10 to 15 percent of global production depending the year. Most of the production is consumed locally as food and livestock feed with a small surplus exported to neighboring countries.

Rice is produced and consumed widely across Nigeria and the government has listed rice as one of the five commodities to attract special focus to increase domestic production. Among the government measures to boost production there is an import duty of up to 110 percent on imported rice. Rice importation remains restricted to the sea ports and importation of rice over land borders is prohibited, although it still occurs. The government took this decision in order to reduce smuggling and evasion of duty payments. In principle, Nigeria’s fertile land and rich agro-climatic conditions provides enormous potential to feed its population, generate jobs and income for its people. However, the country’s local rice production still accounts for less than 50 to 70 percent of its total consumption and the demand gap has been filled by rice imported mostly from India, Thailand, and Brazil. The lack of infrastructure and low private sector investment in the rice sector value chain cannot support the large increase in production that self-sufficiency would require. Population growth, urbanization and rising incomes are expanding rice consumption in Nigeria. Urban consumers prefer long grain, polished and de-stoned imported rice over local varieties. Imported parboiled rice also competes effectively against other basic food staples while domestic production supplements the input supply.

Nigeria is the largest producer of sorghum in West Africa accounting for about 71% of the total regional sorghum output. The country is the third largest world producer of sorghum after the United States and India but while these two countries use almost all its output for animal feed, in Nigeria most of the sorghum is for human consumption. Sorghum is the primary food crop in virtually all northern Nigeria. There are two uses for sorghum in Nigeria: traditional and industrial uses. The traditional uses include a variety of foods, beverages and drinks. Moreover, sorghum is traditionally used for thatching of roofs and fencing of compounds. Regarding the industrial production, the cereal is used for brewing. Most of the production in Nigeria is for the local market. Minimal amounts are exported and imported informally to and from the neighboring countries.

Figure 5.10: Crops Production and Net Exports in Nigeria (in tons, 2011)



Source: FAO.

For the five crops under study in Nigeria, markets are relatively free with supply and demand establishing the market and farm gate prices. The only major restrictions affecting the crop prices are those related to import duties and bans affecting from time to time rice and maize as it was previously discussed. Most markets are heavily contested, except perhaps for maize where a single wholesaler has a market share of around 43 percent (Table 5.3).

5.3. Simulation results

We use the model of section 2 to study how changes in domestic competition among processors and wholesalers and changes in several constraints affecting agricultural production affects farm gate prices. We investigate five food crops in Nigeria: cassava, maize, millet, rice, and sorghum. Except for rice that is heavily imported, all other crops are produced for the domestic market with little international trade. We use the export food model for cassava and millet and the import food model for maize, rice and sorghum. As before, given the complexity of the scenarios, we simplify the analysis by working with a sequence of partial equilibrium models so that each case study is dealt with separately.

Table 5.3: Market Shares in Nigeria

Cassava		**Maize**		**Millet**	
Company	*Share*	*Company*	*Share*	*Company*	*Share*
BLESSING CASSAVA	15.20%	ALH OLADIPUPO	43.78%	ALH ISMAILA ISA	11.91%
CHINYERE CASSAVA SHOP	15.20%	ALH LAWALI SAHABI	6.13%	ALH LADAN ASARE	10.42%
OLUCHI CASSAVA	11.40%	ALH AHMADU DANCHIFFO	5.95%	ALH UBA DANKOLI	9.68%
TOCHI GARRI	11.40%	ALHAJI MUKTI MOMO	4.93%	GUINESS NIGERIA PLC	9.38%
MARIA CASSAVA SHOP	11.40%	ALH MUFTAU ADISA YUSUF	4.38%	SAIDO INVESTMENT	9.30%
OTHERS COMBINED	35.39%	OTHERS (COMBINED)	34.83%	OTHERS COMBINED	49.31%

Rice		**Sorghum**	
Company	*Share*	*Company*	*Share*
IKEDI VENTURES	9.12%	ALH BALA FARU	13.07%
D.N KEKE	8.12%	SAIDO INVESTMENT	11.44%
JOHNISCO ENTERPRISE	7.19%	ALH MUSTAPHA KALLE	10.46%
ALH ABU KOFA	6.99%	ALH SIDDI SHUNI	9.15%
SALIU OGUNGBADE	5.12%	ALH MODE YARTUKUWA	7.84%
OTHERS (COMBINED)	61.5%	ALH SHAIBU MAKAFI	7.84%
		OTHERS COMBINED	40.19%

We present the results of the simulations for cassava in Table 5.4. As the status quo shows already a much contested market, small changes in the level of competition would have negligible changes in farm gate prices for cassava (row 1). Even in the limit case of perfect competition, farm gate prices would increase around 1 percent. Going to changes in constraints affecting farm production, (row 1) we observe significant effects on prices only in two cases. An increase of 10 percent in the international price would increase farm gate prices by 20 percent (row 2). This large elasticity is due mainly to the poor supply response from cassava farmers following the shock. The other simulation were the effect on prices is sizeable is in the case of transaction cost of cassava production. A 10 percent increase in those costs will reduce the supply of cassava and increase farm gate prices by 8.7 percent (row 9). The spillover effects on cassava prices from cash crop production costs (row 2 and 3) and its price (row 7) are very small. An increase in the preference parameter associated with food security will increase the demand for cassava and consequently its price albeit modestly (row 6). The joint effect of an international price increase and moving to perfect competition would increase farm gate prices for cassava 24 percent. This joint effect is higher than the sum of their individual effect highlighting the importance of considering the degree of complementarity of policies.

Millet (Table 5.6) is the other crop for which we use the food export model. As in the case of cassava, the effects of change in competition among wholesalers and processors are very small because the market is already very competitive. In the leader split simulation (column 2, row 1) famgate price would increase only 0.09 percent and if the most efficient firm were to leave the market (column 4, row 1) farm gate prices would decrease only 0.10 percent. On the other hand, a 10 percent increase in the international price for millet would increase farm gate prices by 30 percent accordingly to the model (row 2). Transaction costs on millet production have as well a large effect on farm gate prices. If those costs were to increase by ten percent that would translate in equilibrium in almost a 13 percent increase in the price paid to the millet producer.

Maize (Table 5.5), rice (Table 5.7), and sorghum (Table 5.8) are the imported food crops in Nigeria. In particular rice is heavily imported despite the restrictions imposed by the government. In this model an increase in competition among importers will reduce the mark up on the imported commodity putting downward pressure in the price paid to local producers of that commodity. The simulations show however that this effect would be small because there is already a lot of competition among importers in these three crops. In all cases, the limit case of perfect competition would reduce the farm gate price as little as 0.86 percent (rice) and as much as 2.05 percent (in the case of maize). An increase in the international price of these commodities will not be fully transmitted to farmers. For instance, when the international price of rice increases 10 percent, the model predicts that local farmers producing rice would see the price their receive increase by 4.2 percent. In the case of maize this increase would be of 6.1 percent and in the case of sorghum 7.1 percent. It is interesting to see that the same model offers qualitatively different results for different crops. For instance, the increase in the endowment has a negative effect on the price of rice because farmers produce more rice but has a positive effect in the price of sorghum and maize because farmers switch to the more profitable cash crop. Similarly, an

increase in the parameter associated with the preference for auto-consumption increases the price of maize and rice but reduces the price of sorghum.

5.4. Welfare impacts

As in the previous cases, we conclude the analysis for Nigeria with an assessment of the poverty impacts of the price changes discussed in the previous session. The welfare impacts of the price changes are reported in Tables 5.9 to 5.13 for the cases of cassava, maize, millet, rice, and sorghum. We show the impacts of shocks to the market structure in the first row and to illustrate the role played by complementarities, we show results for a combination of shocks to market structure and international prices. We show average results for the total population, the poor, and the non-poor, and separate results for household that declare to be a producer of the crop under consideration.

We expect this first order effect to be small in the case of competition policy for two reasons. The first one is that in the five crops under studies in Nigeria there is already a healthy level of competition among processors and wholesalers and therefore the effect on farm gate prices in the simulation was modest, even for the limit case of perfect competition. The second reason is that many households, in particular those in rural areas, are both consumer and producer of the commodity and therefore their net position is very small. An inspection of the welfare results in the five tables confirms this expectation. In all cases the first order welfare effects are close to zero.

