Changes in the Structure of the Value Chain in Agriculture in Zambia Impacts on Farm Income[1]

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1 Introduction

Rural Zambia holds 61.8 percent of the country's poor population. Most of these farmers are engaged in agriculture and produce a variety of different crops. While the vast majority of households in rural areas produce food for home consumption, the number of farmers engaged in commercial agriculture like tobacco, cotton, or horticulture, is much lower. It has long been recognized that, under the right circumstances, commercial agriculture can work as an effective vehicle for poverty alleviation. This is because commercial crops often show higher returns (per unit of inputs) than home consumption crops. However, commercialization of agriculture is produced along a value chain where intermediaries, exporters, downstream producers and upstream producers interact with farmers.

Farmers produce raw agricultural commodities that are the basic input of these value chains. The most important market chains, like cotton, tobacco or vegetables, involve international markets and exports. Sometimes, crop production is just labeled, packaged, and marketed. In other cases, the raw product is processed, at least partially, and then sold (abroad). The farming sector itself is composed of many atomistic smallholders. Instead, the lower-layer of the chains is usually dominated by a small number of firms. Farmers may thus suffer from the non-competitive behavior of agents at other layers of the chains.

In this scenario, changes in the structure of these layers, for example by increasing downstream competition, will affect the prices received by farmers and therefore their income and earnings from agriculture. The main purpose of our analysis is to estimate the impacts, at the farm level, of changes in the value chains in agriculture on household income. Understanding how these market forces—particularly in the context of imperfect competition—determine the prices of commercial crops and the income of rural households is a critical component of a sound strategy towards poverty reduction in rural

[1] We thank Anke Reichhuber and Paavo Eliste for their support. This is a background paper for the Zambia Value Chain Analysis. We thank A. Ambrus and A. Reichhuber for comments and suggestions.

Africa. In Zambia, changes in the structure of the value chains may also play a key role in the way international markets and domestic conditions reach farmers in rural areas. These complementarities may also be important factors in a strategy of rural growth and poverty reduction.

Our household analysis at the farm level is quite broad. To begin with, we want to know how the income of an average farmer already participating in the chain will respond to changes in the structure of that chain. These are the farmers that are most likely to be affected by any changes in agriculture commercialization. At the same time, we want to shed some light on the income responses of those smallholders who are initially not participating in the chain. If these are the poorest or more vulnerable households, larger impacts on poverty should be expected when these farm responses are included in the analysis.

1.1 Overview of the Model

To address these questions, the analysis proceeds in two stages. In the first stage, we simulate the changes in farm-gate prices of key agricultural products (cotton, tobacco) given hypothetical changes in the structure of the chain. In the second stage, we utilize these price changes to estimate household income responses using household survey data.

The first stage

To compute the price changes that would be generated by changes in the value chain, we set up a theoretical model of a sector with a vertical structure and different layers in the value chain. We begin with a simple model in which atomistic farmers produce an agricultural commodity that is sold to an oligopsonistic exporter. Then, we expand this basic model to include two layers along the chain so that farmers interact with both upstream and downstream producers/retailers. Based on data on the elasticity of demand in the different layers, the elasticity of supply of farm output, the number of firms operating in each layer and other relevant information, we simulate the price changes caused by changes in the main parameters of the model that characterize the value chain. The simulations involve the re-evaluation of the solution to the theoretical model under different assumptions about the value of those parameters.

The Second stage

In this stage, we feed the price changes calculated in the first stage to household survey data. The available household surveys have information on the structure of income derived from agricultural activities like tobacco and cotton. Faced with a price change in one of these agricultural activities, the effect on the income of farmers can be studied by exploring the income shares obtained from that activity (Deaton, 1989; Deaton, 1997). This methodology provides an evaluation of the income responses of those households already participating in the value chain. By inspecting the distribution of the income shares along the income distribution, it will be possible to identify which farmers will benefit more from the price changes and whether the poor will enjoy any of these benefits.

Our analysis takes a further step and evaluates the likely responses of those farmers initially not involved in the value chain. This is an important addition to the more standard analysis, since those farmers that are out of the chain are likely to be the poorest or the most vulnerable households. To do this, we proceed as follows. First, based on information from the household survey, we estimate a Probit model of participation into the value chain. This model gives us a prediction of the probability of participation for all farmers in the household survey sample. Second, using the simulated price changes from the first stage, aggregate supply responses at the farm level are calculated. Third, these supply responses are allocated to the farmers in proportion to the estimated Probit probabilities. Notice that this method allows these supply responses to affect farmers already in the chain as well as farmers outside the chain. Fourth, the average supply responses, evaluated at the changed prices from the simulation from the first stage, provide an estimate of the income gains from enhanced participation into the value chain.

1.2 Value Chain Changes

It is worth discussing the sort of simulations that we perform in this study. As already explained, we are interested in exploring how changes in the structure of the value chains affect agricultural prices and household income. Therefore, the basic starting point of our analysis is changes in the number of firms, and in their behavior, along the different layers of the chain. These comparative static results imply an increase in competition along the chain and thus an increase in the prices faced by farmers.

We carry out an additional exercise. We study the role of vertical agreements in agriculture. In Zambia, it is often the case that firms provide inputs on loan to the farmers that have to be repaid at harvest time. These outgrower contracts are feasible in part because of the non-competitive structure of the value chains that allows firms to monitor and successfully enforce contracts. When competition increases, thus, there is a risk of an induced failure in the outgrower contracts that may hurt farmers. In the analysis, we address these issues to illustrate some potential risks of changes in the value chains.

1.3 Poverty in Zambia

Our ultimate goal is to explore how changes in the value chain in agriculture can potentially affect the income of the most vulnerable households, especially in rural areas. It is therefore useful to provide a quick overview of the poverty numbers in Zambia. We do this is Table 1. Poverty is a severe phenomenon in Zambia: 56 percent of the national population is poor (i.e., enjoys a level of expenditure which is below the poverty line). As expected, poverty is more pervasive and widespread in rural than in urban areas. While in urban areas the poverty rate is 45.3 percent, 61.8 percent of the rural population is poor.
Poverty rates vary significantly across provinces. The highest poverty rates are observed in the Northern, Luapala, and Northwestern provinces. The lowest poverty rates are instead observed in Lusaka and Southern provinces. The poverty gap is a measure of how

far are the poor from the poverty line. Intuitively, it is the share of the poverty line that would be "necessary" to put the poor out of poverty. Notice that rural Lusaka has a relatively "moderate" poverty of 63 percent but it has one of the largest poverty gaps in the country. This means that, even though the number of poor individuals is relatively small, they are farther away from the poverty line.

Table 1
Poverty in Zambia
(Percent)

	Poverty Rate			Poverty Gap			Severity of Poverty		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
National	45.33	61.75	56.02	16.73	23.44	21.10	8.19	11.60	10.41
Central	51.61	55.00	54.20	19.65	18.71	18.93	9.54	8.34	8.62
Copperbelt	48.31	65.17	51.64	18.99	25.14	20.20	9.62	12.38	10.17
Eastern	34.47	57.65	55.62	11.09	19.88	19.11	4.73	8.91	8.54
Luapala	47.63	70.06	66.59	17.05	30.29	28.25	8.32	16.53	15.26
Lusaka	43.42	63.07	47.04	14.86	30.20	17.69	6.90	17.44	8.84
Northern	59.15	77.98	75.45	24.61	32.90	31.79	13.46	17.48	16.94
North-Western	36.85	64.42	60.77	14.36	22.79	21.67	7.33	10.73	10.28
Southern	32.48	51.15	47.12	10.92	16.62	15.39	4.98	7.52	6.97
Western	40.41	53.35	51.90	11.55	20.08	19.12	4.73	9.72	9.16

Own calculations from 2003 Living Conditions Monitoring Survey. Poverty rates are computed using measures of per adult equivalent consumption aggregates. The head count is the proportion of the population with an income below the poverty line. The Poverty Gap is a measure of the amount of money that would move the poor to the poverty line. The Severity of Poverty puts more weights to the poorest individuals.

2 The Methodology

Our methodology comprises two different models, one to identify price and quantity changes following a hypothetical shock to the value chain and another to feed these price and quantity changes to the household and to measure the income effects.

2.1 Models of Value Chains

Briefly, our aim in this section is to develop a set of theoretical models of value chains that we will use to represent different sectors in Zambian agriculture. All the models share some common features. There are basically three agents: farmers, upstream agricultural processors and downstream agricultural retailers. The different models that we develop here describe different interrelationships between theses actors. In sections 3-5, we use these different models to characterize the varying structure of the value chains in different sectors in Zambia.

2.1.1 Model 1: The Exporter's Model

This is the simplest model of value chains. We consider a market structure with two production sectors, an agricultural sector ("farmers") and an exporter sector ("exporters"). "Farmers" are atomized and thus competitive while "exporters" are concentrated and may use market power over "farmers." However, these "exporters" are small in world markets so that they cannot exercise market power in international markets and are thus price takers. For instance, this market structure could be compatible with vegetable markets where vegetables are produced by households and then bought by a small number of packer firms, which transport, select, clean, pack and sell the vegetables in international market. This model is also a good representation for the market for cotton lint.

The model builds on the supply function of the crop produced by the household (say, fresh vegetables or cottonseeds) and on the demand for the final product (say, packed vegetables or cotton lint). The farmers inverse supply function $S(\cdot)$ is given by

(1) $$P^f = S(Q^f),$$

where Q^f is the total production of the raw agricultural product and P^f is the price per unit received by the farmers. In principle, $S(\cdot)$ is upward-sloping so that higher crop prices can trigger supply responses from the farmers. Also, notice that to set up production, farmers may need factors like fertilizers, seeds, capital, and infrastructure. We will discuss and exploit these complementarities in more detail below.

The inverse demand function for the final product (i.e., the packed vegetables or cotton lint) is given by

(2) $$P^e = P^I - T,$$

where P^I is the international price of the final good and T is a per unit import tariff. These tariffs are included to model potential complementarities between the structure of the domestic value chain and the structure of trade protection in international markets (especially tariffs faced by Zambian producers in world markets, if any).

