Agricultural Prices, Household Wellbeing and Poverty Alleviation in Tanzania

The Role of Agricultural Supply Chains and Household Constraints

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This version: June 2015

Abstract: We study the interplay between market structure and domestic complementary factors in the production and consumption decisions of agricultural families in Tanzania. We study changes in market structure and in key parameters of the model that capture various household constraints and institutional access. In general term, the effect of more competition on farm gate prices depends on the initial level of competition in each 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, 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. The response of prices to this shock and others in the model is cushioned to a very large extent by the market structure.

Key words: Supply chains; Tanzania; Food crops; Cash crops; Market Structure; Poverty

JEL codes: Q12, Q13

1. Introduction

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. Cash crops are a major source of export revenue for a large number of African countries and the livelihood basis for millions of rural households. 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 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, and sorghum are essential for the everyday life of most African farmers as they constitute their dietary base. 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. 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. We use simulation analysis to isolate and quantify the effect of changes in the level of competition in domestic markets, both in food and cash 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.

We present results for several crops in Tanzania. In Section 2, we introduce 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 (cotton), farmers sell products to oligopsonies, who then do the international trading. In the case of exported food crops (cassava), there are oligopsonies in charge of exports, but there is also a domestic residual market of Tanzanian net-consumers of cassava. Finally, in the case of imported foodstuff (rice and maize), excess demand is met via international trade, and net-consumers must purchase these agricultural goods from oligopolies. In Sections 3, we present the results of the simulations. 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 some poverty results stemming from the simulations by combining the prediction of the model with the information from the household surveys.

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 o 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, 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 farmgate 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 ϑ_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

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

where m^f and m^c are the marginal (unit) costs 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 credit 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 $(p^c - m^c) > (p^f - m^f)$ so that it may be eventually profitable to produce c. In other words, per unit sold, a farmer earns more 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

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

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

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 $(p^c - m^c) > (p^f - m^f)$. 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

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

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

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

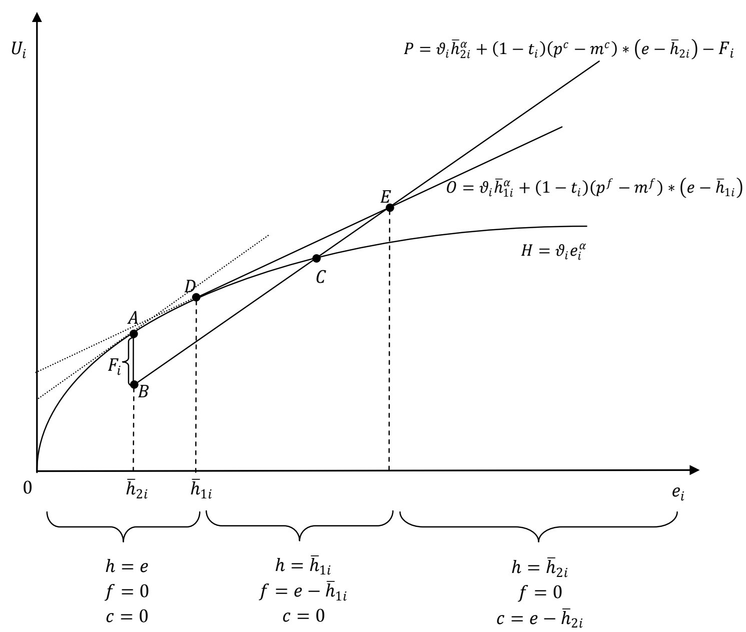
Given these conditions, it is easy to determine conditions that are consistent with different knds of production decisions/allocations:

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 farmer 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

Figure 2.1: Optimal Allocations



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.

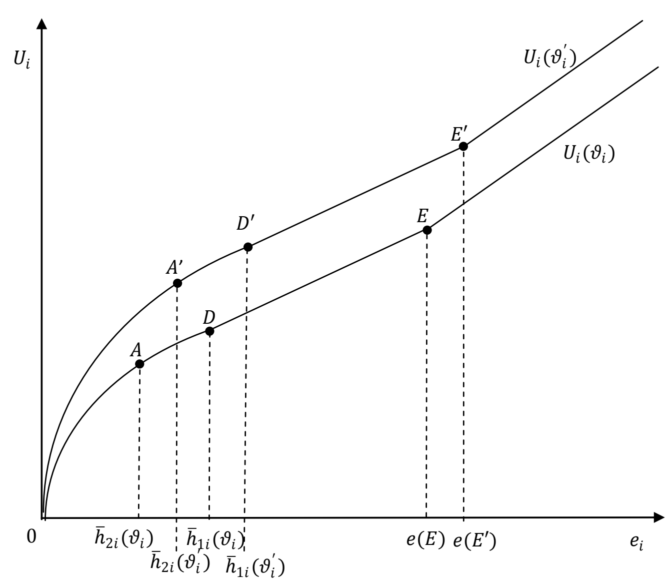
Several observations arise from this graph. Firstly, the marginal utility of h is decreasing, while those of c and f are constant. The intuition is that the law of diminishing marginal utility is stronger for a specific product such as self-sufficiency food than for money in general. In the graph, this 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.

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.