On the other hand, in the case of an increase of the international price we saw that the effect on farm gate prices was large for the crops where Nigeria is an exporter (cassava and millet) and modest for those commodity where the country is an importer (maize, rice, and sorghum). However, it is not clear that an increase in farm gate prices will translate on welfare improvement as households in rural areas tend to be both producers and consumers of food staples but those in urban areas are in general net consumer of agricultural products. An increase of ten percent in the international price of cassava will be welfare improving for the average household in Nigeria (Table 5.9). This effect is larger for poor (1.13 percent) than non poor household (0.96 percent). Obviously, the effect would be even larger if we consider only those households producing cassava as they would see their initial income increased by 5.14 percent following the increase in international prices. A similar effect with a lower overall impact on welfare is observed in the case of millet. However, in this case, non poor (0.28 percent) would benefit more than poor households (0.12 percent). In the case of rice, the increase in international prices would have on average a welfare negative effect as Nigerian households are net consumers of rice and the negative impact would be larger for poor than for non poor households. Only rice producers would benefit from the increase in the international price but their gains are not enough to compensate the welfare loses of the population.

Table 5.4: Simulation Results for Cassava

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	0,08	-0,09	-0,10	0,50	1,17
Increase of 10% in:						
International Price	20,20	20,41	19,98	19,97	20,57	24,00
Marginal Cost of Producing Cash Crop	-0,33	-0,22	-0,46	-0,46	0,16	1,17
Fixed Cost of Producing Cash Crop	-0,07	0,02	-0,17	-0,17	0,43	1,17
Endowment	-0,06	0,03	-0,16	-0,16	0,43	1,17
Preference Paremeter	0,78	0,81	0,75	0,75	1,31	1,17
Cash Crop Price	0,54	0,58	0,49	0,48	1,04	1,17
Marginal Cost of Producing Food Crop	0,48	0,52	0,42	0,42	0,97	1,17
Transaction Costs on Crop Production	8,69	8,78	8,59	8,59	8,85	10,32
Transaction Costs on Inputs	0,14	0,15	0,12	0,12	0,28	1,17
Non-Farmer demand	0,03	0,11	-0,06	-0,06	0,53	1,17

Source: simulation results from the model of Section 2.

Table 5.5: Simulation Results for Maize

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	-0,14	0,05	0,21	-1,46	-2,05
Increase of 10% in:						
International Price	6,11	6,02	6,05	6,20	4,74	4,97
Marginal Cost of Producing Cash Crop	-0,63	-0,74	-0,66	-0,51	-2,01	-2,07
Fixed Cost of Producing Cash Crop	-0,07	-0,22	-0,05	0,10	-1,54	-2,07
Endowment	0,02	-0,13	0,05	0,20	-1,44	-2,07
Preference Paremeter	0,35	0,16	0,41	0,58	-1,23	-2,07
Cash Crop Price	0,67	0,45	0,76	0,92	-0,88	-2,07
Marginal Cost of Producing Food Crop	0,53	0,32	0,61	0,78	-1,03	-2,07
Transaction Costs on Crop Production	2,63	2,59	2,60	2,67	2,04	2,14
Transaction Costs on Inputs	0,15	0,09	0,18	0,23	-0,30	-2,07
Non-Farmer demand	0,07	-0,09	0,11	0,26	-1,41	-2,07

Source: simulation results from the model of Section 2.

Table 5.6: Simulation Results for Millet

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	0,09	-0,08	-0,10	0,60	1,49
Increase of 10% in:						
International Price	30,15	30,43	29,84	29,83	30,72	35,16
Marginal Cost of Producing Cash Crop	-0,26	-0,16	-0,35	-0,37	0,34	1,49
Fixed Cost of Producing Cash Crop	-0,14	-0,05	-0,23	-0,25	0,48	1,49
Endowment	-0,01	0,08	-0,09	-0,11	0,57	1,49
Preference Paremeter	0,88	0,92	0,87	0,85	1,49	1,49
Cash Crop Price	0,80	0,84	0,77	0,75	1,41	1,49
Marginal Cost of Producing Food Crop	0,45	0,51	0,40	0,38	1,05	1,49
Transaction Costs on Crop Production	12,96	13,09	12,83	12,83	13,21	15,12
Transaction Costs on Inputs	0,13	0,15	0,12	0,11	0,30	1,49
Non-Farmer demand	0,08	0,16	0,00	-0,01	0,68	1,49

Source: simulation results from the model of Section 2.

Table 5.7: Simulation Results for Rice

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	-0,04	0,04	0,04	-0,31	-0,86
Increase of 10% in:						
International Price	4,20	4,19	4,22	4,22	3,95	3,84
Marginal Cost of Producing Cash Crop	-0,64	-0,65	-0,64	-0,63	-0,85	-0,86
Fixed Cost of Producing Cash Crop	-0,04	-0,08	0,00	0,00	-0,33	-0,86
Endowment	-0,11	-0,15	-0,08	-0,07	-0,40	-0,86
Preference Paremeter	0,53	0,45	0,60	0,61	0,20	-0,86
Cash Crop Price	0,50	0,43	0,57	0,57	0,20	-0,86
Marginal Cost of Producing Food Crop	0,41	0,35	0,48	0,48	0,10	-0,86
Transaction Costs on Crop Production	1,81	1,80	1,81	1,82	1,70	1,65
Transaction Costs on Inputs	0,12	0,10	0,14	0,14	0,03	-0,86
Non-Farmer demand	0,11	0,06	0,16	0,17	-0,19	-0,86

Source: simulation results from the model of Section 2.

Table 5.8: Simulation Results for Sorghum

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	-0,09	0,10	0,11	-0,62	-1,54
Increase of 10% in:						
International Price	7,10	7,06	7,12	7,13	6,50	6,53
Marginal Cost of Producing Cash Crop	-0,44	-0,50	-0,38	-0,37	-1,04	-1,54
Fixed Cost of Producing Cash Crop	-0,15	-0,24	-0,07	-0,07	-0,78	-1,54
Endowment	0,18	0,08	0,29	0,30	-0,44	-1,54
Preference Paremeter	-0,03	-0,13	0,07	0,08	-0,70	-1,54
Cash Crop Price	0,76	0,62	0,91	0,92	0,12	-1,54
Marginal Cost of Producing Food Crop	0,43	0,30	0,56	0,57	-0,22	-1,54
Transaction Costs on Crop Production	3,05	3,04	3,06	3,07	2,79	2,81
Transaction Costs on Inputs	0,12	0,09	0,16	0,16	-0,06	-1,54
Non-Farmer demand	0,06	-0,04	0,16	0,17	-0,56	-1,54

Source: simulation results from the model of Section 2.

Table 5.9: Cassava Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	0,00	0,00	-0,01	0,03	0,06
International Price	1,06	1,07	1,05	1,05	1,08	1,26
Poor						
Competition Policy	0,00	0,00	-0,01	-0,01	0,03	0,07
International Price	1,13	1,14	1,11	1,11	1,15	1,34
Non Poor						
Competition Policy	0,00	0,00	0,00	0,00	0,02	0,06
International Price	0,96	0,97	0,95	0,95	0,98	1,14
Producers						
Competition Policy	0,00	0,02	-0,02	-0,02	0,13	0,30
International Price	5,14	5,19	5,08	5,08	5,23	6,11

Note: first order impact on household welfare.

Table 5.10: Maize Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	0,00	0,00	0,00	-0,03	-0,04
International Price	0,11	0,11	0,11	0,11	0,09	0,09
Poor						
Competition Policy	0,00	0,00	0,00	0,00	-0,03	-0,04
International Price	0,10	0,10	0,10	0,11	0,08	0,09
Non Poor						
Competition Policy	0,00	0,00	0,00	0,00	-0,03	-0,04
International Price	0,12	0,12	0,12	0,12	0,09	0,10
Producers						
Competition Policy	0,00	-0,01	0,00	0,01	-0,11	-0,15
International Price	0,44	0,43	0,43	0,45	0,34	0,36

Note: first order impact on household welfare.

Table 5.11: Millet Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	0,00	0,00	0,00	0,00	0,01
International Price	0,18	0,19	0,18	0,18	0,19	0,22
Poor						
Competition Policy	0,00	0,00	0,00	0,00	0,00	0,01
International Price	0,12	0,12	0,12	0,12	0,13	0,14
Non Poor						
Competition Policy	0,00	0,00	0,00	0,00	0,01	0,01
International Price	0,28	0,28	0,28	0,28	0,28	0,32
Producers						
Competition Policy	0,00	0,01	-0,01	-0,01	0,06	0,16
International Price	3,19	3,22	3,16	3,16	3,25	3,72

Note: first order impact on household welfare.

