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The Rise of Agribusiness and the Distributional Consequences of Policies on Intermediated Trade

Swati Dhingra
Silvana Tenreyro

LSE THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

UKRI Economic and Social Research Council

Abstract
Policies to encourage agribusinesses-led development of crop markets are high on the agenda of many policy-makers. Since the 1980s, several countries have moved to a model in which agribusinesses provide market access to farmers. The motivation behind these policies is to raise income and wellbeing, particularly for low-income rural households. Yet, systematic analyses of the overall impact of such policies on household welfare are scant. This paper provides a novel modelling framework to study the role of agribusinesses in shaping the gains from trade and the share accruing to small farmers. Exploiting a national policy change in Kenya in 2004, we find that the shift to the agribusiness model reduced farmer incomes from policy-affected crops, relative to other crops. The relative fall in incomes was higher for farmers selling primarily to large agribusinesses. Correspondingly, agribusiness firms specialized in policy-affected crops saw larger increases in profit margins. Farmers in villages with a comparative advantage in policy-affected crops saw larger reductions in consumption, especially of durable assets. The findings contribute to the academic and policy debate on the impact of market power on the size and distribution of the gains from trade.

Key words: agribusiness, market power, intermediated trade, middlemen, oligopsony
JEL Codes: F1; F6; Q1; O1

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Swati Dhingra, London School of Economics, CEPR and Centre for Economic Performance, London School of Economics. Silvana Tenreyro, London School of Economics, CEPR, CFM and Centre for Economic Performance, London School of Economics.

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1. Introduction

Trade rarely takes place directly between producers and final consumers of the product. Intermediaries grease the wheels of commerce. They evoke images ranging from being the unsung heroes of trade to being the villains who siphon off the gains from trade away from producers and consumers (Antras and Costinot 2011). There are few examples where the role of intermediation takes on greater significance for economic welfare than in agricultural markets faced by small farmers.

Agriculture continues to support a vast majority of people in many countries, particularly in low-income countries where agriculture is the main source of livelihood, employment and exports. Agricultural productivity in these areas has remained low and most farmers are at the bottom end of their national income distributions (e.g. Lagakos and Waugh, 2013; Conley and Udry, 2010). Much of the literature in international trade treats crops as homogenous products that are exchanged in perfectly competitive markets. While this may be true of world commodity markets, a vast literature finds that farmers face high transaction costs in selling their crops to markets at home and abroad (example, Fafchamps and Hill 2008). The bulk of the world's farmers - about 80 per cent- are smallholders who lack the productive assets, access to technologies, and infrastructure needed to market their produce. They rely overwhelmingly on intermediated trade of their crops, through government boards, state companies, traders, cooperatives or agribusinesses (Lowder et al. 2014, Barrett 2008).

Since market reforms in many countries in the 1980s and 1990s, governments have moved away from controlling crop markets to encouraging participation by private-sector firms (Dillon and Dambro 2017). There has been an accompanying increase in the production of export crops and a rise in new intermediaries including supermarket chains, agro-industrial firms, and export oriented companies offering outgrower schemes (Barrett and Mutambatsere 2008). Examples of these new relationships include small farmers that engage in tobacco production for the British American Tobacco company (Minot 2011), vegetable farming for European supermarkets by farmers in Madagascar (Minten et al. 2009), and production for supermarket supply chains in Latin America, Asia and Africa (Reardon and Timmer 2007).[1]

The process of moving to an agribusiness model continues to be high on the agenda of many governments. For example, policymakers in Africa are currently introducing new

[1]Further examples include contract farming in Senegalese groundnut production (Warning and Key 2002), contract farming of high-value crops by Mexican farmers for exports to the US (Runsten 1994), pineapple and banana farming in Central American for exports to the US and Europe (Goodman and Watts 1997), commercial farming of export crops in Kenya and commercial farming of cash crops like sugar, cotton and tea in Europe and Central Asia (Robbins and Ferris, 2003).

legislations for seeds, land, contract enforcement, and taxes to ease consolidation and operation of large commercial farms (UNCTAD 2009; Provost et al. 2014; Provost and Kabendera 2014; Carr 2013). The Ethiopian government has committed to enabling long-term land leases and greater enforcement of commercial farm contracts. Governments in Malawi and Ghana promised to set aside 200,000 and 100,000 hectares of prime land for commercial investors respectively. Many of these investments are for non-food crops, including cotton, biofuels and rubber, or for projects explicitly targeting export markets.