Next, we need to model the technology of production of the farm product and of the exportable good. To simplify the model, and to focus on competition effects, we assume that the exporters utilize a Leontief technology with fixed proportions and constant returns to scale. Without loss of generality, we assume input requirements such that $Q^f = Q^e = Q$, where Q^e is the total production of the exportable. Under these assumptions, the cost of production of the exportable has two components: the cost of purchasing the farm output and the cost of manufacturing the final good. A representative exporter cost function is given by

(3) $$C^e = (c^e + P^f)q^e,$$

where C^e is the exporter's total cost of producing q^e. The cost of purchasing a unit of farm output is P^f and the (constant) unit cost of processing is c^e.

Exporters choose output levels to maximize profits, taking as given the export price (and other parameters of the model like tariffs) and the behavior of other firms. The representative exporter profit function is

(4) $$\Pi^e = (P^I - T - c^e - P^f)q^e.$$

The first order condition is

(5) $$P^I - T - c^e - P^f - \frac{\partial P^f}{\partial Q}\frac{\partial Q}{\partial q^e}q^e = 0.$$

Rewriting it in terms of elasticities yields

(6) $$P^I - T = P^f(1 + \frac{\theta^f}{\varepsilon^f}) + c^e,$$

where $\varepsilon^f = \frac{\partial Q}{\partial P^f}\frac{P^f}{Q}$ is the farmers price supply elasticity and $\theta^f = \frac{\partial Q}{\partial q^e}\frac{q^e}{Q}$ is the exporter's oligopsony market power conjectural elasticity. The supply elasticity is a measure of how responsive farmer output is to prices. The conjectural elasticity θ^f is a measure of the exporter's oligopsonistic market power and shows how equilibrium output Q responds to a change in the production level of an individual exporter. In perfect competition, $\theta^f = 0$ because each individual exporter would be too small to affect the market; in the case of a monopsony, $\theta^f = 1$ since the exporter is the only buyer and $Q = q^e$. In the case of imperfect competition, θ^f lies between 0 and 1, being closer to 0 when the ``exporters'' are less concentrated and closer to 1 when they are more concentrated.

The first order condition ((6)) has a simple interpretation. As usual, profit maximization requires the equalization of the marginal revenue from the production of an additional unit of exports (the international price net of the tariff given by the left hand side) with the marginal cost. This is given by the unit processing cost c^e and the price paid to farmers P^f, taking into account the supply response and the conjectural elasticity. Several interesting cases emerge.

Consider first the case where there is competition among exporters in the value chain. In this case, $\theta^f = 0$ so that the first order condition implies

(7) $$P^f = P^I - T - c^e.$$

In this case, there is no strategic behavior of the exporters and therefore the price paid to the farmer is just the difference between the net price of exports and the cost of processing. Since exporters do not have market power over farmers, the price paid adjusts to eliminate profits among exporters.

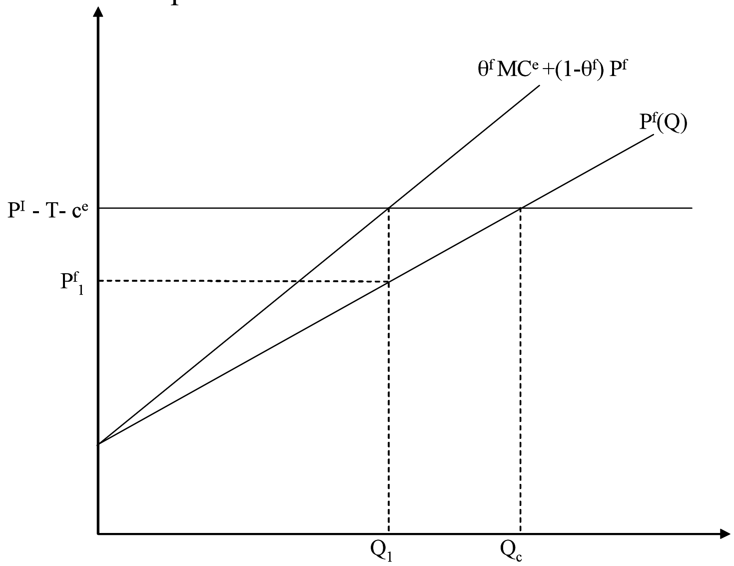
The opposite case arises when there is only one exporter, who thus acts as a monopsonist over the farmers. In this case, the price paid to the farmer is actually lower than the net price of the exporter ($P^I - c^e - T$), a fact that reveals monopsonistic behavior. Intuitively, by reducing the price below this level, the exporter realizes a gain not only on the marginal unit but also on the inframarginal units. This makes price reductions—from the competitive level—profitable for the exporter. In consequence, the price paid to the farmer is lower than the competitive price and the extent of this wedge depends on the elasticity of supply of farm output. Intuitively, the higher the elasticity of supply ε^f, the higher the price received by the farmers. When the processors decide to cut P^f (from, say, the competitive equilibrium), farmers respond by decreasing quantities to an extent given by ε^f. When ε^f is high, farmers respond a lot to given price cut and this reduces the profitability of further price cuts leading, in the end, to higher equilibrium prices.

Finally, for a given elasticity of supply, the price paid to the farmers increases when the competition among exporters is more intense. In the model, this is captured by a lower value of θ^f, the parameter that describes the competitive nature of the model and that depends on the number of firms and their relative size. A low θ^f means that a given exporter expects little reaction from other exporters. This translates into higher farm-gate prices P^f. Conversely, a higher θ^f means less competition (more monopsonistic power) and lower farm-prices.

These results can be visualized in an intuitive way in Figure 1. The graph shows the equilibrium of the model when the international price (net of the tariff) is given in international markets at p^I. The supply curve of the farmers in $P^f(Q)$. Under perfect competition, the equilibrium would be found at the intersection of the net export price $P^I - T - c^e$ and the supply curve with a level of output of Q_c. When there is monopsonistic behavior in the exporters, the relevant curve is the perceived marginal cost for the firm. This function takes into account that, after a decrease in quantities purchased by one processor, other processors will react too.[2] As a result, it becomes profitable for the exporters to contract production and thus lower the price paid to the farmer. The graph shows how a decrease in θ^f—more competition for cotton seeds among exporters—results in an increase in the final price received by the farmers. Also, an increase in international prices, a decrease in tariffs on Zambian exports, or an improvement in the production costs of the exporters (via better infrastructure for example) can lead to a higher price for the farmers.

[2]As described, this is captured by θ^f. (A higher θ^f means a higher degree of imperfect competition).

Figure 1
Model 1 – Exporter's Model



Note: At the competitive equilibrium, output is given by Q_c, the price received by the exporters is $P^I - T$ and the price received by the farmers is $P^I - T - c^e$. Under imperfect competition, equilibrium output is Q_1 and the prices received by the exporters and the farmers are $P^I - T$ and P_1^f respectively.

2.1.2 Model 2: A Three-Sector Value Chain with Fixed International Price

In this section, we extend the model to consider a market structure with three production sectors. As before, there is a set of household agriculture producers, the ``farmers"; in addition, there is an intermediate industrial sector, the ``processors"; and finally, there is an industry that produces the final product, the ``retailers." Retailers sell the final good in international markets at a fixed price. As before, farmers are atomized; instead, processors and retailers are concentrated. An example of this type of value chain could be the processed food value chain, where agricultural exporters buy raw vegetables from small producers and sell them to a food processor which exports the final product to international markets.

As before, the building blocks of the model are the supply of farm output and the demand of the final product. The farmers inverse supply function is given by equation ((1)) and the final product inverse demand function is given by equation ((2)). The cost functions of the processors and retailers are, respectively

(8) $C^p = (c^p + P^f)q^p$

(9) $C^r = (c^r + P^p)q^r$,

where c^p and c^r are fixed per unit production costs and P^p and P^f are the processor price and the farmers price, respectively. Let T be a per unit tariff. The profit functions are, thus

(10) $\Pi^p = (P^p - c^p - P^f)q^p$

(11) $\Pi^r = (P^I - T - c^r - P^p)q^r$.

The first order conditions from profit maximization are

(12) $$P^I - T - c^r - P^p - \frac{\partial P^p}{\partial Q}\frac{\partial Q}{\partial q^r}q^r = 0$$

for the retailers and

(13) $$P^f - c^p - P^f - \frac{\partial P^f}{\partial Q}\frac{\partial Q}{\partial q^p}q^p = 0,$$

for the processors.

As before, it is useful to rewrite these expressions in terms of elasticities. This yields

(14) $$P^I - P^p(1+\frac{\theta^p}{\varepsilon^p}) = c^r + T$$

(15) $$P^p - P^f(1+\frac{\theta^f}{\varepsilon^f}) = c^p.$$

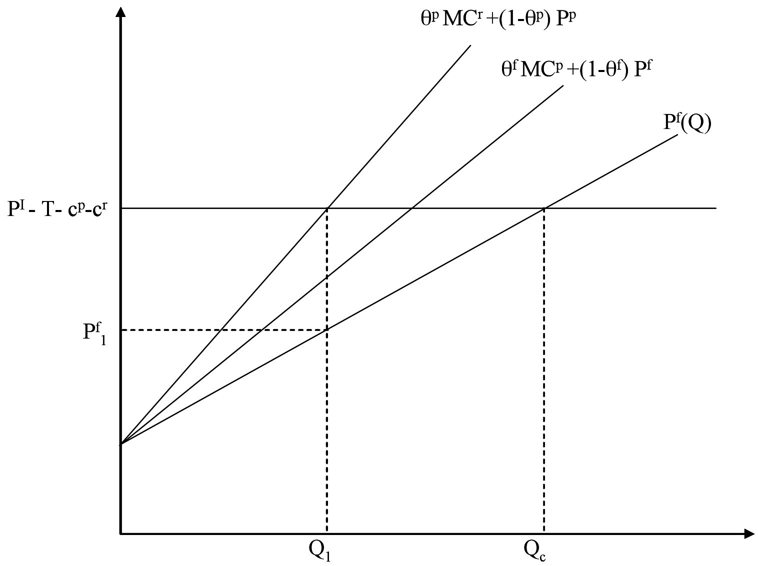
Market equilibrium in this case is determined by equations ((1)), ((2)), ((14)) and ((15)) where $\varepsilon^p = \frac{\partial Q}{\partial P^p}\frac{P^p}{Q}$ is the derived supply elasticity of ``processors" and $\varepsilon^f = \frac{\partial Q}{\partial P^f}\frac{P^f}{Q}$ is the supply elasticity of ``farmers". The competition parameters are $\theta^p = \frac{\partial Q}{\partial q^r}\frac{q^r}{Q}$ and $\theta^f = \frac{\partial Q}{\partial q^p}\frac{q^p}{Q}$ which measure the oligopsonistic market power of ``retailers" and ``processors" respectively. When $\theta^{\{p,f\}} = 0$, downstream firms are small to affect market volumes and therefore are competitive; instead, when $\theta^{\{p,f\}} = 1$ both firms have monopsonist power. Intermediate parameter values of θ capture different degrees of imperfect competition.