Table 5.12: Rice Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	0,00	0,00	0,00	0,01	0,02
International Price	-0,09	-0,09	-0,09	-0,09	-0,09	-0,08
Poor						
Competition Policy	0,00	0,00	0,00	0,00	0,01	0,03
International Price	-0,14	-0,14	-0,14	-0,14	-0,13	-0,12
Non Poor						
Competition Policy	0,00	0,00	0,00	0,00	0,00	0,01
International Price	-0,03	-0,03	-0,03	-0,03	-0,02	-0,02
Producers						
Competition Policy	0,00	-0,01	0,01	0,01	-0,04	-0,12
International Price	0,61	0,61	0,61	0,61	0,57	0,55

Note: first order impact on household welfare.Table 5.13: Sorghum Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	0,00	0,00	0,00	-0,01	-0,02
International Price	0,08	0,08	0,08	0,08	0,07	0,07
Poor						
Competition Policy	0,00	0,00	0,00	0,00	0,00	-0,01
International Price	0,05	0,05	0,06	0,06	0,05	0,05
Non Poor						
Competition Policy	0,00	0,00	0,00	0,00	-0,01	-0,03
International Price	0,12	0,12	0,12	0,12	0,11	0,11
Producers						
Competition Policy	0,00	-0,01	0,01	0,01	-0,06	-0,16
International Price	0,72	0,72	0,73	0,73	0,66	0,67

Note: first order impact on household welfare.

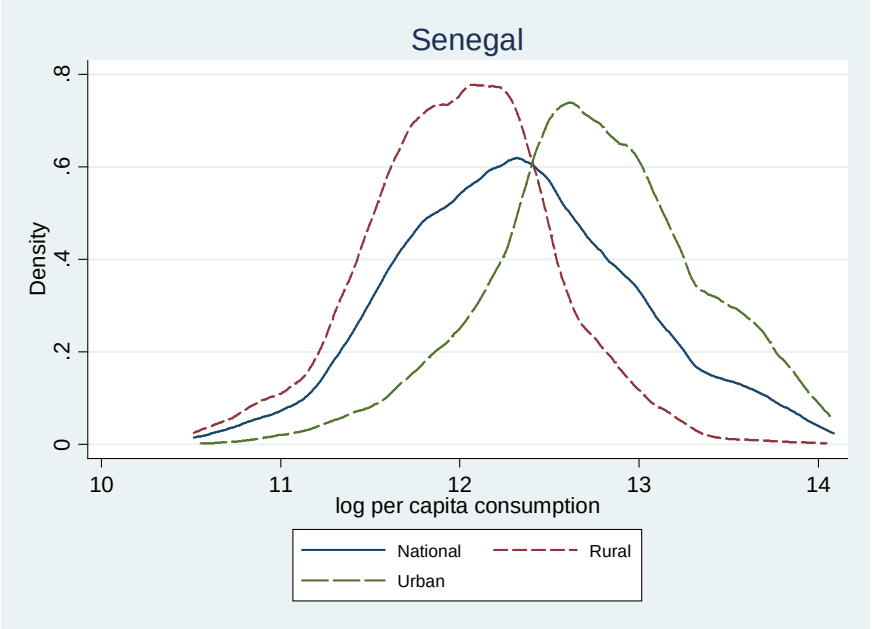
6. Welfare effects of domestic market structure and household constraints: The case of Senegal

6.1. The Household Survey Data

The household survey used in the case of Senegal is the "Enquête de Suivi de la Pauvreté au Sénégal" of 2011. The survey covers 5,953 households of which 48.5 percent are in rural areas. Female headed households are 24.3 percent of the sample, 15.5 percent in rural areas and 35.9 in urban areas. Of the countries in the analysis, Senegal has the largest proportion of wage earners with 48.67 percent declaring to receive a salary. As expected, this proportion is larger in urban (67.1 percent) than in rural areas (37.9 percent). Senegal is also the country in the analysis that has the lowest share of people working in agriculture with 31.4 percent for the total sample, 46.2 percent for the households in rural areas and 6.2 percent for those in urban areas.

Figure 6.1 shows the distribution of income in Senegal. The graph shows the estimated density function of the logarithm of household per capita expenditure at the national level and for urban and rural regions separately. As expected, the density for urban areas lies to the right of the density for rural areas, thus indicating that urban households enjoy, on average, a higher level of expenditure per capita than the rural households. This difference seems to be very important in the case of Senegal.

Figure 6.1: The Distribution of Income
Density of (log) per capita household expenditure



Source: Enquête de Suivi de la Pauvreté au Sénégal (2011).

We turn now to a description of sources of income and patterns of consumption across households. In Table 6.1, we present the budget shares for the total, rural and urban population. Auto-consumption in Senegal is relatively very small. This is consistent with a lower share of rural population and those declaring to depend from agriculture and with the observer larger share of wage earners. Only 7.3 percent of average Senegalese household is from auto-consumption (12.5 percent for rural households and 0.4 percent for urban households). Almost half the budget is spent on food (49.1 percent) with this share been larger for rural than urban households (52.4 versus 44.8 percent). The most important crop in the budget is rice both for urban and rural households (10.8 percent of the budget). This is followed by millet and cowpea (more important in rural areas) and livestock (more important for urban households). Other traditional crops such as maize, cassava, and sorghum have much lower shares than it the other countries in the analysis.

Table 6.1: Budget Shares

Senegal	Total	Rural	Urban
Total consumption per capita	**100,0**	**100,0**	**100,0**
Expenditures	**92,7**	**87,5**	**99,6**
Food	49,1	52,4	44,8
Manufactures	19,3	15,4	24,6
Services	10,2	8,7	12,3
Others	14,0	11,1	17,9
Auto-consumption	**7,3**	**12,5**	**0,4**
Auto-consumption food	7,3	12,5	0,4
Auto-consumption others	0,0	0,0	0,0
Total Food consumption	**56,4**	**64,8**	**45,2**
Total crops	**22,8**	**30,8**	**12,2**
Rice	10,8	13,4	7,4
Maize	1,5	2,4	0,3
Sorghum	0,4	0,7	0,0
Millet	5,2	8,4	1,0
Cassava	0,5	0,5	0,5
Cowpea	2,4	3,8	0,4
Livestock	2,0	1,5	2,7

Source: Enquête de Suivi de la Pauvreté au Sénégal (2011).

In Table 6.2, we show different sources of income for Senegalese households. Consistent with the previous description, cash income (91 percent) is more important than auto-consumption (9 percent). Agriculture is responsible for about one third of total income for

the total sample and more than fifty percent when we consider only rural households. Livestock, cowpea, and millet are each responsible for 3.6 percent of total income. Rice generates on average 1.2 percent of the income and maize 0.8 percent. If we consider rural households only, millet is the most important source of income with 6.2 percent, followed by cowpea with 6.1 percent, and livestock with 5.7 percent.

Table 6.2: Income Shares

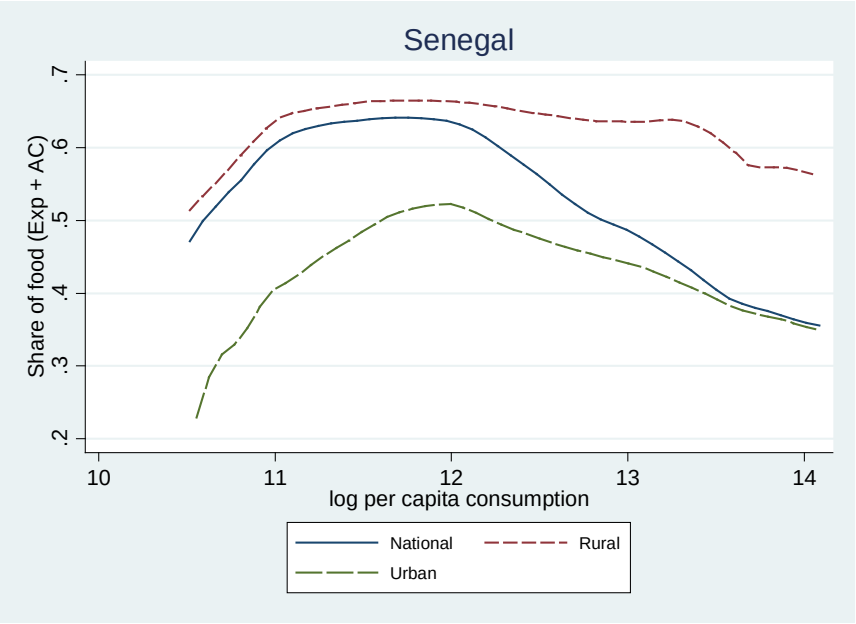
Senegal	Total	Rural	Urban
Total Income per capita	**100,0**	**100,0**	**100,0**
Incomes	**91,0**	**84,9**	**99,1**
Food (agriculture)	23,6	37,0	5,9
Wage	26,2	20,4	33,8
Enterprises	12,1	10,5	14,3
Transfers	29,1	17,0	45,2
Auto-consumption	**9,0**	**15,1**	**0,9**
Auto-consumption food	9,0	15,1	0,9
Auto-consumption others	0,0	0,0	0,0
Total Food income and AC	**32,6**	**52,1**	**6,7**
Total crops	**13,3**	**22,3**	**1,4**
Rice	1,2	2,1	0,0
Maize	0,8	1,3	0,1
Sorghum	0,3	0,6	0,0
Millet	3,6	6,2	0,3
Cassava	0,2	0,3	0,0
Cowpea	3,6	6,1	0,3
Livestock	3,6	5,7	0,7

Source: Enquête de Suivi de la Pauvreté au Sénégal (2011).