The hope with such market reforms and agribusiness policies is that they will stimulate growth in smallholder agriculture through better technology and market development. This will unleash the potential to lift millions of low-income households out of poverty (Barrett and Mutambatsere 2008). Yet much of agriculture, especially in the poorest parts of the world, has shown few signs of the radical transformation that was hoped for. For example, Collier and Dercon (2014) note that low yields, limited commercialisation and unchanging population-land ratios have characterised the last fifty years of African agriculture. They argue that this raises doubts over the ability of the current development model in transforming agriculture. There is growing concern that market reforms may have created a dual structure in farming activities, with few large agribusinesses that have the scale and capital to wield market power over many small farmers.[2]

While plans for new policies to commercialise smallholder farming abound, systematic analysis of the topic is remarkably thin. In particular, there is little quantitative evidence on the effects of regulatory barriers on intermediary competition and welfare of farmers (Dillon and Dambro 2017). This paper contributes towards understanding these policy impacts by providing a theoretical framework which is implemented empirically in the context of Kenya.

Kenya typifies the debate over policies to move to agribusiness-led development of crop markets for farmers. In 2004, the Kenyan national government implemented a set of policies to shift from state-led to agribusiness-led intermediation. Laws pertaining to eighteen distinct crops (out of about 100) saw a radical shift in policy towards operation of private-sector firms in intermediation and agribusiness activities, like milling and processing of produce. These crops made up about half of farm income among Kenyan households, on average. Given this national policy change and reliable panel data

[2]Case studies provide some evidence for these concerns. For example, Warning and Key (2002) look at melon cultivation in Senegal and document that small farmers had negotiated a fixed price for their produce. But when there was a glut in supply, the contracting firm did not return to purchase the melons and farmers lost out as spot market prices fell dramatically.

during the period, Kenya provides a unique setting to examine the impacts of policies on intermediated trade.

Building on key insights from Antras and Costinot (2011), the paper develops a model where farmers differ in their comparative advantage across crops, and intermediaries differ in their technology and market power. More specifically, in our setting, farmers differ in their comparative advantage (or relative productivity) in policy-affected crops, relative to other crops. Farmers can sell the policy-affected crops through state companies or private firms that have oligopsonistic power. In turn, state and private firms differ in their intermediation productivity and market power, which generates differences in how much they pay to farmers. Private firms include small traders and agribusinesses, who buy the policy-affected crops from farmers to sell to others. Agribusinesses also provide facilities such as processing or quality knowhow, which raise the value of farm produce when farmers make sunk investments to realize these productivity gains. In equilibrium, farmers with the highest comparative advantage in policy-affected crops sort into engaging with agribusinesses. Medium comparative-advantage farmers do not invest in a relationship with agribusinesses and receive the farmgate price paid by intermediaries (private or state). Finally, the lowest comparative-advantage farmers select into growing other crops.

Moving to an agribusiness model directly expands the market size available to private intermediaries, especially agribusinesses in the economy. This induces firms to pay higher farmgate prices because they account for greater price sensitivity in a bigger market. But it also affects the cropping and intermediation choices of farmers and the entry decisions of firms into intermediation and agribusiness activities. Increased supply of policy-affected crops together with greater entry of firms indirectly determines the size of the market per firm and hence the market power that firms wield over farmers after the policy change. The net impact on farm incomes from policy-affected crops is positive or negative, depending on this tradeoff between market expansion and market power. When firms are sufficiently productive in intermediation, the tradeoff goes towards raising farm incomes owing to greater entry of firms operating in the market for policy-affected crops. In contrast, moving to an agribusiness model lowers farm incomes when farmers depend on relatively inefficient intermediary firms that wield increased market power from greater supply of policy-affected crops per firm. The net impact on farmers' incomes from the policy-affected crops therefore is an empirical question, which we take to the data.

Comparing crops that were affected by the policy with other crops, the shift in national policy raised farmers' engagement with agribusinesses in the policy-affected

crops. Farm incomes from the policy-affected crops fell, and they fell much more than those from other crops. Putting together data on profits margins of agribusiness firms listed on the Nairobi stock exchange, we examine the mirror image of the division of the gains from trade. Agribusiness profit margins rose, and much more so for firms specialised in policy-affected crops, relative to other crops. In our setting, the shift to an agribusiness model therefore reallocated the gains from trade from smallholder farmers to agribusinesses specialised in the policy-affected crops.

Overall, household welfare, measured by total net incomes or value of assets owned by households, declined. The welfare losses were concentrated in villages that had a comparative advantage in the policy-affected crops. Comparative advantage villages (with above-median potential yields in policy-affected crops based on FAOSTAT's agroecological model) have greater income dependence on policy-affected crops and suffered greater losses in household welfare. The findings validate concerns that commercialisation of agriculture through monopsonistic firms is not a panacea for lagging productivity and limited poverty reduction in rural areas (Dillon and Dambro 2017, Collier and Dercon 2014).