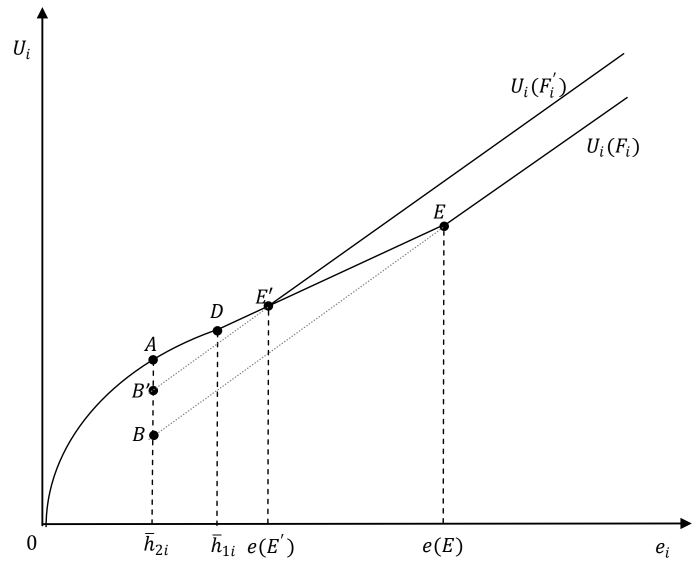
The parameter ϑ_i accounts for the household´s preference to auto-consumption. A larger ϑ_i will increase the marginal utility of producing h for each e, therefore increasing the values of $\bar{h}_{1i}$ and $\bar{h}_{2i}$, as is shown in Figure 2.2. Farmers that were originally producing f can switch 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 ϑ_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 $(p^c - m^c) > (p^f - m^f)$, 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 2.4. 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 E to E'. 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)

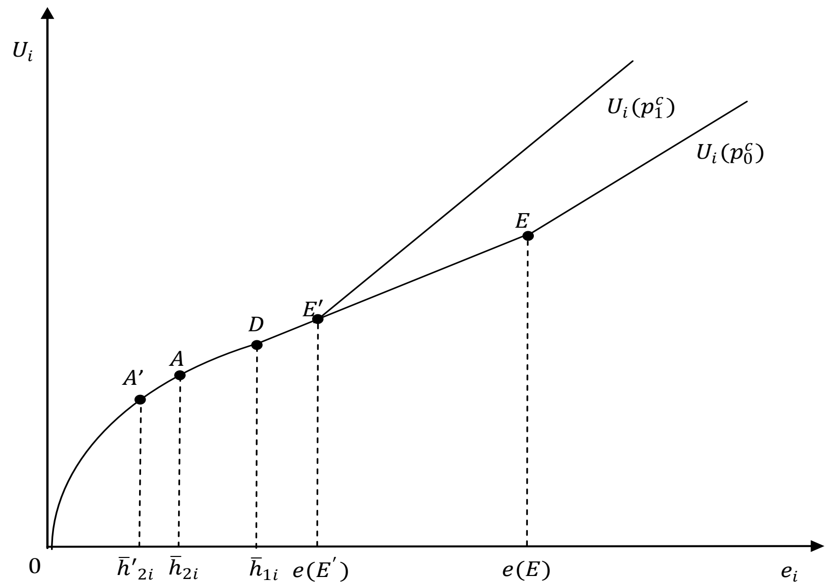
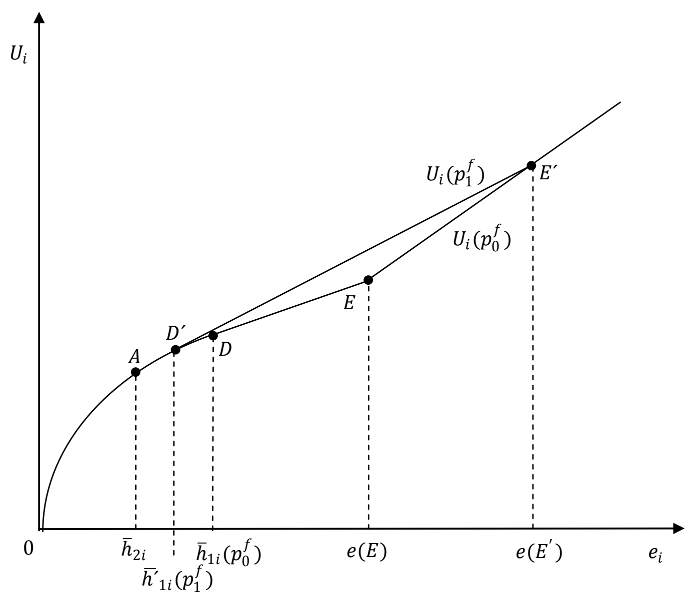


Figure 2.5: An Increase in Food Sales Prices p^f (from p_0^f to p_1^f)



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 $F_i > \bar{F}_{1i}$):

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

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:

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

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^c depends 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 perceives the following problem:

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

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

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 $S^{c''}(p^c) < 0$. 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. By the Maximum Theorem under convexity, 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:

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

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:

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

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:

$$fp^f + gp^g = d_i\,,$$

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

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

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: $(1-t_i)(p^f - m^f) * f_i$, if the farmer produces food for sale; $(1-t_i)(p^c - m^c) * c_i - F_i$, 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:

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

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

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

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:

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

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

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 $NS^{f''}(p^f) < 0$. 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, the function $f_j(D^f)$ is well defined and continuous.

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

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

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

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

2.3 Net Food Imports

The model is the same as in Section 2.3. 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:

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

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

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

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

Net demand is defined as

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

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

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:

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

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

With n importers, the first order conditions are:

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

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

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 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: α_r; α_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^c as a fixed parameter that is not be 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 (see section 2). 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 is 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 2.2, 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. The Case of Tanzania

The household data comes from the 2008 Tanzania National Panel Survey. The dataset contains information on over 16 thousand households. Around one third of these households reside in urban areas and two-thirds in rural areas. The Tanzanian population is young: 45 percent of the sample is less than 15 years old and over 90 percent is under 65 years old. There are slightly more females (52 percent) than males (48 percent). However, only 25 percent of the households are headed by females. On average, household size is 6.77 members per family. In turn, households in rural areas are bigger than in urban areas (7 versus 5.98 members per family).