Figure 6.2 below shows households' food shares as a function of the level of per capita consumption of the household. In the case of Senegal, it does not display the downward schedule we observed in other cases. The share households spend on food in Senegal first increases with the level of income from 50 percent to around 65 percent and later declines to less than 40 percent. On average, rural households spend more on food than urban households for all levels of livelihood.

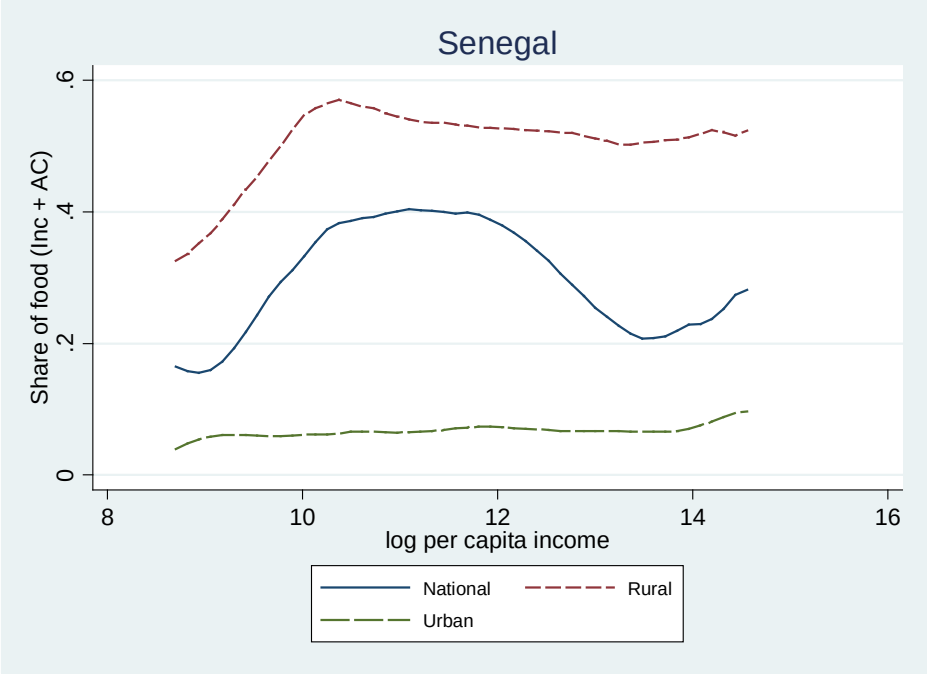
The importance of food as a source of income has a similar pattern than the one observed for the budget shares. It first increases with the level of livelihood and then declines. We can only see for the graphs that agriculture has only a marginal contribution to the income of the urban households.

Figure 6.2: Total Food Budget Share across the Income Distribution



Source: Enquête de Suivi de la Pauvreté au Sénégal (2011).

Figure 6.3: Total Food Income Share across the Income Distribution

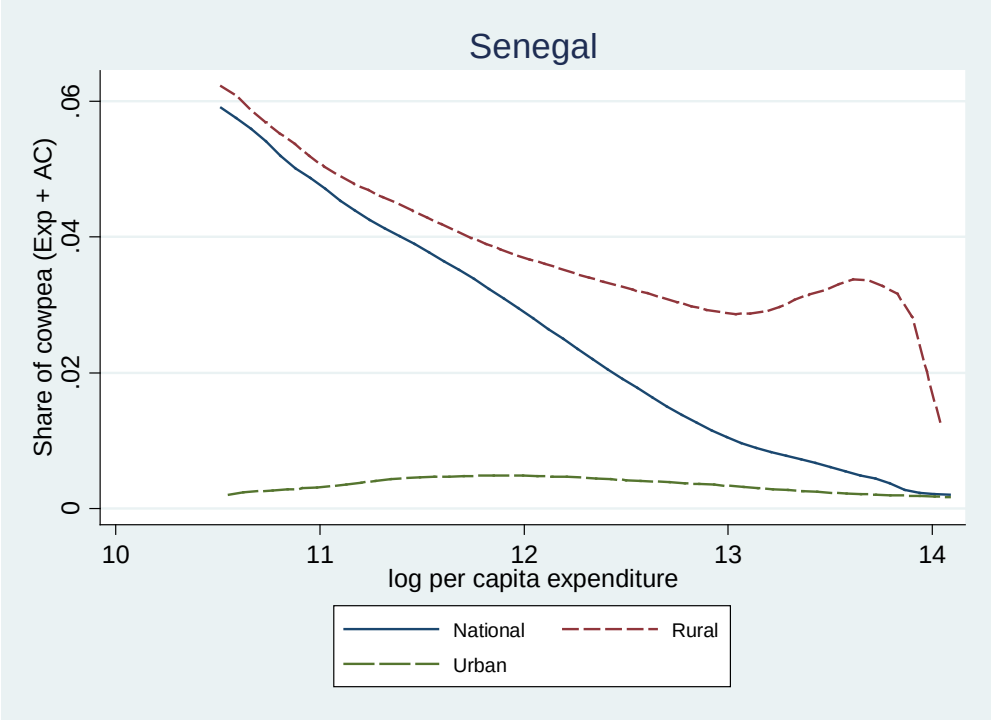


Source: Enquête de Suivi de la Pauvreté au Sénégal (2011).

We now take a closer look at the patterns of income and budget shares across the income distribution for three of the crops under study in Senegal (Figures 6.4-6.9), namely cowpea, millet and rice.

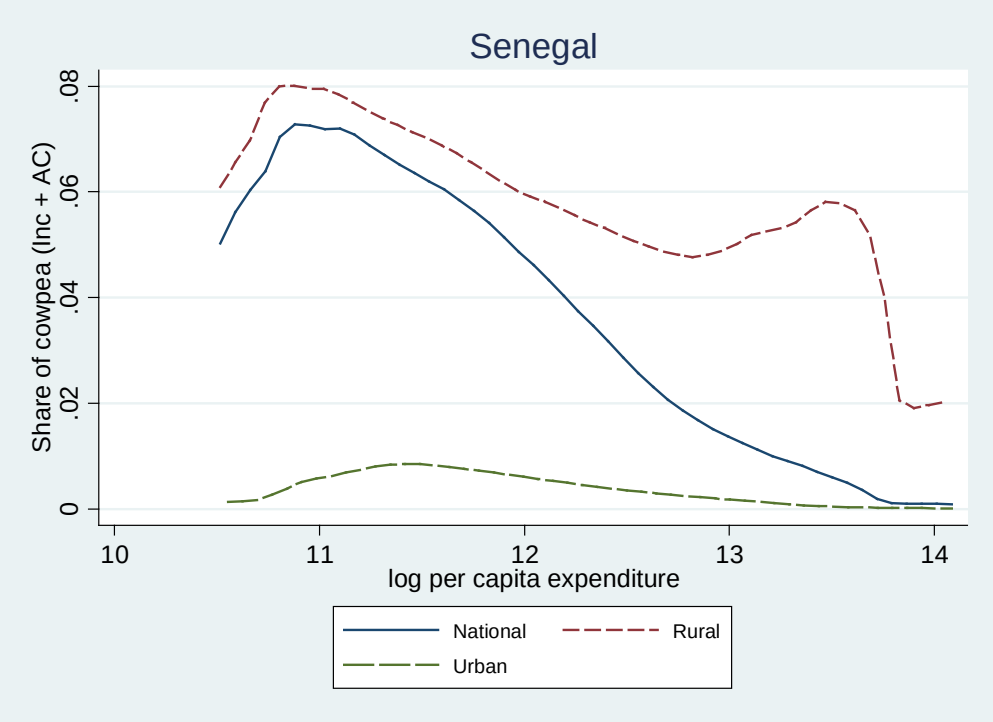
In Figure 6.4 we display the budget share of cowpea with respect to the level of livelihood of Senegalese households. The importance of cowpea in the budget decreases with the level of per capita consumption. The poorest households spend around 6 percent of their income in cowpea while the richest spend close to zero. Cowpea seems to be only important in the budget of rural households as the figures for budget shares of cowpea are meager for urban households. The share of income from cowpea (Figure 6.5) shows a similar pattern to the expenditures shares as cowpea has an important auto-consumption component with small rural to urban trade.