The rest of the paper is organized as follows. After connecting our findings to other strands of the literature, Section 2 starts with a discussion of the context of Kenyan agriculture and data sources. Section 3 presents the theoretical framework and discusses its implications. Section 4 presents the empirical results and Section 5 concludes.

Related Literature. The paper connects to a growing literature that has focused on intermediaries in agriculture (as discussed earlier and in references cited in the several surveys cited above). Our findings are also related to other branches of the literature on intermediaries and market power. On the theoretical side, early work has examined how factor prices under comparative advantage are altered in the presence of a monopsony (Feenstra,1980; Markusen and Robson 1980; McCulloch and Yellen 1980; Bhagwati et al.,1998, Devadoss and Song 2006). Recent contributions on intermediated trade have focused on some of the microfoundations for market power. In particular, Antras and Costinot (2011) and Chau et al. (2009) focus on search and matching frictions that confer market power to intermediaries. Bardhan et al. (2013) stress reputational rents in the intermediation and Sheveleva and Krishna (2016) the contractual environment in developing economies. Our main theoretical contribution is to embed key structural characteristics of smallholder farming to examine policy shifts in the presence of agribusiness activity.

On the empirical side, our findings are related to work on gains from trade in the presence of intermediaries. For example, Atkin and Donaldson (2012), Startz (2018) and Grant and Startz (2019) examine the gains from trade to Ethiopian and Nigerian consumers of products sold by imperfectly competitive intermediaries. The work is also related to recent findings on intermediated trade in agriculture. Macchiavello and Morjaria (2015b) estimate the value of the relationship between domestic exporters and foreign buyers of Kenyan roses. Casaburi and Reed (2017) and Bergquist (2017) recover market structure parameters using experimental evidence on traders, while Chatterjee (2019) and Tomar (2018) estimate a positive relationship between competition among small traders and the shares received by Indian farmers.

2. Context and Data

The application to Kenyan agriculture captures the institutional context of small farmers selling through traders and agribusinesses in an economy that is highly dependent on agriculture. Kenya is a lower middle-income country in sub-Saharan Africa, where agriculture makes up 25 per cent of GDP and 75 per cent of the labor force.

Kenyan agriculture typifies the broad debate on how to cope with declining agricultural productivity growth in a predominantly smallholder agricultural economy. While a vast majority of people continue to be employed in agriculture, productivity growth has been slow and yields per acre of land are low. A principal solution proposed to address this problem has been to encourage large-scale agribusinesses in developing crop markets for farmers. The motivation is that they will provide the improved inputs, technologies and access to world markets needed to raise farm incomes substantially.

We inform this debate by examining the extent to which policies that reduce the role of the state and encourage agribusinesses affect farmers. Two features enable the analysis. First, the Kenyan government adopted a national policy to reduce the role of the state as a buyer of crops from farmers and to encourage agribusiness participation instead. The policy applied to 18 (out of over 100) major crops, which make up half of household farm incomes during the period. Second, the database contains a panel of incomes of Kenyan households by crop and buyer types, which is rare in most low-income countries and which provides the microdata to examine the policy impacts.

The main crops for farmers in Kenya are maize, tea, sugarcane, coffee cherries, bananas, wheat and tomatoes. In each of these crops (except tea), Kenya is an exporter but makes up less than 1 per cent of world exports. Maize is the most important main crop every year and the ranking of the other main crops changes slightly across years.

The first part of our analysis will examine farm incomes at the household-crop-season-year level to understand the impacts of policies on intermediated trade across crops based on whether they were affected by the policy or not. It will then determine the profits earned by firms, based on whether they were specialised in the policy-affected crops or other crops. The second part of our analysis will examine the welfare impacts of the policy for the household, so the analysis will then be conducted at the household-year level. Summary statistics for key variables are in an Appendix, and further statistics related to Kenyan farming are relegated to the descriptives in Dhingra and Tenreyro (2017) while here we focus on discussing key features of the policy shift and the income panel.