Equation ((14)) is the retailer first order condition. It states that the retailer chooses to produce a quantity such that the international price P^I equals the sum of the unit import tariff (T), the unit production cost (c^r), and the marginal cost of getting a unit of processed input (q^p). This marginal cost depends on the competition parameter θ^p (the ability to affect other retailers production), on the supply elasticity of processors (ε^p), and on the equilibrium processor price. This equation determines the processor price, which, in equilibrium, is a wedge on the net price received by the retailers. This wedge depends on θ^p and ε^p; the intuition and mechanisms are exactly as before, in Model 1. In particular, more competition among retailers (i.e., a lower θ^p) brings the processor price closer to the competitive price level $(P^I - c^r - T)$, and a higher θ^p (more monopsonistic power of retailers) reduces P^p.

Equation (15) summarizes an analog condition for the processor optimization and implicitly defines the farm price, given the equilibrium producer price P^p. Farm prices are, once again, a wedge on producer prices P^p and this wedge depends on θ^f and ε^f in exactly the same manner as in Model 1. Notice, however, that his model has a prediction of how P^f responds to imperfect competition at the retailer level. This is because θ^p determines P^p, which in turn determines P^f. More concretely, more competition at the retail level (a low θ^p) implies a higher producer price P^p and thus, via (15), higher farm prices.

Figure 2 provides a representation of the equilibrium. It can be used to illustrate the comparative static effects of changes in competition on farm prices. As before, the international price is given at P^I and this defines a net price of $P^I - T - c^r$ for the retailers. (In the graph, we subtracted the processor costs c^p as well for simplicity). The supply curve of the farmers is still represented by $P^f(Q)$.

Figure 2
Model 2 - Three-Sector Value Chain Fixed Prices



Note: At the competitive equilibrium, output is Q_c. The prices received by retailers, processors and farmers are $P^I - T$, $P^I - T - c^r$ and $P^I - T - c^r - c^p$, respectively. Under imperfect competition, equilibrium output is produces Q_1, and farmgate prices are P_1^f.

Since in this model there are two active layers in the value chains, there are two different curves representing the perceived marginal cost of the processors and retailers respectively. Given the monopsonistic power of the processors, the parameter θ^f captures how close the marginal cost of the processors will be to the supply curve of the farmers. Similarly, the monopsonistic power of the retailers and the parameters θ^p determine their perceived marginal costs. At the competitive equilibrium, production is Q_c, the price received by the retailers is $P^I - T$ and the price received by the farmers is $P^I - T - c^r - c^p$. Departures from the competitive equilibrium lead to lower farm-gate prices. In the Figure, the equilibrium is such that farm prices are P_1^f.

Both θ^f and θ^p affect farm prices. More concretely, a lower θ^p and a lower θ^f imply more competition and higher prices for the farmers. Notice that the degree of imperfect competition at both layers of the value chain matters. The monopsonistic behavior of processors towards farmers was established with the exporters' model. In addition, for a given monopsonistic behavior of the processors (even competition), more competition among retailers will translate into higher farm-gate prices for the crop producers.

2.1.3 Model 3: A Full Three-Sector Value Chain

The most complete model extends the Three-Sector value chain model of section 2.1.2 to allow retailers to have market power in selling the output. This situation can arise if the retailers sell in the domestic markets, or if Zambia exports a differentiated product in international markets. In these cases, the demand function for the final downstream product is

(16) $P^r = D(Q)$.

This additional feature in the theoretical structure introduces significant challenges to the solution of the model because retailers and processors may exercise oligopsonistic and oligopolistic market power simultaneously. This involves a complex bargain interaction between them. To illustrate how this affects farm prices, we develop two bound models (instead of modeling the bargaining game). In the first model, we assume that the processors have oligopoly market power over the retailers and that retailers behave competitively with respect to the processors; in the second model, we instead assume that the retailers have oligopsony market power over the processors, who act competitively with respect to the retailers.

Model 3.1: Processors Hold Market Power. In the first bound model, the processors may still use their oligopsonistic market power over the farmers as in section 2.2.1; now, however, the retailer's profit function incorporates the consumer inverse demand (16) and thus the derived demand for the processors's product is no longer perfectly elastic. This allows the processors to use oligopolistic market power over the retailers. We model this with the conjectural elasticity $\xi^p = \frac{\partial Q}{\partial q^p}\frac{q^p}{Q}$ which is a measure of market power: it represents how much the total processor supply to the retailers (and thus their derived demand) would change after a change in the output of a given processor. In other words, as before, the conjectural elasticity represents the ability of processors to change market quantities and thus market prices, incorporating not only the impacts of the actions of a given processor but also the responses of all other processors. In a competitive environment, this conjectural elasticity is equal to zero and it is one in a purely monopoly case. In this model, the retailers do not have oligopsonistic power, but they may impose oligopolistic power over the consumers. To capture this, we define the conjectural elasticity $\xi^r = \frac{\partial Q}{\partial q^r}\frac{q^r}{Q}$, which captures the overall responses of domestic retailers to the actions of a given retailer. In other words, ξ^r gives us a sense of how response market prices are to a given actions of a retailers, taking into account the responses of all other retailers.

The first order conditions are

(17)

(17)

$$P^r - T - c^r - P^p + \frac{\partial P^r}{\partial Q}\frac{\partial Q}{\partial q^r} q^r = 0$$

$$P^f - c^p - P^f + \frac{\partial P^p}{\partial Q}\frac{\partial Q}{\partial q^p} q^p - \frac{\partial P^f}{\partial Q}\frac{\partial Q}{\partial q^p} q^p = 0.$$

These yield the following equilibrium conditions

(18) $$P^r(1+\frac{\xi^r}{\eta^r}) - P^p = c^r + T$$

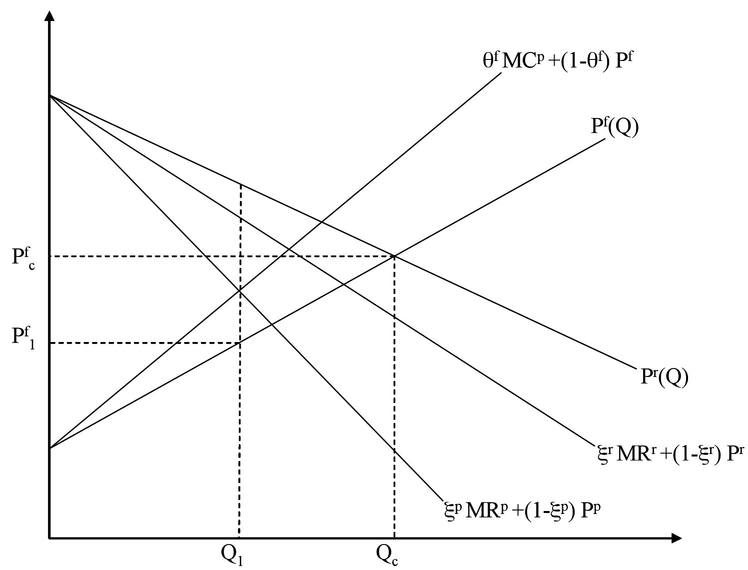
(19) $$P^p(1+\frac{\xi^p}{\eta^p}) - P^f(1+\frac{\theta^f}{\varepsilon^f}) = c^p$$

Equation ((18)) is the first order condition for profit maximization of the retailers. Production level q^r is chosen to equate marginal revenue ($P^r(1+\frac{\xi^r}{\eta^r})$) with the sum of the per unit tariff (T), the per unit cost (c^r) and the input price (P^p). This equation has a standard monopoly pricing interpretation. Concretely, the price charged by retailers P^r is a markup on marginal costs. The markup depends on the (inverse) of the elasticity of demand η^r (so that a more inelastic demand leads to higher equilibrium prices) and on the competition parameter ξ^r. When there is perfect competition ($\xi^r = 0$), price is just equal to marginal cost. Under imperfect competition, a higher ξ^r (so that the actions of a given retailer trigger significant responses from the competitor retailers) leads to higher equilibrium prices.

Equation (19) summarizes the first order condition of the processors. Since processors may use both oligopsonistic and oligopolistic power, the optimization condition takes into account the whole set of upstream and downstream reactions measured by θ^f, ξ^r and ξ^f (as well as on the demand elasticity η^p and the supply elasticity ε^f). Equilibrium farm prices are a wedge on the net producer prices, as before. Although we now have several additional mechanisms to explore, the basic intuition is similar to that in Models 1 and 2. For example, farm prices respond to the processor monopsonistic power parameter (θ^f) and the supply elasticity (ε^f) in exactly the same way as before. In addition, farm prices respond to changes in the oligopoly parameter of processors towards retailers (ξ^p). If there is no oligopolistic behavior and processors behave competitively when selling the output to retailers, then the pricing condition is closer to the simpler models previously discussed. Notice also that the producer price depends on the oligopoly parameter of the retailers in the downstream sector. Hence, changes in (ξ^r) affect producer prices and thus farm prices as well.

Figure 3 depicts the equilibrium. International prices are not given as before; instead, the retailers face a downward sloping demand curve. Farmers supply is $P^f(Q)$ as before.

Figure 3
Model 3.1 - Three-Sector Value Chain Fixed Prices



Note: To simplify the graphic, we assume $c^p = c^r = 0$. Competitive equilibrium produces Q^c and farmers receive P_c^f. Imperfect competition produce Q^1 and price P_1^f for farmers.

In this model, the processors have market power with respect to the farmers. Hence, the perceived marginal cost departs from the supply curve $P^f(Q)$ to an extent that depends on the imperfect competition parameter θ^f (as before). Since processors hold all marker power in this model (and thus retailers behave competitively towards them), there is no additional shift in the perceived marginal cost of the retailers.