Figure 6.4: Cowpea Budget Share across the Income Distribution



Source: Enquête de Suivi de la Pauvreté au Sénégal (2011).

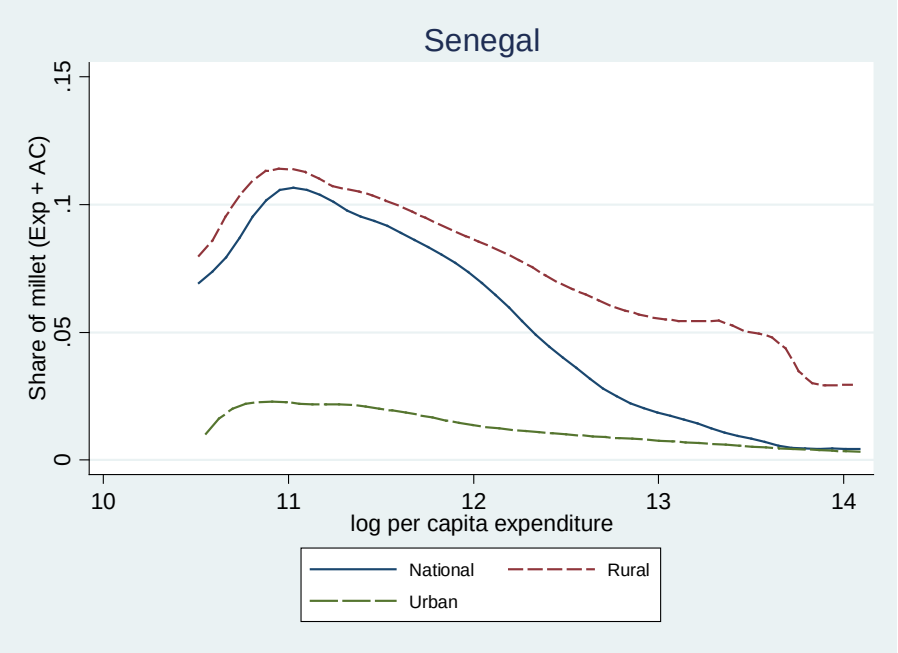
Figure 6.5: Cowpea Income Share across the Income Distribution



Source: Enquête de Suivi de la Pauvreté au Sénégal (2011).

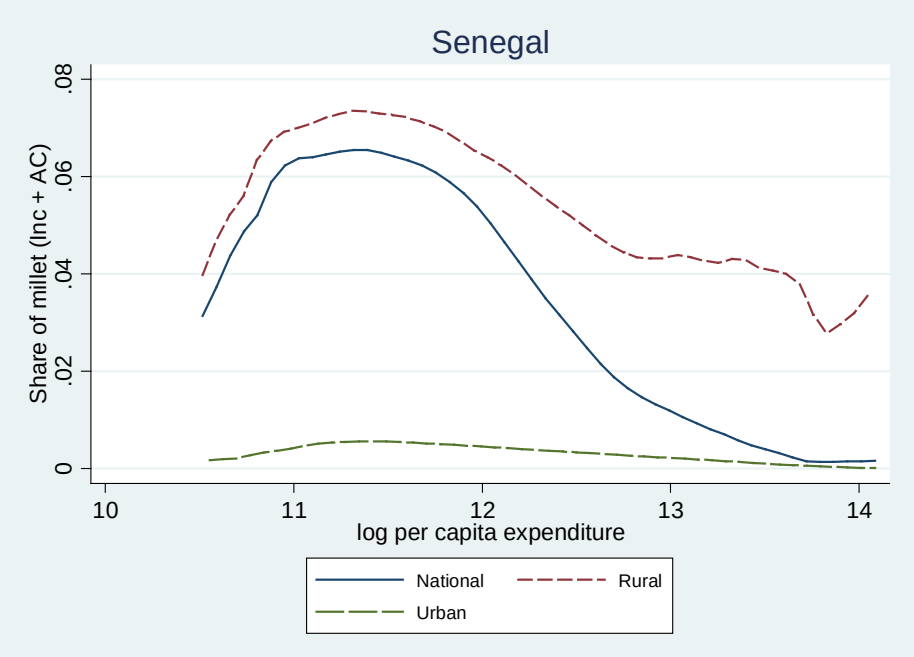
Millet is an important component of the budget of rural poor households (Figure 6.6). The poorest households spend around 10 percent of their budget on millet. The incidence of this crop declines with the level of livelihood with the richest rural households spending less than 4 percent of their income on millet. On the other hand, for urban households millet is not as important with the poorest urban households spending less than 3 percent of their income on this crop. The graph of millet as a source of income (Figure 6.7) shows different levels and dynamics what suggest that there is an important trade component for this crop. While the incidence of millet as a source of income is always larger on average for rural than urban households, the relationship between millet income and household per capita expenditure is similar for both urban and rural households. It first increases with the level of livelihood and it later declines.

Figure 6.6: Millet Budget Share across the Income Distribution



Source: Enquête de Suivi de la Pauvreté au Sénégal (2011)

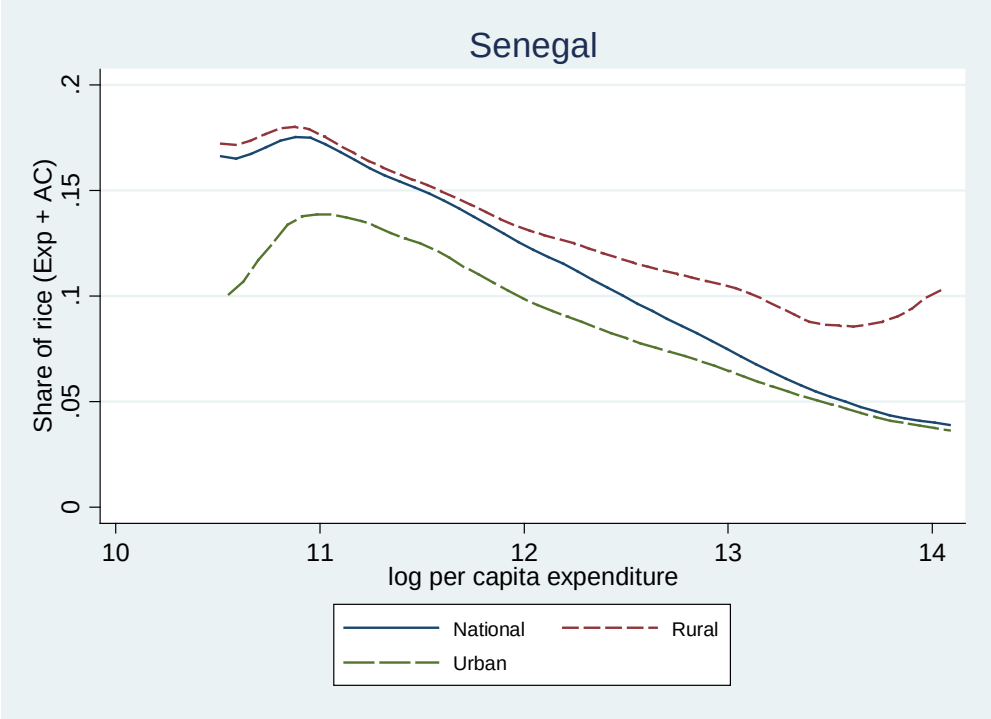
Figure 6.7: Millet Income Share across the Income Distribution



Source: Enquête de Suivi de la Pauvreté au Sénégal (2011).