By the 1980s, agricultural growth in Kenya had stagnated and state presence had expanded to board purchases and administered prices. For example, maize and wheat prices were set by a national board until 1996, after which the administered price regime was largely done away with (Winter-Nelson and Argwings-Kodhek 2007). Although price controls had been lifted and divestment in state companies had started, the big push to commercialize agriculture came in 2004 when policies were put in place to encourage agribusiness participation in crop markets. Two key developments prompted this policy shift. A new government headed by President Kibaki came to power in 2002 on the platform to "do something about agriculture." The general view was that processing costs and marketing margins of state companies were higher in Kenya than best practices elsewhere. Moreover, horticulture and floriculture, which had been largely undistorted by government purchases, had experienced high growth rates but they made up a small share of farmer incomes (see Machhiavello and Morjaria 2015a). This led to the view that the success of the growing sectors could be replicated by reducing state presence and encouraging agribusiness operation in crop markets which had previously experienced state presence.

In March 2004, the Strategy for Revitalising Agriculture (SRA) was launched, proposing a "radical reform" of the role of the state within Kenyan agriculture. In particular, President Kibaki outlined the broad strategy as follows: *The strategy emphasizes the creation of an environment to promote private sector-led agricultural development. In this regard, my government is determined to rationalize the functions of agro-based parastatals by privatising the ones performing commercial activities while strengthening the capacity of the ones whose function is basically regulation. I would like to emphasize that it is not the intention of my government to create roadblocks in the way of the private sector... The primary objective of the strategy is to provide a policy and institutional environment that is conducive to increasing agricultural productivity, promoting*

investment, and encouraging private sector involvement in agricultural enterprises and agribusiness (SRA 2004).

The launch of this strategy was seen as a way for the new government to differentiate itself from the long regime of the previous president. Former President Moi was seen to have used the main state parastatal, the National Cereals and Produce Board, to channel resources to his home area after the 1978-82 drought (Poulton and Kanyinga 2014). President Kibaki's policy was expected to lower the power of state parastatals, which were considered inefficient compared to agribusinesses that operated elsewhere in Africa.

It was commonly thought that state parastatals had high intermediation costs and agribusinesses would provide better market access to farmers (FAOSTAT 2013). Agribusinesses operated in Kenya before 2004. For example, top agribusiness firms included a mix of multinational and domestic firms like Unilever, British American Tobacco Company, Kakuzi/Camellia and Unga Group. But their operations were constrained by government policy.

To shift from state presence to agribusiness participation, policy changes included divestiture from government services and companies, rationalization of laws to ease private-sector operation in processing activities and automatic licenses under investment incentives. Although the policy documents are too lengthy to be reproduced fully here, key pieces of legislation included the SRA 2004, which contains within it a list of Acts and Amendments applicable to different crops as well as laws specific to certain activities like the Investment Promotion Act and the Privatization Act. The SRA 2004 fully liberalized the processing and marketing of crops such as coffee, sugar, pyrethrum and cotton. The Investment Promotion Act 2004 opened up several avenues for agribusiness activities in many crops. For example, it entitled investment certificate holders the license to grow pyrethrum, mill maize, grow sisal, establish sisal factories and deal in coffee. The Privatization Act 2005 put down certain statutory boards and government companies for review and divestment.

We compile the full list of crops that shifted to an agribusiness model from the official documents (SRA 2004 and Acts contained therein). The policy-affected crops include different varieties of maize, coffee cherries, wheat, cotton, sugarcane, sisal, pyrethrum, fodder, cashewnuts, rice and oats. Other crops that are grown in Kenya but were not affected by the policy included varieties of fruit, vegetables, flowers, legumes, certain coarse grains and tea (which had previously been largely shifted to worker controlled agencies).

Information on the cropping patterns and the incomes received per buyer are obtained from surveys implemented by Egerton University in Nairobi. The sampling frame was designed in consultation with the Kenya National Bureau of Statistics. The surveys randomly sample over 1,300 rural households that represent eight different agricultural-ecological zones in Kenya (see Chamberlin and Jayne 2013 for details of the stratified random sampling).

The Kenyan household panel covers rural households with less than fifty acres of land. They are surveyed in 2000, 2004 and 2007. Compared to similar surveys in developing countries, the attrition rates of the original Kenya sample are low – about 90 per cent of the households are resampled. This is particularly important because standard datasets of rural households in low-income countries can have attrition rates as high as 20 per cent (Suri et al. 2009) or even 50 per cent (as in the World Bank's LSMS datasets).

In each year, the survey asks households to report the quantity harvested of each crop on each field, the type of buyer to whom the largest sale is made and the price paid for the latter. Aggregating up across all fields, the income earned per household-crop-buyer is the sum across all fields of the quantity times the price paid by the largest buyer for each field on which the crop is grown. The overwhelming majority of households sell each crop to just one type of buyer. We therefore aggregate the data up to the household-crop level for each cropping season and year, and categorize sales by an indicator for the buyer type for each household-crop-season-year observation. Monetary values are reported in Kenyan shillings (Ksh) here and they are deflated with World Bank GDP deflators to 1999 values.