Retailers have market power over consumers, though. Therefore, they look at the marginal revenue curve when setting prices. Under imperfect competition, the relevant curve is the perceived marginal revenue, which converges to the demand curve under perfect competition (ξ^r=0) and to the marginal revenue curve when there is a monopoly ($\xi^r = 1$). Further, by assumption, processors retain market power when selling to the retailers. This generates another layer of oligopolistic behavior, which shifts the perceived marginal revenue of the processors down. This depends on the imperfect competition parameter ξ^p.

At the equilibrium described in Figure 3, farmer output is Q_1 and farmer prices are P_1^f. It is clear that a decline in θ^f (more competition among processors when buying crops from the farmers) leads to higher farmgate prices. Also, a more competitive attitude of processors towards retailers implies higher farm-gate prices. By the same token, a more competitive behavior of retailers towards final consumers also leads to higher farm gate prices. The Figure clearly shows that farmers suffer from lower prices by the imperfect competition structure at different layers of the chain. The monopsonistic behavior of the processors certainly matters, as before. But the oligopolistic behavior of sellers down the chain matters as well.

Model 3.2: Retailers Hold Market Power The second bound model is similar to the first one, but now it is assumed that the retailers use both oligopsonistic and oligopolistic market power over the processors and the consumers. In contrast, the processors can only exercise oligopsonistic market power over the farmers. The first order conditions of retailers and processors are

(20) $$P^r - T - c^r - P^p + \frac{\partial P^r}{\partial Q}\frac{\partial Q}{\partial q^r}q^r - \frac{\partial P^p}{\partial Q}\frac{\partial Q}{\partial q^r}q^r = 0$$

(21) $$P^f - c^p - P^f - \frac{\partial P^f}{\partial Q}\frac{\partial Q}{\partial q^p}q^p = 0,$$

respectively. These lead to the following pricing equations

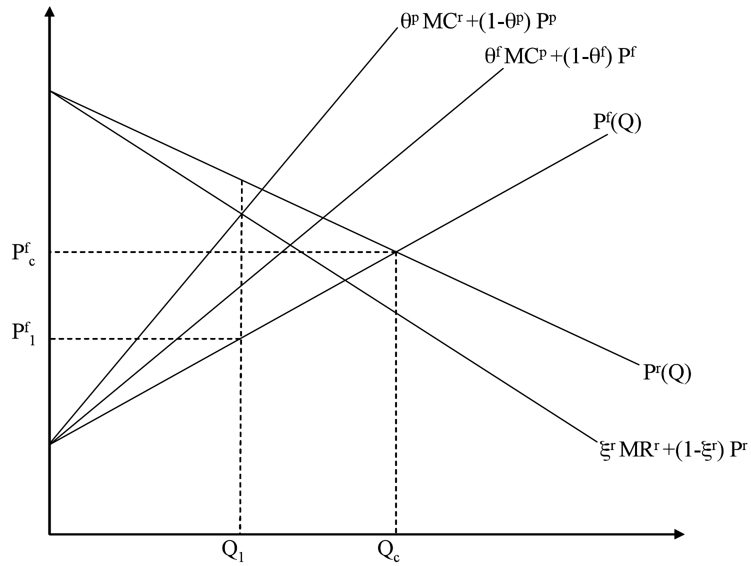
(22) $$P^r(1+\frac{\xi^r}{\eta^r}) - P^p(1+\frac{\theta^p}{\varepsilon^p}) = c^r + T$$

(23) $$P^p(1+\frac{\xi^f}{\eta^f}) - P^f = c^p.$$

The equilibrium of the model is characterized by equations ((1)), ((16)) ((22)), and ((23)).

In equation ((22)), the retailers retain monopsonistic and monopolistic power; as a result, they have to account for both consumer's and processor's reaction as well as for their market power over them. Equation ((23)) describes the optimization condition for the processors, which only takes into account the farmers reaction and market power over them. The intuitions are as in Model 3.1 and are depicted in Figure 4.

Figure 4
Model 3.2 - Three-Sector Value Chain Fixed Prices



Note: To simplify the graphic, we assume $c^p = c^r = 0$. Competitive equilibrium produces Q^c and farmers receive P_c^f. Imperfect competition produce Q^1 and price P_1^f for farmers.

In the Figure, there is one perceived marginal revenue curve that captures the imperfect competition of retailers towards final consumers. Also, there is a standard perceived marginal costs of the processors (to capture oligopsonistic behavior of processors towards farmers) and, by assumption, there is a perceived marginal cost of the retailers that represents their oligopsonistic power over the processors. The equilibrium output under imperfect competition is Q_1 and farm prices are P_1^f. It is observed that farm-gate prices increase when there is more competition at different layers of the chains.

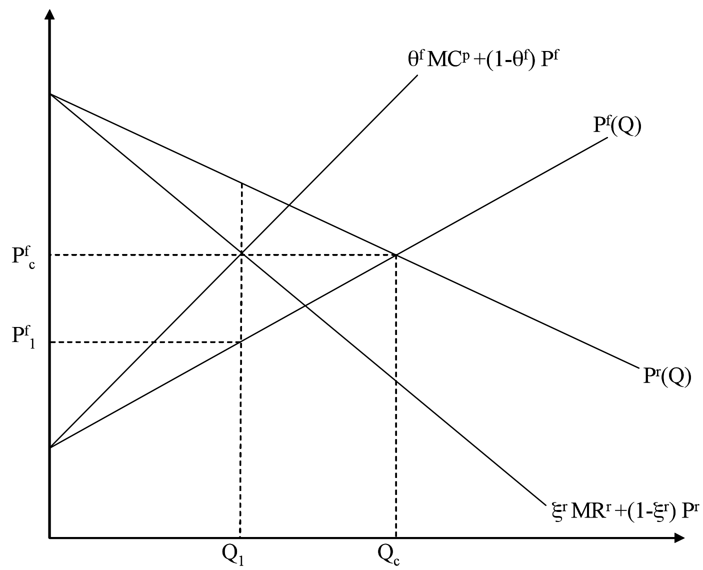
2.1.4 Model 4: Downstream Industrial Agreement

In this model, the value chain comprises three production sectors as in Models 3. The difference is that ``processors'' and ``retailers'' agree to chose an output level to maximize joint profits. In practice, they act as if there where only one industry that buys, using oligopsonistic power, to ``farmers'' an then sells, using oligopolistic power, to the final consumers. This is probably an unlikely scenario, but it illustrates an interesting baseline to compare with Models 3.1 and 3.2. Equilibrium in this model is given by ((1)) ((16)) and ((24)). The solution to the optimization is

(24) $$P^r(1-\frac{\xi^r}{\eta^r}) - P^f(1+\frac{\theta^f}{\varepsilon^f}) = c^r + c^p + T$$

Equation ((24)) characterizes the solution in terms of the relevant parameters of the model. The conjectural elasticities θ^r and ξ^r determine the amount of market power over ``farmers" and consumers; the price elasticities $\eta^r$ and $\varepsilon^f$ measure the price responsiveness of atomized ``farmers" and ``consumers." The interpretation of this solution follows the same lines as before. Figure 5 depicts the equilibrium conditions.

Figure 5
Model 4 - Three-Sector Value Chain Fixed Prices



Note: To simplify the graphic, we assume $c^p = c^r = 0$. Competitive equilibrium produces Q^c and farmers receive P_c^f. Imperfect competition produce Q^1 and price P_1^f for farmers.

2.1.5 A Caveat

One of the key message of these models is that farm-gate prices are higher when there is more competition among both processors and retailers. This is because the model emphasizes efficiency issues and efficiency achieved under perfect competition. This does not necessarily rule out cases where imperfect competition may end up being beneficial for the farmers. This situation may arise, for example, if the realization of monopoly profits allows for the creation of new goods and markets that use farm outputs as key inputs. In other words, in cases where monopoly profits allow firms to create new markets for the poor, it may be desirable to allow for imperfect competition at different layers of the value chain. Our analysis does not accommodate these cases. However, in the simulations below, we consider cases where the presence of a few firms allows for the success of the outgrower scheme in cotton. This is a vertical arrangement that provides inputs to the farmers and allows them to undertake the production of cash crops. This is an instance where imperfect competition, to some degree at least, is desirable.

2.2 Microeconometric Model: Household Impacts

Models 1-4 in the previous section provide a menu of imperfect competition models to characterize different agricultural sectors in Zambia. The numerical solutions to these models deliver market prices and quantities in equilibrium. These solutions can be shocked to simulate price and quantity responses from a baseline situation to a proposed scenario. With this simulations and a household survey, our task next is to estimate welfare effects. To be as comprehensive as possible, we want to include first order effects and second order effects which include supply responses.

First order effects are the direct impact, caused by those price changes, over current producers of the agriculture product in question (say, cotton or vegetables). First order effects are computed as the agriculture share of total household income times the percent change in prices. For example, if a household earns 50 percent of its income from cotton and the price of cotton increases by 50 percent, then the first other effect of this price change would be equivalent to 25 percent of the (initial) household income. These effects represent the short term impacts of the price changes, before any production response.

Our analysis also accounts for supply responses. This means that, when prices go up, farmers are allowed to expand production and even switch from other crops. These comprise second order effects of the price change, which are a measure of the benefit from adjusting production. Changes in production levels are calculated with the imperfect competition models of value chains in the previous section. The main issue with the estimation of second order effects is how to allocate these quantity changes among farmers. In this paper, we adopt a procedure that assigns responses in proportion to the likelihood of being a producer of the agriculture product. This probability can be estimated with the relative propensity score as follows.

First, we define the propensity score $p(x)$ as the probability of producing the agriculture crop under study (say, cotton) as a function of a vector of characteristics x. The estimating equation of the propensity score is

$$(25) \qquad p(\mathbf{x}_i) = P(D = 1 \mid \mathbf{x}_i)$$

where D is an indicator function of whether the household is a producer of the agricultural product and $\mathbf{x}$ is the set of relevant characteristics.[3]

Next, we re-scale these probabilities by the sum of the individual propensity scores

$$(26) \qquad \widetilde{p} = \frac{p(x_i)}{\sum_i p(x_i)}.$$

[3]In the empirical applications, these characteristics include household size, distance to the market, production assets, housing ownership, number of farm workers, province dummies, and others. See the discussion below.