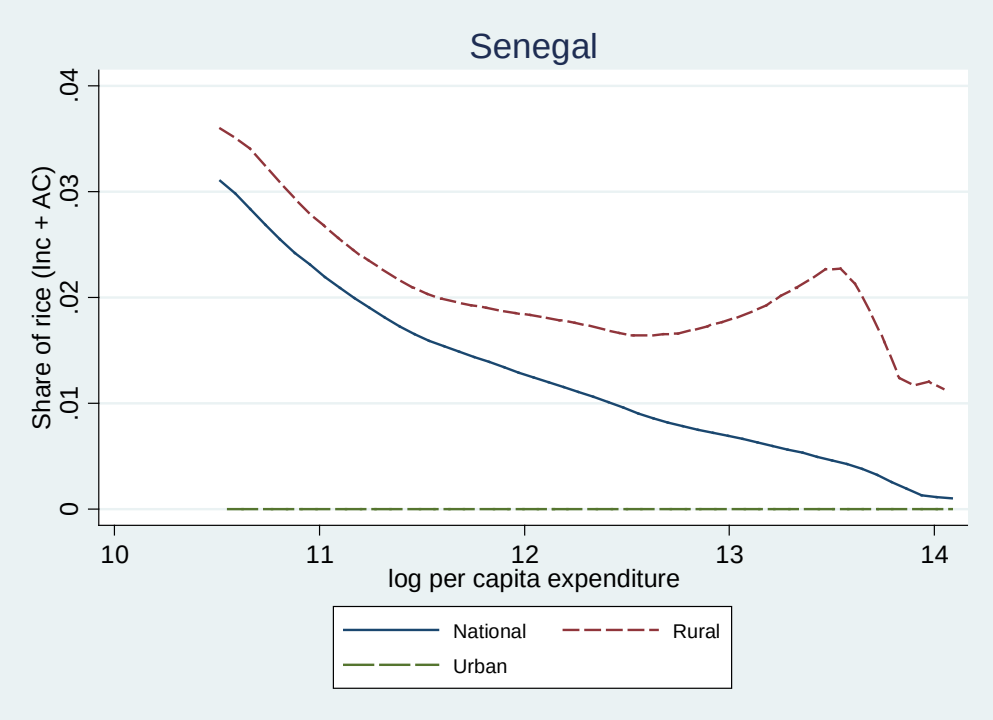
Finally, Figures 6.8 and 6.9 show the relationship between rice budget and income shares with the level of livelihood. Figure 6.8 shows that rice has a larger incidence in the budget of rural than urban households for all levels of income. For instance, the poorest rural households spend around 17 percent of their income on rice while their urban counterpart spends around 10 percent. Rice budget shares declines with the level of income, with the richest household spending less than 5 percent of their income on this crop. Virtually no income is derived from rice in urban areas.

Figure 6.8: Rice Budget Share across the Income Distribution



Source: Enquête de Suivi de la Pauvreté au Sénégal (2011).

Figure 6.9: Rice Income Share across the Income Distribution



Source: Enquête de Suivi de la Pauvreté au Sénégal (2011).

6.2. Food Crops in Senegal

Most of Senegal lies within the drought-prone Sahel region, with irregular rainfall and generally poor soils. Only about 5% of the land is irrigated and therefore crops heavily rely on rain fed cultivation, which often produces large fluctuations in production. Only 10-15 percent of the land is cultivated in the country. Agriculture (including forestry, livestock, and fisheries) accounted for 16.7% of GDP in 2012. Most Senegalese farms are small and about 60% are in the so-called Peanut Basin, east of Dakar. Much of the agricultural land is still tribally owned. The country was a net food exporter until the late 1970's. From the 1980s food trade balance quickly deteriorated until recently when the government started to invest heavily in agriculture following the 2009 Comprehensive Africa Agriculture Development Programme (CAADP) Investment Plan. In terms of value the most important agricultural products in Senegal are groundnuts, rice, cattle, and millet.

Cowpea is the most important food legume produced in Senegal and it is well suited for the agro-climatic-edaphic, technological and socioeconomic situations in Senegal. Two thirds of the production takes place in the northern regions of Louga and St Louis. Production in 2012 amounted to 55,000 metric tons. The export market for cow peas is concentrated in Europe, France in particular.

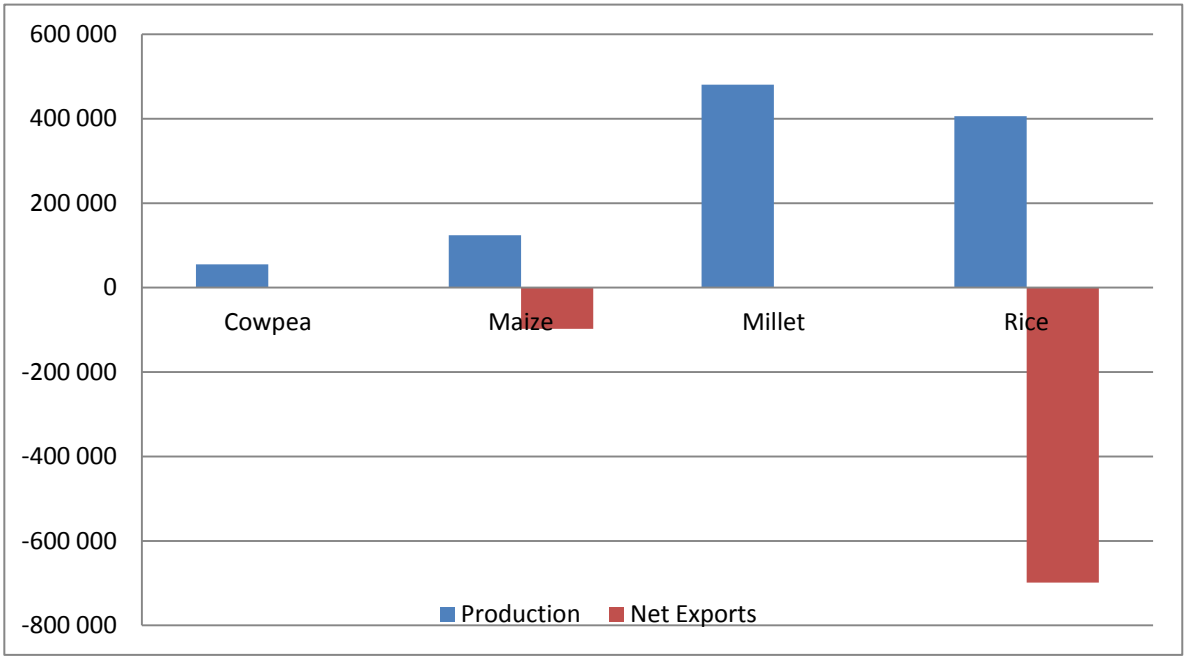
Maize is produced and consumed in areas around Kaolack, Tambacounda, and the Senegal River Valley. The local production does not cover local consumption and imports of maize (in particular from South America) have been growing since 2000. Senegal's smallholders are up against sophisticated cereal production, storage and trading systems and therefore tend to favor other crops over maize. However, with a growing poultry local industry and the possibility of producing locally bouillon and infant cereal food, there are opportunities to increase the local production of maize if some of the weakness in the value chain (such as average farm size less than 5 hectares, no industry scale production, low average yields, and poor quality and inconsistent supply lines) can be addressed.

Millet is the most important crop in Senegal. About 1.0 million hectares or one-third of Senegal's arable land is devoted to this crop. Millet is preferred by farmers over rice or sorghum because of its resistance to droughts. Most of the millet is produced in the Senegalese regions of Kaolack, Kaffrine and Fatick jointly with peanuts, typically on sandy soil. In fact, millet is interchanged with peanuts from one year to the next. This relationship is vital as peanuts help fix nitrogen into the soil. Besides agronomic reasons, millet is nutritious and it has deep cultural roots. When local production of millet does not satisfy the demand, Senegal imports millet from India or with informal trade from neighboring Mali and even Burkina Faso.

The principal zones of production of rice in Senegal are in the Senegal River Valley for irrigated rice and the Casamance region for rain-fed cultivation. Irrigated rice represents 70 percent of national production. Farmers produce rice predominantly for subsistence and consumption smoothing, and not so much for commercialization. The West African region depends heavily on international imports of rice and Senegal is not the exemption. Rice is a core staple of the Senegalese diet, averaging as much as 93 kg per capita per year. In fact, with a population of only 13 million, Senegal is the world's tenth largest rice importer making the country vulnerable to price spikes and supply shortages. Because of this, the government has targeted measures to increase the local production of rice and greater consumer access to domestically produced rice.

Agricultural markets are mostly deregulated in Senegal, with the government intervening only in case of food crisis. Markets for cowpea and millet are very competitive with many players in the value chain. Maize and rice markets are more concentrated but have anyway a healthy level of competition among local processors and importers.

Figure 6.10: Crops Production and Net Exports in Senegal (in tons[3], 2011)



Source: FAO.

Table 6.3: Market Shares in Senegal

Cowpea		**Maize**	
Company	*Share*	*Company*	*Share*
KEBE SALL	8%	SAER KANE	15%
SEUR DIOUF	5%	SIDI SILLA	12%
TOURE IBRA	5%	KEBE SALL	8%
Others	72%	Others	65%
Millet		**Rice**	
Company	*Share*	*Company*	*Share*
SAER KANE	10%	Moustapha TALL	25%
SIDI SILLA	7%	Compagnie d'Investissement Céréalier (CIC)	10%
MOUDOU SEIDOU	5%	AGRIZ produit alimentaire	7%
Others	78%	Others	58%

[3] Trade data for cowpea is not available from FAOStat

6.3. Simulation results

In this section, we use the model to perform various simulations. We are interested both in changes to the level of domestic competition among processors, exporters and importers, and on changes in some of the constraints affecting the decision of the farmers. We investigate four case studies for Senegal: cowpeas, maize, millet, and rice.