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.

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 regions. As expected, the share of auto-consumption is much larger in rural areas than in urban areas. In fact, for urban households, 93.9 percent of their expenditure is cash spending. For rural households, cash expenditures account for 59.2 percent of the total budget, while home-produced expenditures account for the remaining 40.8 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, 65.4 percent of the Tanzanian budget is allocated to food. This share is larger for rural households (69.6 percent) than for urban households (50.9 percent). Urban people are richer and thus spend more on other goods and services than on food. Among food item, the most significant crop in consumption is maize. On average, maize represents 15.7 percent of Tanzania's household expenditure (17.7 percent of rural expenditure and the 8.6 percent of urban expenditure). Rice accounts for 4.8 percent of the budget, with slightly higher shares among urban households. Cassava accounts for 4.8 percent of expenditures in rural areas and for 1.1 percent in urban areas.

In Table 3.2, we show different sources of income. As expected, rural households have low shares of cash income (32.4 percent), because their gross income comes mostly from auto-consumption. On the other hand, urban cash income represents 78.4 percent of total income. Looking at crop income, maize is the most important crop. It represents 20.7 percent of rural household income and 7.4 percent of urban household income. Rice (4.5 percent) and cassava (6.4 percent) are also relatively important sources of income in rural areas, but not so much in urban areas (1.6 and 1.1. percent respectively).

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 if income food (cash agricultural plus auto-consumption). The food share profile slopes steeply downward. At the bottom of the distribution, around 80 percent of the budget is allocated to food, while at the top, only about 20 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. Unlike expenditures, income shares are stable along the log per capita expenditure. 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.

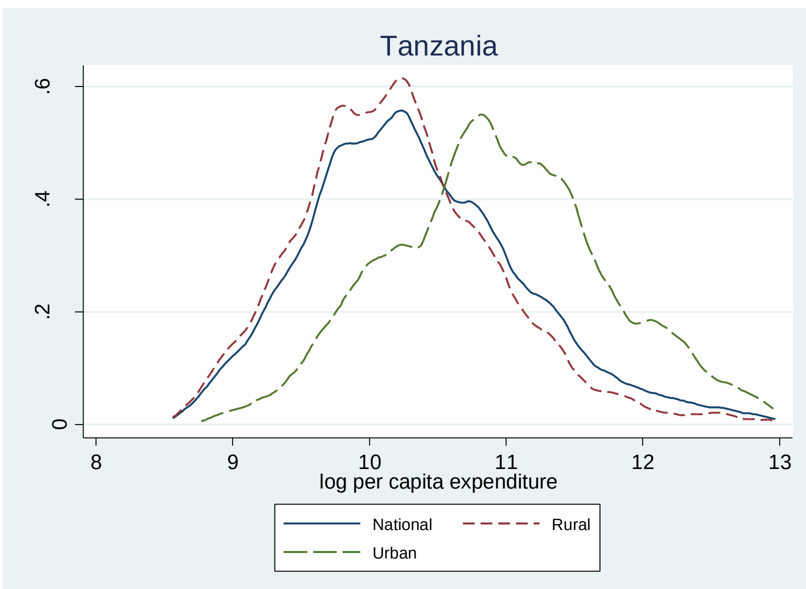
We now take a closer look at the patterns of income and budget shares across the income distribution for the main crops under study in Tanzania (Figures 3.4-3.9). Urban budget expenditures in rice are larger than rural shares along the log per capita expenditure (Figure 3.4). Middle class households spend more on rice in both regions. Looking at income shares in rice (Figure 3.5), the low and middle classes among urban households show a high income rice share. Among the wealthier households, the rural rice income share is larger than the urban share.

Maize is almost completely consumed by poor people (Figure 3.6). The rural share of maize is larger at all levels of wellbeing (log per capita expenditure). An increase in the price of maize will affect poor people more than rich people, because their consumption budget in maize is larger. Looking at income shares (Figure 3.7), we find that poor people in urban regions have larger maize income shares than richer households. This follows because the nonparametric regressions slope down. On the other hand, the negative correlation between the share of maize in income and the level of expenditure is not clear among rural farms.

Figure 3.8 shows a clear relation between its share of cassava and the level of expenditure. Cassava consumption tends to decrease when log per capita expenditures rise. For poor people it represents almost 15 percent of their budget share, whereas the budget share of rich people is negligible. This is a crop that is almost completely consumed by poor and middle-income households, which are thus more likely to be affected by cassava price changes. Figure 3.9 shows cassava income shares. The relationship with wellbeing is still negative but much less pronounced. Nevertheless, at the bottom and the middle of the distribution, the income share of cassava is comparable to the budget share (although a bit smaller). Comparing regions, the curve for rural areas lies above the curve for urban areas, which implies that welfare effects in rural areas will tend to be larger than in urban areas.

We end this section with a quick look some measures of infrastructure, household constraints and institution access. More concretely, based on the information from the household surveys, we look at education and services. According to this information, Tanzania has a low level of development in education. In Tanzania, 59.7 percent of the population has no formal education, 25.6 percent of population has complete primary education and only 0.5 percent has complete secondary education. We also find that educational achievements are higher in urban than in rural areas. In urban regions 49 percent of the population does not have formal education, but in rural regions the percentage rises to 62.8 percent. Educational constraints, with known implications for agricultural productivity and labor opportunities, seem to be binding. Another indicator that provides information about household constraints and about institutional and infrastructure access is the average distance to important centers such as District HQ, school, market milling machine, bank, police station, etc. In general, the data show that the population of Tanzania faces large distances to most of the important centers. For example, the average distance to District HQ is 36.9 km, and to the government hospital is 26.6 km. When comparing regions, distance seems to be greater in rural areas, making these constraints even more binding.