This re-scaling transforms the estimated propensity score into weights that can be used to allocate the increased production that is computed from the imperfect competition models in section 2.1.

3 Cotton

The value chain in cotton includes the production of cotton seeds at the farm level, the production of cotton lint, the production of cotton yarn, and, eventually, the production of textiles. In Zambia, most of the production of cotton seeds is devoted to the exports of cotton lint and, to a much lesser extent, of cotton yarn. In this section, we produce simulations of the impacts of changes in the value chains in these two scenarios.

3.1 Cotton Lint

The case of exports of cotton lint is perhaps the simplest one. In this scenario, farmers produce cotton, which is purchased by the ginneries to produce cotton lint. Cotton lint is then exported to world markets. World markets for cotton lint are best described as competitive; that is, any given firm cannot influence world prices to a large extent. For the purpose of the simulations, we thus assume that the export price of cotton is given. Farmers are atomized and cannot exert monopoly power when selling the cotton seeds. Instead, it is assumed that the ginneries can act monopsonistically over farmers. In this situation, therefore, the best model to describe the value chains in cotton in Zambia is the exporters model of section 2.1.1.

We first calibrate a baseline scenario based on information on the number of firms in each sector and on their market shares. In the case of cotton, we build measures of market shares based on the available data on processing capacity. There are six major players in cotton: Dunavant (44 percent), Cargill (32 percent), Amaka (13 percent), Mulungushi (6 percent), Continental (5 percent) and Mukuba (1 percent). Minor changes in these shares are not likely to affect our results. A key parameter of the model, in contrast, is the elasticity of supply of cotton at the farm level. Estimates of the elasticity of supply are generally hard to obtain. In principle, this elasticity should be quite low, particularly in the short run. Based on estimates available in the literature and also based on personal interviews with cotton farmers in Zambia, we use a baseline elasticity of supply of 0.75. To explore how robust results are, we carry out a full set of sensitivity results in Appendix 1. We then simulate five different competition configuration scenarios: ``Leader splits," ``Small entrant," ``Leaders merge + Small entrant," ``Leaders merge," ``Exit of the largest," ``Equal market shares," and ``Competition." These simulations describe several possible mergers, splits and new entrants in the industry.

Table 2
Changes in Income
(Percent)

	Sim1	Sim2	Sim3	Sim4	Sim5	Sim6	Sim7
$P^f \Delta$ %	0.1253	0.0221	-0.3049	-0.3429	-0.0937	0.1955	0.4237
Total	0.0049	0.0008	-0.0074	-0.0080	-0.0029	0.0082	0.0227
1^{st} Order	0.0043	0.0008	-0.0104	-0.0116	-0.0032	0.0066	0.0144
2^{nd} Order	0.0006	0.0000	0.0030	0.0037	0.0003	0.0016	0.0083
Producers	0.0430	0.0075	-0.1004	-0.1126	-0.0314	0.0677	0.1515
1^{st} Order	0.0424	0.0075	-0.1033	-0.1161	-0.0317	0.0662	0.1435
2^{nd} Order	0.0006	0.0000	0.0028	0.0035	0.0003	0.0015	0.0079
Poor	0.0047	0.0007	-0.0067	-0.0072	-0.0027	0.0080	0.0224
1^{st} Order	0.0040	0.0007	-0.0098	-0.0111	-0.0030	0.0063	0.0137
2^{nd} Order	0.0007	0.0000	0.0031	0.0039	0.0003	0.0017	0.0088
Non-Poor	0.0052	0.0008	-0.0085	-0.0092	-0.0032	0.0086	0.0232
1^{st} Order	0.0046	0.0008	-0.0112	-0.0126	-0.0034	0.0072	0.0156
2^{nd} Order	0.0006	0.0000	0.0027	0.0034	0.0003	0.0014	0.0076

Own calculations based on the exporter model and household data from the 2003 Living Conditions Monitoring Surveys.
Simulation 1: ``Leader splits''
Simulation 2: ``Small entrant''
Simulation 3: ``Leaders merge + Small entrant''
Simulation 4: ``Leaders merge''
Simulation 5: ``Exit of the largest''
Simulation 6: ``Equal Market Shares'' (imperfect competition)
Simulation 7: ``Competition''.

Table 2 presents the simulation results for each competition scenario by different rural population groups. The exercise shows that the change in cotton prices ranges from -34 percent (in cases of increased market power) to 42 percent (in cases of increased competition).

The main conclusion from Table 2 is that competition at the cotton processing level is good for the farmers. In the model, more competition among processors translates into higher farm-gate prices. As a result, either entry or split of incumbents generates welfare gains for the farmers. This can be seen, for example, in Simulation-1 (``Leader splits'') and Simulation-2 (``Small entrant''), both involving an increase in competition. On the other hand, further market concentration leads to lower farm income and generates losses for the farmers. This can be seen, for example, in Simulation-3 (``Leaders merge + Small entrant'') and Simulation-4 (``Leaders merge''), both involving a decrease in competition.

Notice that small changes in the value chains are not likely to generate large impacts on farmers. For instance, Simulation-2 (``Small entrant'') shows very small impacts on farm income; in contrast, large changes in competition like Simulation-1 (``Leader splits'') cause much larger effects. Similar remarks can be made about decreases in competition.

Small changes in market power generate relatively small impacts at the farm level (compare Simulation-3 with Simulation-4).

For a given simulation, the average percent income change is much larger for cotton (household) producers than for non-cotton producers. For example, in Simulation-1 (``Leader Splits"), the increase in farm-gate prices is 12.53 percent. This generates an increase in the average income of rural households of 0.49 percent, an effect that is quite small from a practical point of view. However, the income of a cotton producer increases instead by 4.30 percent. This is a sizable income effect, especially for the poor. The impacts at the entire rural population are smaller because of two main factors. First, only 8.4 percent of households are cotton producers and, second, their average specialization rate is 35.5 percent. This means that the increase in cotton prices would only affect a relatively small fraction of the income of an average farmer.

Another way to see this is by comparing the first and second order impacts of the price change. First order effects reveal the impacts at a given level of production (without any adjustments). The second order impacts allow farmers to respond to the new prices as well. In other words, second order effects allow for supply responses and increased farmer participation in cotton. The simulations clearly show that the first order effects account for most of the change in household income.

Notice that the previous result is true even in the presence of supply responses. The reason is that, in the case of supply responses, higher cotton prices are enjoyed on marginal units only and this is usually a small number. However, even though the second order effects are small, they are very important for ``non-producers." While the second order impacts on producers account for a small fraction of their overall gains, they account for all the benefits accruing to non-producers.

Another important result is that the non-poor would benefit more than the poor. This illustrates the potential poverty-reducing impacts of increases in competition in the cotton value chain.

One concern often encountered in practice is to better understand the implications of exit, particularly of the largest firm. This is the reason behind Simulation-5. In the case of cotton, the exit of Dunavant would lead to a decrease of competition among firms and thus to a decline in farmgate prices by 9.37 percent. This would cause income losses for farmers, equivalent to 0.29 percent for an average farmer (not necessarily producing cotton to begin with) and to 3.14 percent for an average cotton producer.

We run two additional simulations to try and quantify the largest potential gains for the farmers. In the first case (Simulation-6, ``Equal Market Shares,"), we assume that imperfect competition remains in place (so that the processors retain market power over farmers) but we assume that the benchmark firms alter their market shares to reach equal market participation (that is, if production were to be relocated from big companies to small ones). This scenario would reveal an upper bound increase in income under imperfect competition. In this case, farmgate prices would increase by 19.55 percent (due to increased competition among cotton firms). Higher prices translate into higher household income: 0.82 percent for an average producer and 6.77 percent for a cotton producer. This scenario produces large impacts on household income (but is probably unlikely).

The final simulation assumes perfect competition among processors (Simulation 7). This maximizes overall efficiency. Farmgate prices could be 42.37 percent higher than in the current situation. This implies large increases in household incomes. An average farmer would enjoy benefits of up to 2.27 percent and, in contrast, a typical cotton producer would enjoy gains of 15.15 percent, on average. This situation would lead to the largest possible gains for the farmers.

3.2 Outgrower Schemes: Adverse Competition Effects

Small farmers can receive financing from processors (in the form of inputs) in exchange for future production through the outgrower scheme. In absence of enforcement mechanisms, however, processors wouldn't have incentives to provide input in advance. If contracts cannot be enforced, farmers can default on their debt and sell all the production to the best buyer (thus depriving processors from their investment returns). Importantly, the degree of failure of the outgrower contract can, at least in part, be linked to increased competition.

We can think about the failure of the outgrower program as increases in the firm costs. There are a number of mechanisms that could prevent farmers from not honoring contracts. Social norms, reputation, monitoring, price controls, collusion and specific storage devices are some examples. Although some of these mechanisms demand no active role of processors, in practice firms spend resources to reduce farmer fraud. An increase in the degree of competition in the processor sector could induce an adverse effect because these contract-enforcing expenses are likely to rise with the number of firms. This would probably translate into lower output prices for farmers. More importantly, we claim that the failure of the outgrower program will increase the price of inputs faced by firms. This increases the costs of production of the farmers and thus reduces household income.

Table 3 incorporates the impacts of increases in the cost of production of the farmers. We assume that these costs increase with competition in proportion to the decrease in θ. More concretely, we assume that the cost of the farmers when there is perfect competition is 10 percent higher than in the baseline situation. This factor of proportionality is kept constant in all intermediate simulations. While arguably this is an arbitrary setting, the idea of this exercise is to exemplify the type of potential hazards associated with increases in competition in the presence of an outgrower scheme.

As the results in Table 3 show, this effect reduces the potential gains and losses of farmers because the impacts of more competition and of higher costs move in opposite directions. For instance, if the chain were characterized by a monopsony, the farmers couldn't be able to sell their product to an alternative buyer and thus the option of not honoring the contract vanishes. Contract enforcement would be maximized. However, the monopsonist would be in a position to extract the largest surplus from the farmers. The impacts of this adverse competition effect can be sizeable. For instance, in Simulation 6, the increase in the prices faced by farmers increase by 14.27 percent, as opposed to 19.55 percent in Table 2. Also, notice the symmetric result: when competition decreases, as for example in Simulations 3 and 4, the price drop faced by the farmers is lower when the effects of the failure of the outgrower scheme are taken into account.