Table 6.4 displays the simulation results for cowpeas in Senegal. Row 1 presents the changes in cowpea farm gate prices arising from changes in the level of competition among cowpea wholesalers and exporters. This is a contested market and small changes in the level of competition do not have important effect on farm gate prices of cowpeas. For example, the leader split simulation predicts an increase in farm gate price of 0.24 percent and the leaders merge a decrease of 0.13 percent. Only sizeable changes in competition like in the case of perfect competition we would observe significant changes in prices (5.16 percent in this case). Starting in row 2, we have in column 1 the predicted effect of changes in complementary factors. The model predicts that the farm gate price elasticity with respect to international prices is 1.1. While a 10 percent increase in transaction costs in inputs would have a very low effect on cowpea farm gate prices, the same increase in transaction cost for the final product would increase its price 4.72 percent. Also important are some of the spillover effects from the cash crop (groundnuts) in Senegal on farm gate prices for cowpeas. A 10 percent increase in the price of cash crops in Senegal would increase the farm gate price of cowpeas by 2.16 percent because of its reduced supply in equilibrium. On the other hand, the effect coming from increased in the marginal (-0.61 percent) and fixed cost (-0.54 percent) of the cash crop is not as important as the direct price effect.

Table 6.5 shows maize simulations. This is treated as an importable food crop in the model. Consequently, increases in competition tend to reduce farm-gate maize prices, while an increase in firms' market power tends to increase crop prices. However, given the structure of the market and the initial status quo, the magnitudes of the effects on prices are generally small. Changes in international prices would be transmitted to the local economy, although the elasticity is lower than 1. In the baseline, a 10 percent price increase would push farm-gate prices up by 7.10 percent. Spillovers from the cash crop are also present in the simulations. For instance, a 10 percent increase in groundnut prices would induce groundnut adoption and thus would create supply shortages of maize, leading to higher prices by around 1.4 percent.

Table 6.4: Simulation Results for Cowpeas

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	0,24	-0,13	-0,26	2,14	5,16
Increase of 10% in:						
International Price	10,98	11,28	10,78	10,66	12,96	17,92
Marginal Cost of Producing Cash Crop	-0,61	-0,36	-0,77	-0,91	1,57	5,16
Fixed Cost of Producing Cash Crop	-0,54	-0,27	-0,69	-0,82	1,62	5,16
Endowment	0,43	0,63	0,33	0,21	2,48	5,16
Preference Paremeter	0,61	0,82	0,51	0,38	2,72	5,16
Cash Crop Price	2,16	2,30	2,14	2,00	4,25	5,16
Marginal Cost of Producing Food Crop	0,61	0,81	0,53	0,42	2,68	5,16
Transaction Costs on Crop Production	4,72	4,85	4,64	4,58	5,57	7,70
Transaction Costs on Inputs	0,18	0,23	0,15	0,12	0,78	5,16
Non-Farmer demand	0,04	0,28	-0,09	-0,22	2,17	5,16

Source: simulation results from the model of Section 2.

Table 6.5: Simulation Results for Maize

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0.00	-0.28	0.25	0.31	-2.71	-5.36
Increase of 10% in:						
International Price	7.10	6.89	7.28	7.35	4.46	2.91
Marginal Cost of Producing Cash Crop	-0.11	-0.36	0.11	0.17	-2.81	-5.36
Fixed Cost of Producing Cash Crop	-0.70	-0.94	-0.52	-0.45	-3.40	-5.36
Endowment	0.69	0.39	0.98	1.04	-2.06	-5.36
Preference Paremeter	0.55	0.26	0.82	0.87	-2.12	-5.36
Cash Crop Price	1.40	1.05	1.72	1.79	-1.32	-5.36
Marginal Cost of Producing Cash Crop	0.37	0.06	0.64	0.69	-2.38	-5.36
Transaction Costs on Crop Production	3.05	2.96	3.13	3.16	1.92	1.25
Transaction Costs on Inputs	0.11	0.02	0.19	0.20	-0.69	-5.36
Non-Farmer demand	0.26	-0.03	0.53	0.58	-2.44	-5.36

Source: simulation results from the model of Section 2.

The simulation results for the case of millet are summarized in Table 6.6. The results are similar to those found for the case of cowpeas. In particular, given the status quo, only important changes in the level of competition would increase farm gate prices for millet (6.72 percent in the case of perfect competition). Increases in international prices, transaction costs of production, and in the competing cash crop would have large effects in the price paid for millet to the smallholder. The model predicts that an increase in production factors available for agricultural production would not reduce the equilibrium price of millet. Instead, this increase would make some millet producers to switch to the production of the more profitable cash crop, increasing the cereal price in equilibrium (0.64 percent). An increase in the risk food parameter would also increase the price of millet in equilibrium (0.78 percent).

Table 6.7 shows the simulation results for the case of rice, another food importable. While the magnitude change a bit, the basic findings from the previous maize case study emerge. More competition depresses rice prices, while less competition boosts it. The impacts are, however, small. International prices and border costs do have sizeable impacts on rice farm-gate prices. There are also relatively important spillovers from incentives to cash crop production. This reveals, once again, the relevance of general equilibrium considerations that our model can accommodate.

6.4. Welfare impacts

We conclude the analysis for Senegal with an analysis of the poverty impacts resulting from the price simulations of the previous section.

The welfare impacts of the price changes are reported in Tables 6.8 to 6.11 for the cases of cowpeas, maize, millet, and rice. We show the impacts of shocks to the market structure in the first row and to illustrate the role played by complementarities, we show results for a combination of shocks to market structure and international prices. We show average results for the total population, the poor, and the non-poor, and separate results for household that declare to be a producer of the crop under consideration.

Table 6.6: Simulation Results for Millet

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0,00	0,33	-0,20	-0,30	3,11	6,72
Increase of 10% in:						
International Price	10,81	11,22	10,49	10,38	13,80	19,56
Marginal Cost of Producing Cash Crop	-0,16	0,16	-0,38	-0,48	2,91	6,72
Fixed Cost of Producing Cash Crop	-0,81	-0,48	-1,06	-1,18	2,28	6,72
Endowment	0,64	0,92	0,48	0,36	3,61	6,72
Preference Paremeter	0,78	1,05	0,61	0,51	3,84	6,72
Cash Crop Price	2,14	2,35	2,04	1,92	5,23	6,72
Marginal Cost of Producing Food Crop	0,42	0,70	0,23	0,16	3,50	6,72
Transaction Costs on Crop Production	4,65	4,82	4,51	4,47	5,93	8,41
Transaction Costs on Inputs	0,12	0,20	0,07	0,05	1,01	6,72
Non-Farmer demand	0,05	0,37	-0,16	-0,26	3,16	6,72

Source: simulation results from the model of Section 2.

Table 6.7: Simulation Results for Rice

% Change in price	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Competition Policy	0.00	-0.49	0.24	0.56	-5.35	-8.07
Increase of 10% in:						
International Price	5.49	5.03	5.69	6.01	0.18	-2.02
Marginal Cost of Producing Cash Crop	-0.46	-0.92	-0.26	0.06	-5.69	-8.07
Fixed Cost of Producing Cash Crop	-0.20	-0.68	0.02	0.34	-5.49	-8.07
Endowment	0.21	-0.30	0.46	0.79	-5.11	-8.07
Preference Paremeter	0.36	-0.14	0.62	0.95	-4.93	-8.07
Cash Crop Price	0.36	-0.14	0.62	0.95	-4.93	-8.07
Marginal Cost of Producing Cash Crop	0.74	0.19	1.03	1.36	-4.69	-8.07
Transaction Costs on Crop Production	2.36	2.16	2.45	2.58	0.08	-0.87
Transaction Costs on Inputs	0.21	0.06	0.30	0.40	-1.36	-8.07
Non-Farmer demand	0.42	-0.10	0.68	1.01	-4.89	-8.07

Source: simulation results from the model of Section 2.

In Senegal, domestic agricultural markets are competitive and therefore changes in the level of competition do not have important effects on farm gate prices, except for the limit case of perfect competition. Senegal is also the country in the analysis that has the lowest share of people working in agriculture and therefore, for a given price change, the average welfare impact would be low. This is verified in the row corresponding to competition policy for the four crops in the study and for the different segments of the population considered (national, poor, non poor, and only producers). When looking at changes in international prices the welfare effects are larger but still modest. Despite small expected effects, some patterns are worth commenting. Increases in farm gate prices, be it because of more competition or a higher international price, have positive welfare effects in the case of cowpea but negative effects in the case of millet. This is because in the first case on average households are net producers while in the second case there are net consumers. In the case of cowpea, non poor households benefit while there is no effect on poor households. While for millet, the effect is negative for both type of households but it is larger in absolute terms for non poor households. In the case of both maize and rice, higher international prices create welfare losses, while the impacts of changes in competition policies is generally very small.