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



Source: Tanzania National Panel Survey (2008)

Table 3.1: Budget Shares

Tanzania	Total	Rural	Urban
Total consumption per capita	**100.0**	**100.0**	**100.0**
Expenditures	**66.9**	**59.2**	**93.9**
Food	32.3	28.8	44.8
Manufactures	15.2	14.7	16.8
Services	19.4	15.7	32.3
Others	0.0	0.0	0.0
Auto-consumption	**33.1**	**40.8**	**6.1**
Auto-consumption food	33.1	40.8	6.1
Auto-consumption others	0.0	0.0	0.0
Total Food consumption	**65.4**	**69.6**	**50.9**
Total crops	**39.4**	**43.2**	**26.2**
Maize	15.7	17.7	8.6
Rice	4.8	4.4	6.4
Livestock	5.9	6.1	5.1
Cassava	3.9	4.8	1.1
Cowpea	4.4	4.9	2.7
Yam	0.3	0.3	0.1
Wheat	1.0	1.0	1.2
Groundnut	1.5	1.8	0.4
Sweet potato	1.9	2.3	0.5

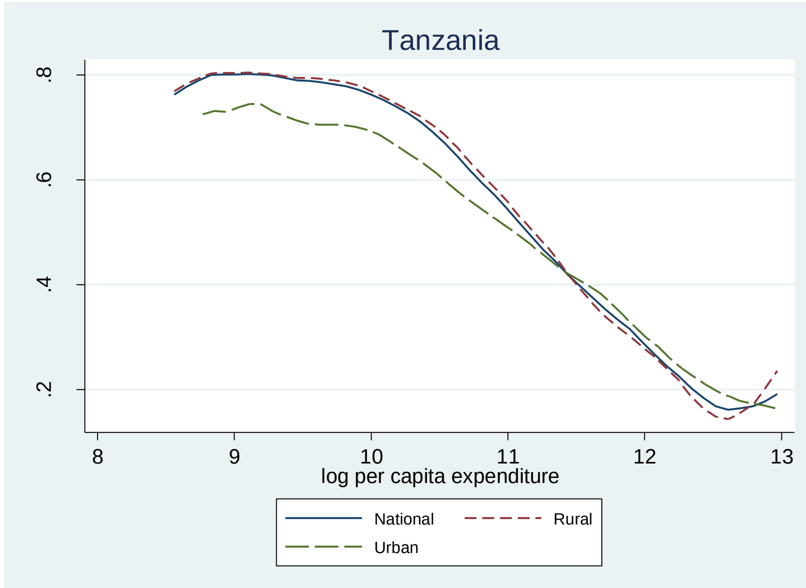
Source: Tanzania National Panel Survey (2008)

Table 3.2: Income Shares

Total Income per capita	**100.0**	**100.0**	**100.0**
Incomes	**41.1**	**32.4**	**78.4**
Food (agriculture)	15.1	16.9	7.2
Wage	16.2	8.9	47.7
Enterprises	8.0	5.2	20.2
Transfers	1.8	1.4	3.3
Auto-consumption	**58.9**	**67.6**	**21.6**
Auto-consumption food	58.9	67.6	21.6
Auto-consumption others	0.0	0.0	0.0
Total Food income and AC	**74.0**	**84.5**	**28.8**
Total crops	**49.2**	**56.6**	**17.0**
Maize	18.2	20.7	7.4
Rice	4.0	4.5	1.6
Livestock	5.0	5.6	2.4
Cassava	5.4	6.4	1.1
Cowpea	4.4	5.2	1.2
Yam	0.4	0.5	0.0
Wheat	0.8	1.0	0.0
Groundnut	2.6	3.0	1.2
Sweet potato	2.8	3.3	0.2
Cotton	1.4	1.7	0.2
Tobacco	0.7	0.9	0.0
Milk	3.5	3.9	1.6

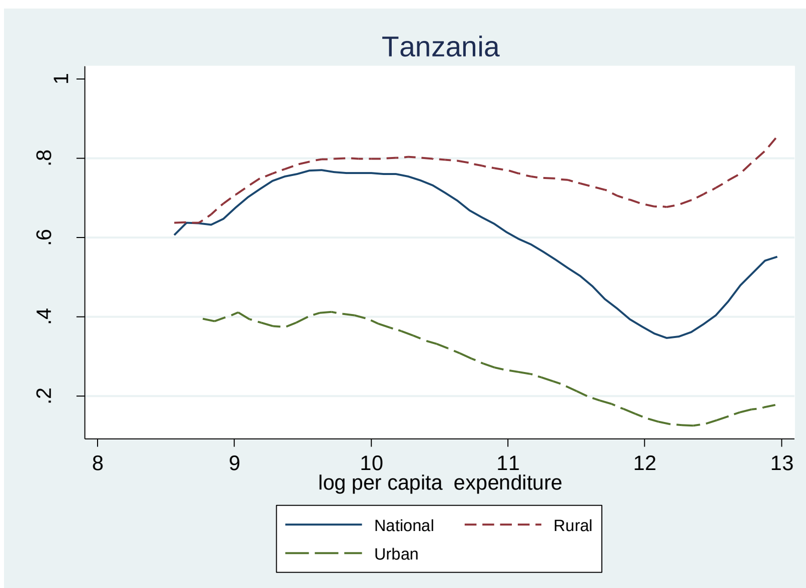
Source: Tanzania National Panel Survey (2008)