Table 3
Changes in Income
(Percent)

	Sim1	Sim2	Sim3	Sim4	Sim5	Sim6	Sim7
$P^f \Delta$ %	0.0906	0.0158	-0.2067	-0.2310	-0.0657	0.1427	0.3184
Total	0.0034	0.0005	-0.0056	-0.0061	-0.0021	0.0057	0.0152
1^{st} Order	0.0031	0.0005	-0.0070	-0.0078	-0.0022	0.0048	0.0108
2^{nd} Order	0.0003	0.0000	0.0014	0.0018	0.0002	0.0008	0.0044
Producers	0.0311	0.0054	-0.0688	-0.0767	-0.0221	0.0492	0.1124
1^{st} Order	0.0308	0.0054	-0.0702	-0.0784	-0.0223	0.0485	0.1081
2^{nd} Order	0.0003	0.0000	0.0014	0.0017	0.0001	0.0008	0.0043
Poor	0.0033	0.0005	-0.0052	-0.0056	-0.0020	0.0055	0.0150
1^{st} Order	0.0029	0.0005	-0.0067	-0.0075	-0.0021	0.0046	0.0103
2^{nd} Order	0.0003	0.0000	0.0015	0.0019	0.0002	0.0009	0.0047
Non-Poor	0.0036	0.0006	-0.0063	-0.0069	-0.0023	0.0060	0.0158
1^{st} Order	0.0033	0.0006	-0.0076	-0.0085	-0.0024	0.0052	0.0117
2^{nd} Order	0.0003	0.0000	0.0013	0.0016	0.0001	0.0007	0.0041

Own calculations based on the exporter model and household data from the 2003 Living Conditions Monitoring Surveys.
Simulation 1: ``Leader splits''
Simulation 2: ``Small entrant''
Simulation 3: ``Leaders merge + Small entrant''
Simulation 4: ``Leaders merge''
Simulation 5: ``Exit of the largest''
Simulation 6: ``Equal Market Shares'' (imperfect competition)

Clearly, this is an important issue in the cotton value chain. The analysis reveals the strong trade-off that has to be unavoidable faced in the current policy discussion. On the one hand, more competition brings about improvement in farm-gate price because of a lower degree of monopsonistic competition among cotton firms. On the other hand, to the extent that the outgrower scheme facilitates farm production, a higher degree of firm concentration and thus lower competition can facilitate access to farm production of high-return cash crops.

However, it is important to notice that the magnitudes of the effects reported in Table 3 are likely to depend heavily on the functional form adopted in the modeling of the adverse effects of increased competition. While there is little guidelines in the available data about the shape of this function, we can explore how sensitive our results are to alternative assumptions. In table 3a and 3b, we adopt a different functional form, whereby the cost of the firms change in response to changes in θ according to the function $(1-\theta^{\alpha})*g$, where g is a constant. This factor g is determined so that when there is perfect competition (θ=0), the outgrower scheme collapses (so as to make the case that some degree of imperfect competition may be necessary to develop a successful outgrower scheme). The parameter α measures the sensitivity of costs to a given change in competition. The results in Table 3a are simulated with α=0.1. These results are close to those in Table 3. Instead, in Table 3b, we assume that α=0.3. We find here that the benefits of more competition (Simulations 1 and 2) tend to disappear, and that the costs of increased monopsonistic power (in terms of lower farmgate prices) decline significantly as well. This indicates that, rather than taking the numbers in these simulations at face value, they instead reveal the nature of a complex trade-off that must be carefully addressed in the forthcoming policy discussion.

Table 3a
Changes in Income
(Percent)

	Sim1	Sim2	Sim3	Sim4	Sim5	Sim6	Sim7
$P^f \Delta$ %	0.0905	0.0167	-0.2467	-0.2787	-0.0732	0.1347	.
Total	0.0034	0.0006	-0.0066	-0.0073	-0.0023	0.0052	0.0000
1^{st} Order	0.0031	0.0006	-0.0084	-0.0095	-0.0025	0.0046	0.0000
2^{nd} Order	0.0003	0.0000	0.0017	0.0022	0.0002	0.0006	0.0000
Producers	0.0310	0.0057	-0.0821	-0.0925	-0.0247	0.0464	0.0000
1^{st} Order	0.0307	0.0057	-0.0838	-0.0947	-0.0248	0.0458	0.0000
2^{nd} Order	0.0003	0.0000	0.0017	0.0021	0.0002	0.0006	0.0000
Poor	0.0032	0.0006	-0.0061	-0.0067	-0.0022	0.0050	0.0000
1^{st} Order	0.0029	0.0005	-0.0080	-0.0090	-0.0024	0.0044	0.0000
2^{nd} Order	0.0003	0.0000	0.0018	0.0023	0.0002	0.0007	0.0000
Non-Poor	0.0036	0.0006	-0.0075	-0.0082	-0.0025	0.0055	0.0000
1^{st} Order	0.0033	0.0006	-0.0091	-0.0102	-0.0027	0.0050	0.0000
2^{nd} Order	0.0003	0.0000	0.0016	0.0020	0.0002	0.0006	0.0000

Own calculations based on the exporter model and household data from the 2003 Living Conditions Monitoring Surveys. Alternative functional form (see text) with α=0.1.
Simulation 1: ``Leader splits''
Simulation 2: ``Small entrant''
Simulation 3: ``Leaders merge + Small entrant''
Simulation 4: ``Leaders merge''
Simulation 5: ``Exit of the largest''
Simulation 6: ``Equal Market Shares'' (imperfect competition)

Table 3b
Changes in Income
(Percent)

	Sim1	Sim2	Sim3	Sim4	Sim5	Sim6	Sim7
$P^f \Delta$ %	0.0197	0.0057	-0.1262	-0.1457	-0.0309	0.0115	.
Total	0.0007	0.0002	-0.0039	-0.0045	-0.0010	0.0004	0.0000
1^{st} Order	0.0007	0.0002	-0.0043	-0.0049	-0.0010	0.0004	0.0000
2^{nd} Order	0.0000	0.0000	0.0004	0.0005	0.0000	0.0000	0.0000
Producers	0.0067	0.0019	-0.0424	-0.0489	-0.0104	0.0039	0.0000
1^{st} Order	0.0067	0.0019	-0.0427	-0.0493	-0.0104	0.0039	0.0000
2^{nd} Order	0.0000	0.0000	0.0004	0.0005	0.0000	0.0000	0.0000
Poor	0.0006	0.0002	-0.0037	-0.0042	-0.0010	0.0004	0.0000
1^{st} Order	0.0006	0.0002	-0.0041	-0.0047	-0.0010	0.0004	0.0000
2^{nd} Order	0.0000	0.0000	0.0004	0.0005	0.0000	0.0000	0.0000
Non-Poor	0.0007	0.0002	-0.0043	-0.0049	-0.0011	0.0004	0.0000
1^{st} Order	0.0007	0.0002	-0.0046	-0.0054	-0.0011	0.0004	0.0000
2^{nd} Order	0.0000	0.0000	0.0003	0.0004	0.0000	0.0000	0.0000

Own calculations based on the exporter model and household data from the 2003 Living Conditions Monitoring Surveys. Alternative functional form (see text) with α=0.3.
Simulation 1: ``Leader splits''
Simulation 2: ``Small entrant''
Simulation 3: ``Leaders merge + Small entrant''
Simulation 4: ``Leaders merge''
Simulation 5: ``Exit of the largest''
Simulation 6: ``Equal Market Shares'' (imperfect competition)

3.3 Cotton Yarn

Another destination of farm cotton is to produce cotton yarn. In this case, the production of the farmers is processed by the ginneries into cotton lint and then sold as cotton yarn. This may involve another layer down the value chain. If producers of cotton yarn have to pay fixed international prices for the input (cotton lint), then the model works like the "exporters" model (so that this addition is immaterial for the farmers). That is, the ginneries check international prices and set farm-gate prices depending on their monopsonistic power as before.

It could be interesting, however, to investigate a model where the price of cotton yarn is fixed in international markets, but spinners compete for cotton lint produced domestically (because of transportation costs, quality, or other barriers that isolate Zambian lint). To study this scenario, we use model 2.1.3. This case is useful to explore how farm-gate prices are affected by the structure of competition both at the retailers (yarn) and processors (lint) level.

Table 4 displays the results of changes in competition at the processor level (ginneries). The simulations are the same as before. As expected, the same conclusions arise, although the magnitudes of price changes are different because of the additional layer of competition at the retailer level. In particular, the price changes are in general smaller than in the "exporters" model. (Notice that the models cannot, however, no directly compared since they assume different structures in the chain).

Table 4
Changes in Income
(Percent)

	Sim1	Sim2	Sim3	Sim4	Sim5	Sim6	Sim7
$P^f \Delta$ %	0.0581	0.0100	-0.1254	-0.1394	-0.0409	0.0924	0.2123
Total	0.0022	0.0003	-0.0033	-0.0036	-0.0013	0.0037	0.0104
1^{st} Order	0.0020	0.0003	-0.0043	-0.0047	-0.0014	0.0031	0.0072
2^{nd} Order	0.0002	0.0000	0.0009	0.0011	0.0001	0.0006	0.0031
Producers	0.0199	0.0034	-0.0417	-0.0463	-0.0138	0.0319	0.0751
1^{st} Order	0.0197	0.0034	-0.0426	-0.0474	-0.0139	0.0314	0.0721
2^{nd} Order	0.0002	0.0000	0.0009	0.0011	0.0001	0.0005	0.0030
Poor	0.0021	0.0003	-0.0031	-0.0033	-0.0012	0.0036	0.0102
1^{st} Order	0.0019	0.0003	-0.0041	-0.0045	-0.0013	0.0030	0.0069
2^{nd} Order	0.0002	0.0000	0.0010	0.0012	0.0001	0.0006	0.0033
Non-Poor	0.0023	0.0004	-0.0038	-0.0041	-0.0014	0.0039	0.0107
1^{st} Order	0.0021	0.0004	-0.0046	-0.0051	-0.0015	0.0034	0.0078
2^{nd} Order	0.0002	0.0000	0.0008	0.0010	0.0001	0.0005	0.0029

Own calculations based on the exporter model and household data from the 2003 Living Conditions Monitoring Surveys.
Simulation 1: ``Leader splits''
Simulation 2: ``Small entrant''
Simulation 3: ``Leaders merge + Small entrant''
Simulation 4: ``Leaders merge''
Simulation 5: ``Exit of the largest''
Simulation 6: ``Equal Market Shares'' (imperfect competition)
Simulation 7: ``Competition''.