Table 6.9: Maize Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0.00	0.00	0.00	0.00	0.02	0.05
International Price	-0.06	-0.06	-0.06	-0.07	-0.04	-0.03
Poor						
Competition Policy	0.00	0.00	0.00	0.00	0.02	0.04
International Price	-0.05	-0.05	-0.05	-0.05	-0.03	-0.02
Non Poor						
Competition Policy	0.00	0.00	0.00	0.00	0.03	0.06
International Price	-0.08	-0.08	-0.08	-0.08	-0.05	-0.03
Producers						
Competition Policy	0.00	0.00	0.00	0.00	0.00	0.00
International Price	0.00	0.00	0.00	0.00	0.00	0.00

Note: first order impact on household welfare.

Table 6.10: Millet Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0,00	-0,01	0,00	0,01	-0,07	-0,16
International Price	-0,25	-0,26	-0,25	-0,24	-0,33	-0,46
Poor						
Competition Policy	0,00	-0,01	0,00	0,00	-0,05	-0,11
International Price	-0,18	-0,19	-0,17	-0,17	-0,23	-0,33
Non Poor						
Competition Policy	0,00	-0,01	0,01	0,01	-0,10	-0,22
International Price	-0,36	-0,37	-0,35	-0,34	-0,45	-0,64
Producers						
Competition Policy	0,00	0,00	0,00	0,00	-0,05	-0,10
International Price	-0,16	-0,16	-0,15	-0,15	-0,20	-0,29

Note: first order impact on household welfare.

Table 6.11: Rice Price Changes and Household Welfare

% Change in Household Welfare	Baseline	Leader Split	Leaders merge	Exit of largest	Equal market shares	Perfect Competition
Total						
Competition Policy	0.00	0.05	-0.02	-0.06	0.55	0.83
International Price	-0.57	-0.52	-0.59	-0.62	-0.02	0.21
Poor						
Competition Policy	0.00	0.04	-0.02	-0.05	0.44	0.66
International Price	-0.45	-0.41	-0.46	-0.49	-0.01	0.16
Non Poor						
Competition Policy	0.00	0.06	-0.03	-0.07	0.71	1.07
International Price	-0.73	-0.67	-0.75	-0.80	-0.02	0.27
Producers						
Competition Policy	0.00	0.00	0.00	0.00	0.00	0.00
International Price	0.00	0.00	0.00	0.00	0.00	0.00

Note: first order impact on household welfare.

7. Conclusions

In this paper we study the interplay between market structure and domestic complementary factors in the production and consumption decisions of agricultural families in Africa. We model the production allocation of factors of production to various cash and food crops and in how this allocation depends on competition along the supply chain and on the constraints faced by different types of farmers. The model describes the behavior of farms, exporters and importers in a simple partial equilibrium setting. In particular, we build three different versions of the model to deal with the three basic scenarios that we face in our empirical work: cash crop production (mostly for exports), net export of a food crop, and net import of a food crop. We study changes in market structure and in key parameters of the model that capture various household constraints and institutional access. We study how farm gate prices respond to changes in international prices, the marginal and fixed cost of producing a cash crop, the marginal cost of producing a food crops and the change in the price paid for a competing crop. We study as well the effects in the change of endowment and a preference parameter associated with food security risk. The model also allows us to study the effect on farm gate prices arising from changes in transaction costs for inputs and outputs.

We calibrate and shock our model for food and cash crops in four ECOWAS countries: Burkina Faso, Ghana, Nigeria and Senegal. We analyze the changes in real income of household caused by the hypothetical price changes of cash and food crops predicted by the models' simulations and budget and income shares from the respective household survey. In general term, the effect of more competition on farm gate prices depends on the initial level of competition in that country and crop. For many crops, in particular food crops, there is already a lot of competition and further changes in the level of competition will not affect farm gate prices much. In some other specific cases, in particular in cash crops and livestock, the initial level of competition is low and more competition is likely to have larger impact on producer prices. The effect also of competition on farm gate prices also depends on whether the country is a net exporter or a net importer of the crop. For crops where the country is an importer, increasing domestic competition will reduce importers markup putting downward pressure on farm gate prices.

In terms of the effect of complementary policy and other factors affecting the allocation decision of farmers, the largest impacts often come from an increase of international price where we often find a pass-through that is higher to one and from changes in the transaction cost on the production of the crop that increases the farm gate price in equilibrium. The magnitude and sign of the other complementary factors depend on the specific crop and country. For instance, the effect of the increase in the endowment on the price paid to food crop producing farmers is ambiguous. In some cases, the increase in the endowment increases the supply of the food crop and reduces the price

in equilibrium while in other, when the endowment increases many farmers find profitable to produce the cash crop and reduce the supply of the food crop what in equilibrium increases the food crop price. Increases in the marginal cost and in the fixed cost of producing a cash crop lead to increases in farm gate prices. Higher costs imply a shift up in the farm aggregate supply and a consequent increase in equilibrium prices. However, the response of prices to this shock and others in the model is cushioned to a very large extent by the market structure. The model also predicts that increases in household risks that lead to higher demands for food security positive affect equilibrium cash crop prices but the effect on the price of the food crops is ambiguous. This result suggests that negative and unwanted shocks to food producers (in rural areas, for example) may end up benefiting cash crop producers. This may exacerbate inequality between farmers and increase relative poverty impacts, for example. The model allows us to study to some extent the spillovers and interrelationships between cash crop production and food markets. In the cash crop export model, farmers take the prices of competing marketable foods as given, but the level of these prices clearly affects production and consumption decision. Similarly, the marginal cost of producing food can also affect cash crop production choices. These feedbacks are seldom studied in the literature but our model shows they can be sizeable.

In the paper we also examine complementarities between shocks to the structure of competition among exporters and shocks to household constraints. The idea is to uncover potential synergies between different types of policies or shocks. Our model features complementarities, and substitutabilities. Complementarities show up when the joint effect is larger than the sum of the separate effects and substitutability when the joint effect is smaller than the sum of the separate effects. It is difficult to generalize the results and to find clear patterns in the results. Sometimes, shocks and policies go in the same direction, sometimes they oppose each other. Sometimes the joint effects are big, sometimes they are small. The important lesson from these exercises, beyond the quantification of the special cases considered in the simulations, is that these complementarities exist and need to be taken seriously in the design of agricultural policies.

For each country and crop we conclude our analysis with a discussion of the poverty impacts of the comparative static results. Ultimately, we are interested in the role of the supply chain in agriculture on household well-being, on whether the poor are affected more or less than the non-poor, and on whether the complementarities between the structure of markets and household constraints can inform policy about ways to boost or ameliorate those poverty impacts. The analysis is done using standard techniques in the literature. We adopt the first order approximation analysis of Deaton (1989, 1997). This implies we can approximate the impact of a price change using income shares and budget shares as measures of exposure. The first order approximation works well if the price changes are small and if there are limited supply and consumption

responses. It is, in general, a very powerful and useful tool to evaluate the welfare effects of price changes.

To a large extent, the welfare impacts we find are small for all groups of households. For most crops, shocks, and affected population, the welfare impacts of the proposed simulations are less than 1 percent of total household expenditures. The only exception is the impact on producers where some sizeable impacts can often be established. These results are expected, given the nature of the exercised considered here, and they are also comparable to the literature on the topic (see the review in Lederman and Porto, 2014). There are various elements that need to be taken into account. First, the income shares and budget shares used in the first order approximation are typically small. Some crops are relevant separately on both the production side and on the consumption side. But a price change affects households as consumers and as producers, and thus the net effect tends to be small in general. Second, in most of the crops considered here, the market was already characterized by some degree of competition, thus leaving small room for sizeable price changes. The combination of small price changes with small net benefit ratios (Deaton, 1997) implies small impacts. The fact that the impacts are typically small does not mean they are not important. As we argued, small results are expected in this literature. They are expected given the context (household survey data and baseline market structure) but are reasonable. We are just assessing the short-run impacts of price changes caused by changes in exporters' market power and the combination with complementary factors. It is important to note that the complementary factors have an independent effect on household welfare that we are not attempting the measure here. If, for instance, the cost of crop production declines due to improvement in infrastructure, access to cheaper and better inputs, access to knowledge or credit, etc., there will be a direct impact on welfare and an indirect one via the combination with changes in market structure. In our study, we measure this additional impact only. It turns out that these additional impacts are small but, since they do not carry additional costs (for example fiscal costs if the complementarities are funded by the government), they only generate benefits.

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