Figure 3.2: Total Food Budget Share Across the Income Distribution



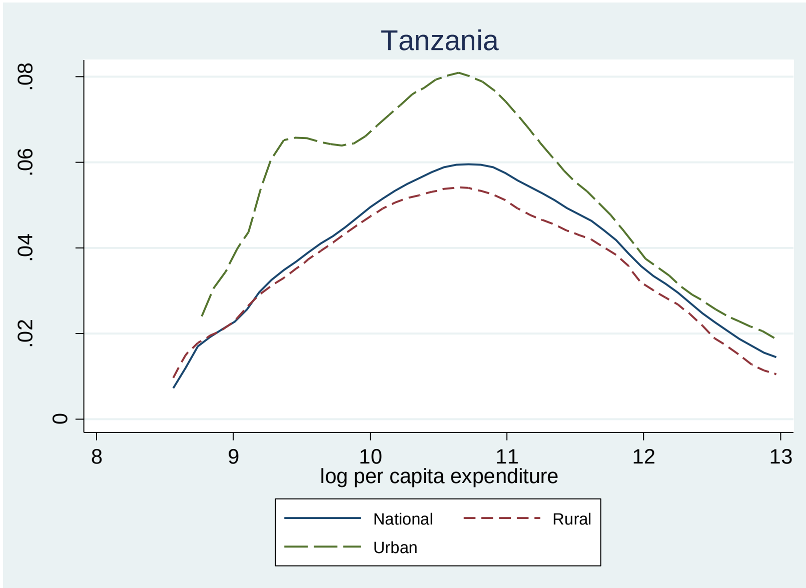
Source: Tanzania National Panel Survey (2008)

Figure 3.3: Total Food Income Share Across the Income Distribution



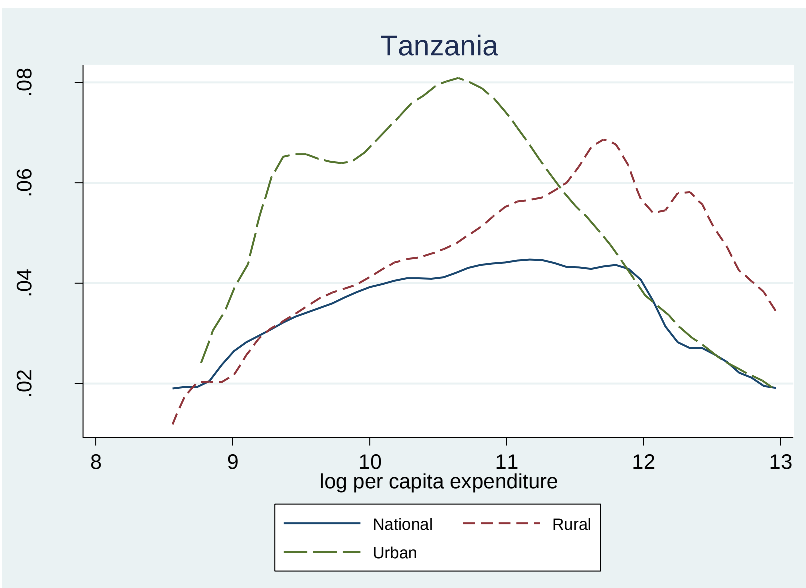
Source: Tanzania National Panel Survey (2008)

Figure 3.4: Rice Budget Share Across the Income Distribution



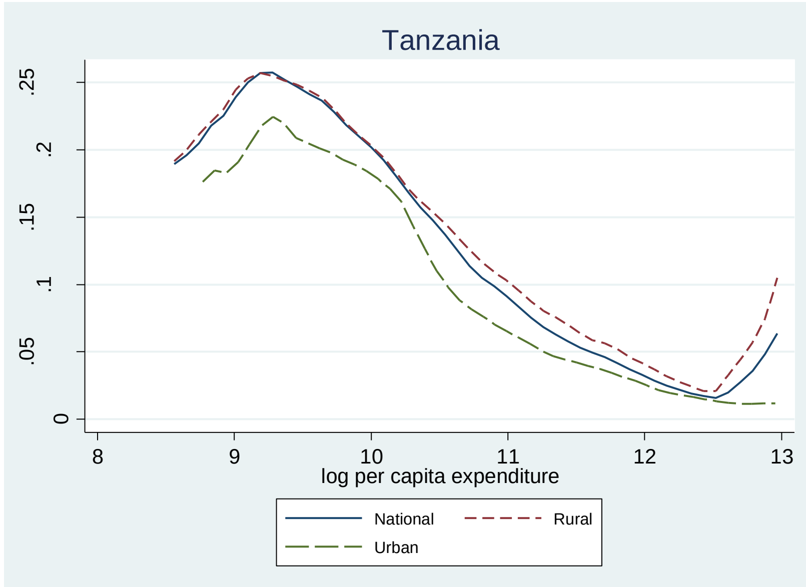
Source: Tanzania National Panel Survey (2008)

Figure 3.5: Rice Income Share Across the Income Distribution



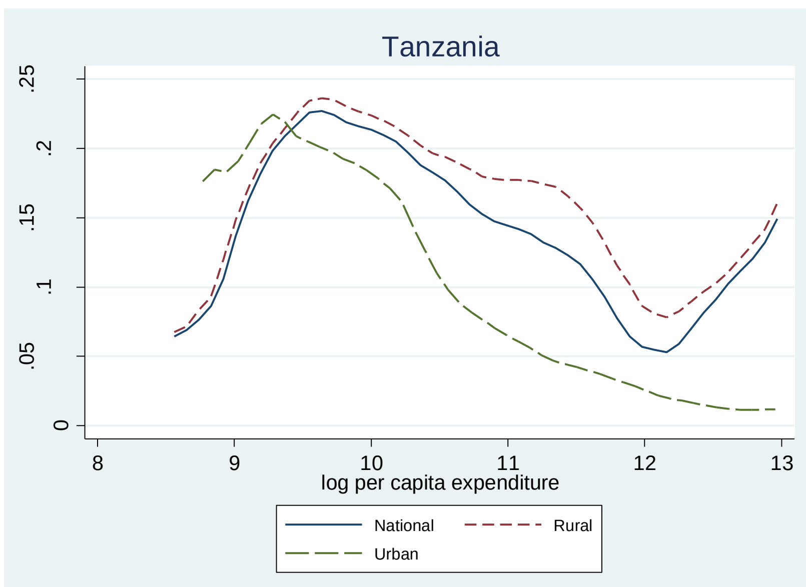
Source: Tanzania National Panel Survey (2008)