Table 5 shows the simulations of changes in competition at the retail level. It is interesting to observe that the qualitative results do not change (in terms of changes in farmgate prices and changes in competition). However, the magnitudes change in a significant way and are now higher than in the exporters model (as they are higher than in Table 4 as well). This suggests that changes at the retail level can be very important in terms of inclusion of farmers into de value chain and poverty reduction. Notice, though, that the room for policy changes at the retail level can be more difficult to achieve.

Table 5
Changes in Income
(Percent)

	Sim1	Sim2	Sim3	Sim4	Sim5	Sim6	Sim7
$P^f \Delta$ %	0.1559	0.0279	-0.4037	-0.4571	-0.1200	0.2412	0.5109
Total	0.0059	0.0010	-0.0107	-0.0118	-0.0038	0.0097	0.0249
1^{st} Order	0.0053	0.0009	-0.0137	-0.0155	-0.0041	0.0082	0.0174
2^{nd} Order	0.0006	0.0000	0.0030	0.0037	0.0003	0.0015	0.0076
Producers	0.0535	0.0095	-0.1342	-0.1516	-0.0405	0.0833	0.1808
1^{st} Order	0.0529	0.0095	-0.1371	-0.1552	-0.0407	0.0819	0.1735
2^{nd} Order	0.0006	0.0000	0.0029	0.0036	0.0003	0.0014	0.0073
Poor	0.0057	0.0009	-0.0099	-0.0109	-0.0036	0.0094	0.0246
1^{st} Order	0.0051	0.0009	-0.0131	-0.0148	-0.0039	0.0078	0.0166
2^{nd} Order	0.0006	0.0000	0.0032	0.0039	0.0003	0.0015	0.0080
Non-Poor	0.0063	0.0010	-0.0121	-0.0134	-0.0041	0.0102	0.0257
1^{st} Order	0.0057	0.0010	-0.0148	-0.0168	-0.0044	0.0089	0.0188
2^{nd} Order	0.0005	0.0000	0.0027	0.0034	0.0003	0.0013	0.0069

Own calculations based on the exporter model and household data from the 2003 Living Conditions Monitoring Surveys.
Simulation 1: ``Leader splits''
Simulation 2: ``Small entrant''
Simulation 3: ``Leaders merge + Small entrant''
Simulation 4: ``Leaders merge''
Simulation 5: ``Exit of the largest''
Simulation 6: ``Equal Market Shares'' (imperfect competition)
Simulation 7: ``Competition''.

4 Tobacco

The tobacco sector in Zambia comprises smallholders that grown tobacco. Most of this tobacco is exported to Malawi, where it is processed and sold to cigarette manufactures that sell in world markets. Farmers are atomized, as before, and are price takers. We assume that processors act monopsonistically towards farmers. Further, since cigarettes are differentiated products, we assume some degree of market power at the retail level (towards final atomized consumers).

We use Model 4 of section 2.1.4 and assume that ``producers'' and ``retailers'' have market power and agree to produce a volume that maximize their joint profits. This is not perhaps unrealistic, since usually the processor is a subsidiary of the retailer. The baseline scenario is derived using data on market shares from the Lusaka floor in 2006 (Zambia Leaf Tobacco, 47.61%, Alliance One Tobacco, 16.34%, Tombwe Tobacco, 25.21%., and Associated Tobacco, 10.84%). Even though the baseline scenario is based on different parameters than the previous cotton baseline, we simulate the same different competition configuration: ``Leader Splits,'' ``Small Entrant,'' ``Leaders Merge + Small Entrant,'' ``Leaders Merge,'' ``Exist of the Largest,'' ``Equal Market Shares,'' and ``Competition.'' To run these simulations, we also need estimates of the supply elasticity of tobacco at the farm level. As in the case of cotton, we use a generic elasticity of supply of 0.75 and carry out a sensitivity analysis in Appendix 1.

Table 6 shows the main results from the simulations. As before, we report overall effects at the national level (in rural areas) as well as for different groups of the rural population, producer and non-producers, poor and non-poor. In the first row of the table, we report the price changes. We find that the changes in tobacco prices range from -19.15 percent to 9.95 percent, depending on the scenario 9 (and up to 43.60 percent under competition).

In short, basically the same conclusions as in the cotton simulations emerge. First, competition is better for the farmers since it leads to higher farm-gate prices. Both producers and non-producers of tobacco can benefit from higher farm-gate prices. Producers, however, tend to benefit more. Notice that, according to the household survey, only 2 percent of farmers are actually engaged in the production of tobacco; further, among producers, the specialization rate is only 46 percent. First Order effects account for most of the total percent change in household income and the poor benefit slightly more that the non-poor. Finally, once again, small changes in competition will not matter much from the perspective of the farmers.

Table 6
Changes in Income
(Percent)

	Sim1	Sim2	Sim3	Sim4	Sim5	Sim6	Sim7
$P^f \Delta$ %	0.1442	0.0472	-0.1074	-0.1915	-0.0535	0.0995	0.4360
Total	0.0022	0.0005	-0.0005	-0.0004	-0.0004	0.0013	0.0133
1^{st} Order	0.0013	0.0004	-0.0010	-0.0017	-0.0005	0.0009	0.0039
2^{nd} Order	0.0009	0.0001	0.0004	0.0013	0.0001	0.0004	0.0094
Producers	0.0672	0.0218	-0.0490	-0.0869	-0.0245	0.0462	0.2099
1^{st} Order	0.0664	0.0217	-0.0494	-0.0882	-0.0246	0.0458	0.2008
2^{nd} Order	0.0009	0.0001	0.0004	0.0013	0.0001	0.0004	0.0092
Poor	0.0022	0.0005	-0.0003	0.0001	-0.0003	0.0013	0.0150
1^{st} Order	0.0011	0.0004	-0.0009	-0.0015	-0.0004	0.0008	0.0035
2^{nd} Order	0.0011	0.0001	0.0005	0.0016	0.0001	0.0005	0.0116
Non-Poor	0.0021	0.0006	-0.0009	-0.0012	-0.0005	0.0013	0.0106
1^{st} Order	0.0016	0.0005	-0.0012	-0.0021	-0.0006	0.0011	0.0047
2^{nd} Order	0.0006	0.0001	0.0003	0.0008	0.0001	0.0003	0.0059

Own calculations based on the exporter model and household data from the 2003 Living Conditions Monitoring Surveys.
Simulation 1: ``Leader splits''
Simulation 2: ``Small entrant''
Simulation 3: ``Leaders merge + Small entrant''
Simulation 4: ``Leaders merge''
Simulation 5: ``Exit of the largest''
Simulation 6: ``Equal Market Shares'' (imperfect competition)
Simulation 7: ``Competition''.

Simulations 6 and 7 give a sense of the potential gains from extreme reforms in the sector. Under simulation 6, ``Equal market share," assumes imperfect competition but with a minimum degree of monopsonistic competition. In this case, prices increase by 9.95 percent. The income of a random farmer would increase by only 0.13 percent, but the income of an average tobacco producer would increase by 4.62 percent.

In Simulation 6, we assume that the sector behaves competitively—this would allow for maximization of overall joint welfare. In this case, farm-gate prices would increase by as much as 43.60 percent, the income of the average farmer, by 1.33 percent, and the income of the average tobacco producer, by 20.99 percent.

There are some interesting differences between these tobacco simulations and the cotton simulations of previous sections. For example, if we compare the results in Table 6 with those in Table 2, we observe that the price changes are usually larger (in absolute value) for cotton than for tobacco (except under competition). For instance, in Simulations 3 and 4, the price changes for cotton are -30.49 and -34.29 percent, and in the tobacco case they are -17.79 and -19.15 percent. Similarly, in Simulation 6, the increase in the price of cotton would be 19.55 percent and 9.95 percent for tobacco. There are several factors that explain these differences. The initial structure of the value chain (the market share of different firms) certainly matters. But the model used in the simulations play a role, too. For example, while the cotton simulations of Table 2 use the "exporters" model, the tobacco simulations of Table 6 use the collusion model. This makes the different simulations across crops difficult to compare.

We turn now to an analysis of the impacts of changes in the value chains when there is strategic interaction between upstream and downstream firms in the sector. If we assume no agreement between ``spinners" and ``textiles", we need to use Model 3 from section 2.1.3 (which defines two bounds, Models 3.1 and 3.2). Table 7 and table 8 present simulation results for the upper and lower bound respectively. The impacts on household income and prices are larger in table 7 than in table 8. This means that a competition change in the ``spinner" sector would generate greater impacts for the ``farmers" when they hold larger bargain power. The intuition is the following: when competition is modified in table's 7 model, not only oligopolistic but also oligopsonistic distortions are affected; in contrast, in table 8 the latter is not affected. If we consider the first scenario (``Leader Splits"), the increase in $P^f$ will be between 15.49 and 13.30 percent depending on the bargaining interaction among ``spinners" and ``textiles". Household income would increase by between 0.22 and 0.17 percent for the entire rural population while the income of a tobacco farmer would increase by between 7.21 and 6.18 percent.