Figure 3.6: Maize Budget Share Across the Income Distribution



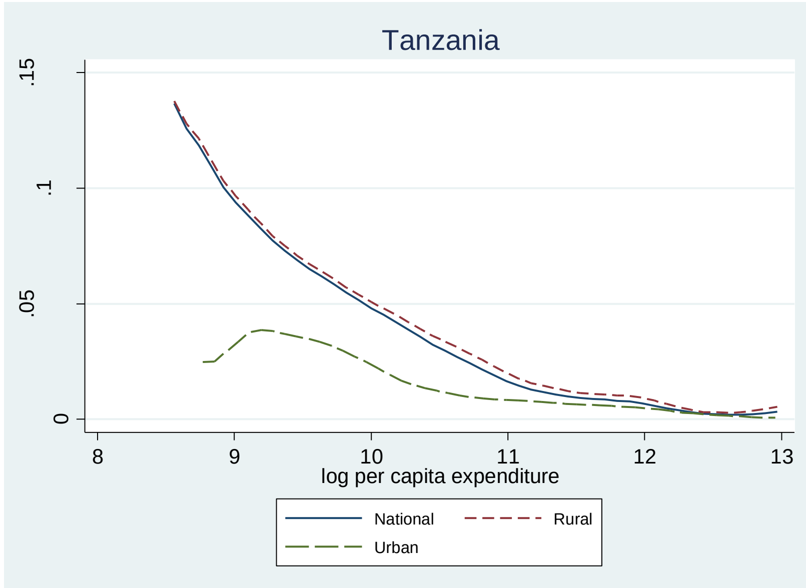
Source: Tanzania National Panel Survey (2008)

Figure 3.7: Maize Income Share Across the Income Distribution



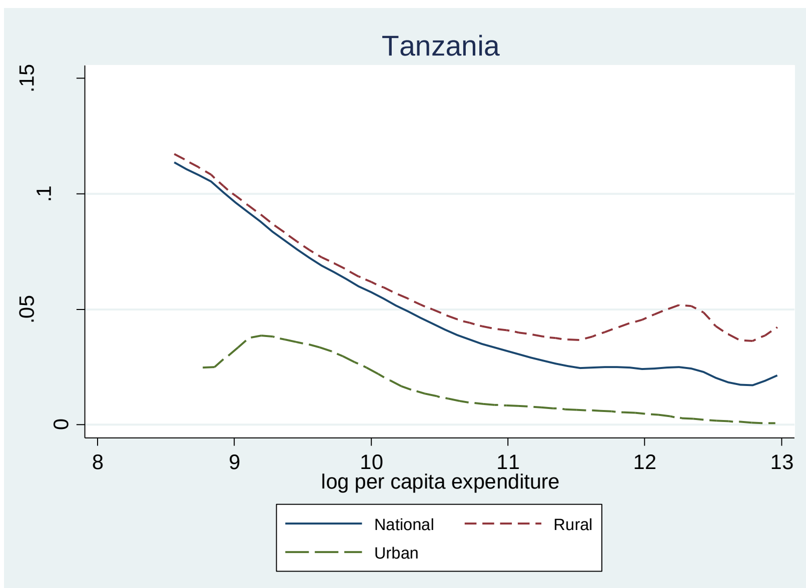
Source: Tanzania National Panel Survey (2008)

Figure 3.8: Cassava Budget Share Across the Income Distribution



Source: Tanzania National Panel Survey (2008)

Figure 3.9: Cassava Income Share Across the Income Distribution



Source: Tanzania National Panel Survey (2008)

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, endowments, risk and food security aversion. We are interested in price changes of the agricultural goods produced in Tanzania. 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 four case studies: cotton, cassava (exportables), rice and maize (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 Tanzania and we thus use the cash crop export model. The price changes from the simulation results are presented in Table 3.3. The first row shows the impacts of changes in competition. As expected, increases in competition raise farmgate 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 3.44 and 3.52 percent respectively. In contrast, the splits of the leader would increase prices by 2.56 percent, and move to an oligopsony with equal market shares, by 1.55 percent, and a move to a limit case of perfect competition, by 18.17 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 3.3, 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 farmgate prices. In the margin, after a price increase of 10 percent, for example, farmgate prices would increase by almost 19 percent. This implies a pass-through rate of 1.9. This is consistent with findings in Porto, Depetris, and Olarreaga (2011), on which our model builds, but it is a large elasticity.

Increases in the marginal cost and in the fixed cost of producing cotton lead to increases in farmgate 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: cost increases of 10 percent lead to price changes of roughly half of a percentage point. 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 cause 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.

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 farmgate cotton prices up. The same happens when the international price increases. Complementarities would occur if the change in farmgate 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 3.3 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 Equal market shares and higher marginal costs. The joint effect of those two shocks would be an increase in farmgate prices of 2.22 percent. Instead, the sum of the separate effects is smaller, 2.16 percent. In this case, the complementarity exists but is small (equivalent to roughly 3 percent of the joint effect). In other cases, the complementarity is much larger. The intuition is that the increase in competition causes prices to increase and this increase is larger if, concurrently, the costs of producing cotton are larger.

Consider now the case of Leader Splits together with an increase in food security and household risk. The result of the joint shock would be an increase in cotton farmgate prices of 4.88 percent. Instead, the sum of the separate shocks would bring prices up by 5.37 percent. This is a "substitutability" effects that implies a difference of 10 percent, approximately. In this case, the increase in food security risks induce farmers to reallocate resources out of cotton and into food, 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 in 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 crop that we study is cassava. This is an exportable food crop. Results are reported in Table 3.4. Given the nature of competition in the supply chain, which is highly competitive in the baseline, changes in the structure of the market has little impact on cassava farmgate prices. This can be seen in the first row of Table 3.4. In general, the price changes are negligible. Even in the move to a limit case of perfect competition (thus eliminating any remaining imperfections in the cassava market), prices would increase by only 1.28 percent. As in the case of cotton, changes in international prices have large impacts on cassava prices. This is roughly consistent with a setting where many traders compete with each other.

It is noteworthy that shocks to complementary factor seem to have small effects on cassava prices. We can divide these factors in two sets. On the one hand, there are factors that affect directly the production of cassava, such as household risks and cassava production costs. On the other hand, recall that our food export model includes a farm production decision that allows farmers to choose between cassava 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 cassava, we find that changes in production costs of the cash crop generate reduction in the price of cassava. 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 cassava supply. The magnitudes are, however, very small. The impact of changes in marginal costs is -0.03 percent (row 3) and the impact of changes in fixed costs is -0.33 percent (row 4). An increase in the price of the cash crop, in turn raises cassava prices (row 7) because it induces farms to produce more cash crop and supply less cassava.

Factors that affect cassava production directly also have small impacts. In row 8, for instance, a 10 percent increase in the marginal cost of producing cassava raises cassava equilibrium prices by only 0.16 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 cassava 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 0.68 percent. The best explanation we can provide for these findings is that while cassava is an important food crop in Tanzania, a lot of it is not channeled through the export market. As a result, changes in household constraints seem to have only small effects on the aggregate cassava supply. Combined with a competitive setting, the equilibrium price change is finally small.

We now turn to the case of rice and maize, two importable food commodities. Both are important crops, both in production and in consumption, and maize appears to be more relevant than rice (in terms of budget and incomes shares at least). We thus begin with the case of maize in Tables 3.5. As shown above, the maize market is dominated by a large number of traders and intermediaries. Analytically, the market behaves very competitively and, as a result, the shocks to market structure imply negligible impacts on prices (row 1). Note that we are dealing with an importable commodity and thus the market is represented by an oligopoly. In consequence, increases in competition should bring prices down (see for example, the price decline 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 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 prices by 0.84 percent. These results imply that the maize market is general inelastic to the shocks considered in our exercises. This is because, even though maize is an important food crop, 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 if the following. When the endowment is higher, the price of maize increases (slightly). A higher endowment allows households to produce more of all crops, including maize. Ceteris paribus, this should lead to price declines because of a larger supply. However, the price of maize 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 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.

Results for rice are presented in Table 3.6. Overall, the simulations for rice resemble qualitatively the results for maize, although the magnitudes of the effects are somewhat smaller. The rice market appears to be quite competitive and, consequently, changes in the nature of competition among importer trading bring only small price changes. 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 maize, all the other parameters of the model generate very small prices changes.

Table 3.3: Simulation Results for Cotton

	Baseline	Leader Split	Leaders merge	Exit of largest	Equal marquet shares	Perfect Competition
Competition Policy	0.00	2.56	-3.44	-3.52	1.55	18.17
Increase of 10% in:						
International Price	18.82	22.06	14.32	14.20	20.40	40.90
Marginal Cost of Producing Cash Crop	0.61	3.11	-2.27	-2.40	2.22	18.18
Fixed Cost of Producing Cash Crop	0.56	3.10	-2.40	-2.51	2.13	18.18
Household Resources (endowment)	-2.21	0.59	-5.82	-5.97	-0.78	18.18
Risk and Food Security Paremeter	2.81	4.88	0.24	0.15	4.28	18.18
Food Crop Price	0.40	2.81	-2.63	-2.72	1.94	18.18
Marginal Cost of Producing Food Crop	-0.17	2.45	-3.67	-3.77	1.41	18.18
Non-Farmer demand	-	-	-	-	-	-

Source: simulation results from the model of Section 2.

Table 3.4: Simulation Results for Cassava

	Baseline	Leader Split	Leaders merge	Exit of largest	Equal marquet shares	Perfect Competition
Competition Policy	0.00	0.06	-0.06	-0.06	0.00	1.28
Increase of 10% in:						
International Price	11.59	11.69	11.48	11.48	11.59	13.78
Marginal Cost of Producing Cash Crop	-0.03	0.03	-0.10	-0.10	-0.03	1.28
Fixed Cost of Producing Cash Crop	-0.33	-0.26	-0.41	-0.41	-0.33	1.28
Household Resources (endowment)	0.18	0.23	0.13	0.13	0.18	1.28
Risk and Food Security Paremeter	0.68	0.71	0.66	0.66	0.68	1.28
Cash Crop Price	0.83	0.85	0.81	0.81	0.83	1.28
Marginal Cost of Producing Food Crop	0.16	0.20	0.11	0.11	0.16	1.28
Non-Farmer demand	0.07	0.13	0.01	0.01	0.07	1.28

Source: simulation results from the model of Section 2.