Table 7
Changes in Income
(Percent)

	Sim1	Sim2	Sim3	Sim4	Sim5	Sim6	Sim7
$P^f \Delta$ %	0.1549	0.0509	0.1909	-0.2086	-0.0579	0.1071	0.4640
Total	0.0022	0.0005	0.0030	-0.0006	-0.0004	0.0014	0.0132
1^{st} Order	0.0014	0.0005	0.0017	-0.0019	-0.0005	0.0010	0.0042
2^{nd} Order	0.0008	0.0001	0.0013	0.0013	0.0001	0.0004	0.0090
Producers	0.0721	0.0235	0.0892	-0.0948	-0.0266	0.0497	0.2224
1^{st} Order	0.0713	0.0234	0.0879	-0.0961	-0.0267	0.0493	0.2137
2^{nd} Order	0.0008	0.0001	0.0013	0.0013	0.0001	0.0004	0.0088
Poor	0.0023	0.0005	0.0031	-0.0001	-0.0003	0.0013	0.0148
1^{st} Order	0.0012	0.0004	0.0015	-0.0017	-0.0005	0.0008	0.0037
2^{nd} Order	0.0010	0.0001	0.0016	0.0016	0.0001	0.0005	0.0111
Non-Poor	0.0022	0.0006	0.0029	-0.0014	-0.0006	0.0014	0.0107
1^{st} Order	0.0017	0.0006	0.0021	-0.0023	-0.0006	0.0012	0.0050
2^{nd} Order	0.0005	0.0001	0.0008	0.0008	0.0001	0.0002	0.0057

Own calculations based on the exporter model and household data from the 2003 Living Conditions Monitoring Surveys.
Simulation 1: ``Leader splits''
Simulation 2: ``Small entrant''
Simulation 3: ``Leaders merge + Small entrant''
Simulation 4: ``Leaders merge''
Simulation 5: ``Exit of the largest''
Simulation 6: ``Equal Market Shares'' (imperfect competition)
Simulation 7: ``Competition''.

Table 8
Changes in Income
(Percent)

	Sim1	Sim2	Sim3	Sim4	Sim5	Sim6	Sim7
$P^f \Delta$ %	0.1330	0.0535	0.1603	-0.1479	-0.0305	0.0966	0.3631
Total	0.0017	0.0006	0.0022	-0.0008	-0.0002	0.0011	0.0077
1^{st} Order	0.0012	0.0005	0.0014	-0.0013	-0.0003	0.0009	0.0033
2^{nd} Order	0.0005	0.0001	0.0008	0.0006	0.0000	0.0003	0.0044
Producers	0.0618	0.0247	0.0746	-0.0676	-0.0140	0.0448	0.1715
1^{st} Order	0.0612	0.0246	0.0738	-0.0681	-0.0140	0.0445	0.1672
2^{nd} Order	0.0005	0.0001	0.0008	0.0006	0.0000	0.0003	0.0043
Poor	0.0017	0.0005	0.0022	-0.0005	-0.0002	0.0011	0.0083
1^{st} Order	0.0011	0.0004	0.0013	-0.0012	-0.0002	0.0008	0.0029
2^{nd} Order	0.0006	0.0001	0.0010	0.0007	0.0000	0.0003	0.0054
Non-Poor	0.0018	0.0006	0.0022	-0.0012	-0.0003	0.0012	0.0067
1^{st} Order	0.0014	0.0006	0.0017	-0.0016	-0.0003	0.0010	0.0039
2^{nd} Order	0.0003	0.0001	0.0005	0.0004	0.0000	0.0002	0.0028

Own calculations based on the exporter model and household data from the 2003 Living Conditions Monitoring Surveys.
Simulation 1: ``Leader splits''
Simulation 2: ``Small entrant''
Simulation 3: ``Leaders merge + Small entrant''
Simulation 4: ``Leaders merge''
Simulation 5: ``Exit of the largest''
Simulation 6: ``Equal Market Shares'' (imperfect competition)
Simulation 7: ``Competition''.

Appendix 1: Sensitivity Analysis

The key parameter of our simulations is the elasticity of supply at the farm level. This parameter was estimated at 0.75 in all the simulations run in the text (based on available estimates in the literature and on personal interviews with Zambian farmers). The aim of this appendix is to illustrate how results would change if different estimates of that elasticity are used. Although we do not have estimates of the standard deviation of our generic supply elasticities, all the evidence indicates that the short-run elasticity is generally low, and often smaller than one. Hence, we re-do the main simulations of the model using two bounds for the supply elasticity: a lower bound of 0.5 and an upper bound of 0.9. Results are reported in Table A.1 (for the lower bound) and Table A.2 (for the upper bound). For simplicity and concreteness, we re-do three of the seven simulations of the main text: simulation 1 (increase in competition); simulation 2 (decrease in competition); and simulation 7 (perfect competition).

The main observation from this sensitivity analysis is that results can be quite sensitive to the elasticity of supply. In Table A.1, the price changes from the same baseline are larger (in absolute value). In Table A.2, the price changes are smaller. For example, while in Simulation 1 (increase in competition) the price faced by farmers would increase by 12.53 percent with an elasticity of 0.75, it would increase by 21.26 percent with an elasticity of 0.5 and by 8.88 percent with an elasticity of 0.9. Naturally, the sign of the change is not affected by the elasticity of supply, but the magnitude of the price changes, and therefore of the income and poverty impacts, do depend critically to that elasticity.

Table A.1
Sensitivity Analysis: Lower Bound Cotton Supply Elasticity 0.5
Exporters Model (table 2)
Changes in Income
(Percent)

	Sim1	Sim4	Sim7
$P^f \Delta$ %	0.2126	-0.7239	0.6608
Total	0.0083	-0.0168	0.0354
1^{st} Order	0.0072	-0.0246	0.0224
2^{nd} Order	0.0011	0.0078	0.0129
Producers	0.0732	-0.2383	0.2368
1^{st} Order	0.0722	-0.2458	0.2244
2^{nd} Order	0.0010	0.0075	0.0124
Poor	0.0080	-0.0152	0.0351
1^{st} Order	0.0069	-0.0235	0.0214
2^{nd} Order	0.0011	0.0082	0.0137
Non-Poor	0.0088	-0.0195	0.0361
1^{st} Order	0.0078	-0.0266	0.0243
2^{nd} Order	0.0010	0.0071	0.0118

Sensitivity analysis from Table 2. The elasticity of supply here is 0.5 (it is 0.75 in the baseline models). Own calculations based on the exporter model and household data from the 2003 Living Conditions Monitoring Surveys.
Simulation 1: ``Leader splits"
Simulation 4: ``Leaders merge"
Simulation 7: ``Competition".

Table A.2
Sensitivity Analysis: Upper Bound Cotton Supply Elasticity 0.9
Exporters Model (table 2)
Changes in Income
(Percent)

	Sim1	Sim4	Sim7
$P^f \Delta$ %	0.2126	-0.7239	0.6608
Total	0.0083	-0.0168	0.0354
1^{st} Order	0.0072	-0.0246	0.0224
2^{nd} Order	0.0011	0.0078	0.0129
Producers	0.0732	-0.2383	0.2368
1^{st} Order	0.0722	-0.2458	0.2244
2^{nd} Order	0.0010	0.0075	0.0124
Poor	0.0080	-0.0152	0.0351
1^{st} Order	0.0069	-0.0235	0.0214
2^{nd} Order	0.0011	0.0082	0.0137
Non-Poor	0.0088	-0.0195	0.0361
1^{st} Order	0.0078	-0.0266	0.0243
2^{nd} Order	0.0010	0.0071	0.0118

Sensitivity analysis from Table 2. The elasticity of supply here is 0.9 (it is 0.75 in the baseline models). Own calculations based on the exporter model and household data from the 2003 Living Conditions Monitoring Surveys.
Simulation 1: ``Leader splits"
Simulation 4: ``Leaders merge"
Simulation 7: ``Competition".

The same conclusions are drawn from the tobacco case. If the simulations are rerun, the price changes are larger in the lower bound (supply elasticity of 0.5) and are smaller in the upper bound (supply elasticity of 0.9). In Table A.3, for instance, the farm-gate price of tobacco would increase by 24.52 percent in Simulation 1 and an elasticity of 0.5, while the baseline price change is 14.42 percent (Table 6). In Table A.4, in constrat, the farm-gate tobacco price would increase by only 10.21 percent with an elasticity of 0.9.

Table A.3
Sensitivity Analysis: Lower Bound Tobacco Supply Elasticity 0.5
Exporters Model (table 6)
Changes in Income
(Percent)

	Sim1	Sim4	Sim7
$P^f \Delta$ %	0.2452	-0.3744	0.6827
Total	0.0037	-0.0008	0.0208
1^{st} Order	0.0022	-0.0034	0.0061
2^{nd} Order	0.0015	0.0026	0.0147
Producers	0.1143	-0.1699	0.3287
1^{st} Order	0.1129	-0.1724	0.3144
2^{nd} Order	0.0015	0.0025	0.0143
Poor	0.0038	0.0002	0.0235
1^{st} Order	0.0019	-0.0030	0.0054
2^{nd} Order	0.0018	0.0032	0.0181
Non-Poor	0.0036	-0.0024	0.0166
1^{st} Order	0.0027	-0.0041	0.0074
2^{nd} Order	0.0009	0.0016	0.0093

Sensitivity analysis from Table 6. The elasticity of supply here is 0.5 (it is 0.75 in the baseline models). Own calculations based on the exporter model and household data from the 2003 Living Conditions Monitoring Surveys.
Simulation 1: ``Leader splits''
Simulation 4: ``Leaders merge''
Simulation 7: ``Competition''.

Table A.4
Sensitivity Analysis: Upper Bound Tobacco Supply Elasticity 0.9
Exporters Model (table 6)
Changes in Income
(Percent)

	Sim1	Sim4	Sim7
$P^f \Delta$ %	0.1021	-0.1288	0.3214
Total	0.0015	-0.0003	0.0098
1^{st} Order	0.0009	-0.0012	0.0029
2^{nd} Order	0.0006	0.0009	0.0069
Producers	0.0476	-0.0585	0.1547
1^{st} Order	0.0470	-0.0593	0.1480
2^{nd} Order	0.0006	0.0009	0.0068
Poor	0.0016	0.0001	0.0111
1^{st} Order	0.0008	-0.0010	0.0025
2^{nd} Order	0.0008	0.0011	0.0085
Non-Poor	0.0015	-0.0008	0.0078
1^{st} Order	0.0011	-0.0014	0.0035
2^{nd} Order	0.0004	0.0006	0.0044

Sensitivity analysis from Table 2. The elasticity of supply here is 0.9 (it is 0.75 in the baseline models). Own calculations based on the exporter model and household data from the 2003 Living Conditions Monitoring Surveys.
Simulation 1: ``Leader splits''
Simulation 4: ``Leaders merge''
Simulation 7: ``Competition''.