Table 3.5: Simulation Results for Maize

	Baseline	Leader Split	Leaders merge	Exit of largest	Equal marquet shares	Perfect Competition
Competition Policy	0.00	-0.02	0.02	0.02	0.00	-0.44
Increase of 10% in:						
International Price	8.43	8.44	8.42	8.42	8.43	8.65
Marginal Cost of Producing Cash Crop	-0.17	-0.18	-0.16	-0.16	-0.17	-0.44
Fixed Cost of Producing Cash Crop	-0.18	-0.19	-0.17	-0.17	-0.18	-0.44
Household Resources (endowment)	0.24	0.21	0.27	0.27	0.24	-0.44
Risk and Food Security Paremeter	0.38	0.35	0.42	0.42	0.38	-0.44
Cash Crop Price	0.84	0.79	0.91	0.91	0.84	-0.44
Marginal Cost of Producing Food Crop	0.15	0.12	0.18	0.18	0.15	-0.44
Non-Farmer demand	0.03	0.01	0.05	0.05	0.03	-0.44

Source: simulation results from the model of Section 2.

Table 3.6: Simulation Results for Rice

	Baseline	Leader Split	Leaders merge	Exit of largest	Equal marquet shares	Perfect Competition
Competition Policy	0.00	-0.03	0.04	0.04	0.00	-0.85
Increase of 10% in:						
International Price	8.84	8.81	8.87	8.87	8.84	8.24
Marginal Cost of Producing Cash Crop	-0.09	-0.12	-0.05	-0.05	-0.09	-0.85
Fixed Cost of Producing Cash Crop	-0.03	-0.06	0.02	0.02	-0.03	-0.85
Household Resources (endowment)	-0.03	-0.06	0.02	0.02	-0.03	-0.85
Risk and Food Security Paremeter	0.14	0.09	0.19	0.19	0.14	-0.85
Cash Crop Price	0.23	0.18	0.29	0.29	0.23	-0.85
Marginal Cost of Producing Food Crop	0.10	0.05	0.15	0.15	0.10	-0.85
Non-Farmer demand	0.11	0.06	0.16	0.16	0.11	-0.85

Source: simulation results from the model of Section 2.

Poverty Simulations

We end our analysis 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 ogal of this section.

The analysis is done using standard techniques in the literature. We adopt the first order approximation analysis of Deaton (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 3.7 to 3.10 for the cases of cotton, cassava, maize and rice. 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. In the case of cotton, we report separate results for cotton 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. Even though there is net production of cassava, 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 cotton producers where some sizeable impacts can be established.

Table 3.7: Cotton Price Changes and Household Welfare

	Baseline	Leader Split	Leaders merge	Exit of largest	Equal marquet shares	Perfect Competition
Total						
Competition Policy	0.00	0.02	-0.03	-0.03	0.01	0.16
International Price	0.17	0.20	0.13	0.13	0.18	0.37
Poor						
Competition Policy	0.00	0.01	-0.02	-0.02	0.01	0.08
International Price	0.08	0.10	0.06	0.06	0.09	0.18
Non Poor						
Competition Policy	0.00	0.04	-0.05	-0.06	0.02	0.29
International Price	0.30	0.35	0.23	0.23	0.32	0.65
Producers						
Competition Policy	0.00	0.44	-0.59	-0.60	0.26	3.11
International Price	3.22	3.77	2.45	2.43	3.49	6.99

Note: first order impact on household welfare.

Table 3.8: Cassava Price Changes and Household Welfare

% Variariation in Utility	Baseline	Leader Split	Leaders merge	Exit of largest	Equal marquet shares	Perfect Competit ion
Total						
Competition Policy	0.00	0.00	0.00	0.00	0.00	-0.01
International Price	-0.11	-0.12	-0.11	-0.11	-0.11	-0.14
Poor						
Competition Policy	0.00	0.00	0.00	0.00	0.00	-0.01
International Price	-0.06	-0.06	-0.06	-0.06	-0.06	-0.07
Non Poor						
Competition Policy	0.00	0.00	0.00	0.00	0.00	-0.02
International Price	-0.19	-0.19	-0.18	-0.18	-0.19	-0.22

Note: first order impact on household welfare.

Table 3.9: Maize Price Changes and Household Welfare

	Baseline	Leader Split	Leaders merge	Exit of largest	Equal marquet shares	Perfect Competit ion
Total						
Competition Policy	0.00	0.00	0.00	0.00	0.00	0.02
International Price	-0.46	-0.46	-0.46	-0.46	-0.46	-0.48
Poor						
Competition Policy	0.00	0.00	0.00	0.00	0.00	0.02
International Price	-0.30	-0.30	-0.30	-0.30	-0.30	-0.31
Non Poor						
Competition Policy	0.00	0.00	0.00	0.00	0.00	0.04
International Price	-0.68	-0.68	-0.68	-0.68	-0.68	-0.70

Note: first order impact on household welfare.

Table 3.10: Rice Price Changes and Household Welfare

	Baseline	Leader Split	Leaders merge	Exit of largest	Equal marquet shares	Perfect Competit ion
Total						
Competition Policy	0.00	0.00	0.00	0.00	0.00	0.02
International Price	-0.22	-0.22	-0.22	-0.22	-0.22	-0.21
Poor						
Competition Policy	0.00	0.00	0.00	0.00	0.00	0.00
International Price	-0.05	-0.05	-0.05	-0.05	-0.05	-0.04
Non Poor						
Competition Policy	0.00	0.00	0.00	0.00	0.00	0.01
International Price	-0.14	-0.14	-0.14	-0.14	-0.14	-0.13

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, 2013). 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 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. 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 Tanzania. 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 Tanzania. 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, 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. 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 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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