Having discussed the context and data, we proceed to incorporating key features of the two in the theoretical framework of the subsequent section and the empirical work to follow afterwards.

3. Theoretical Framework

This section develops a theoretical framework to account for the microstructure of intermediation in crop markets. There is a continuum of farmers, each endowed with a unit of land, on which they can grow the crops which are affected by the policy and other crops. For brevity, we refer to these as Policy crops and Other crops respectively. Policy crops experience a shift in government policy to encourage agribusiness participation. The theoretical framework connects changes in the policy to farm incomes and overall household welfare.

It broadly builds on the work on intermediated trade by Antras and Costinot (2011). Like in their setting, farmers have a comparative advantage in one of two crops and intermediaries have market power. Compared to their setting, we abstract from search frictions and focus instead on the microstructure of intermediation to take the theory closer to our empirical setting. However, the broad forces that operate when policy switches from state actors to private actors are similar to their comparison of intermediation through domestic and foreign traders. In particular, intermediaries differ in bargaining power and they impose externalities on each other through entry and pricing. The focus here is on the impact of policies to shift to agribusiness-led development of markets for farmers, and we will show that these policies can heighten market power through externalities present in these markets.

In our theoretical framework, an economy consists of Farmers who rely on intermediaries to sell their produce. The empirical application will be to Kenya, which is assumed to be a small open economy that takes world prices for crops as given. Intermediation to take the produce to the market is provided by Traders and Agribusinesses who compete oligopsonistically. Intermediation is also provided by the State through boards, cooperatives or government companies. The government chooses policies to shift the economy from state-led intermediation to an agribusiness model. Agribusinesses provide better access to world markets but also have market power because farmers require sunk investments to realise the potential gains from agribusiness activities. This section first describes the cropping and selling choices of farmers, then the pricing and entry decisions of intermediaries and finally the equilibrium earnings of farmers before and after the policy.

3.1. **Farmers.** Each farmer has linear utility for a numeraire good and therefore maximizes farm earnings. A farm can produce φ units of the Policy crops, where φ is drawn from a productivity distribution $G(\varphi)$. Other crops are normalized to provide a unit income. To enable explicit solutions, G is assumed to be Pareto with $G(\varphi) = 1-(\varphi_{\min}/\varphi)^k$ where $\varphi \geq \varphi_{\min} > 0$ and $k \geq 1$. Comparative advantage of the economy in policy crops is reflected in higher values of $\varphi_{\min}$, while a fall in the Pareto shape parameter k captures an increase in inequality (as measured by the Gini index for relative productivity of land in policy crops).

Farmers observe their productivity and choose whether to grow policy crops or other crops. Having chosen to grow policy crops, they choose whether to make investments to engage with agribusinesses. Agribusinesses provide farmers with technical services to transform their produce into more marketable surplus through, for example, quality

control, knowhow or processing facilities. Obtaining these income gains requires sunk relationship-specific investments by the farmer and the surplus from the productivity gains is shared through bilateral Nash bargaining between the agribusiness and the farmer. Once investments are sunk, farmers receive a share of these productivity gains and the going rate for their produce in the market. The going rate depends on what agribusinesses and small traders pay and also on what state companies pay. State companies have the capacity to buy a share κ of all the farm produce. Policies to reduce the share of farm purchases by the state will be our focus and we will show that this can be summarized by a drop in κ.

3.2. **Intermediaries.** There is a finite number N of private-sector firms which provide trading services for the produce of farmers in a Cournot oligopsonistic fashion. Each trading firm pays an entry cost of F units of the numeraire. Profit from providing trading services to farmers for intermediary i is

$$\pi_i = (pm - p_i)q_i$$

where p denotes the world price of the policy crop, $0 \leq m \leq 1$ is the intermediation productivity which acts like the inverse of an iceberg trade cost and p_i is the Cournot price paid to farmers by firms.

A finite number M of the private-sector firms incur entry costs F_a to also engage in agribusiness activities. They potentially provide technical knowhow to farmers which raises the quality or productivity of the marketable farm surplus, a reasoning that is often provided as motivation for agribusiness-friendly policies across the world. Let m_a denote the productivity gain from engaging with an agribusiness, which is realized by the farmer once relationship-specific investments are undertaken. The surplus from the relationship for agribusiness services is shared under bilateral Nash bargaining, with β_a denoting the share of the agribusiness.

State purchases are defined in a similar way to agribusiness purchases, but state companies are assumed to not compete with private firms in price setting. State companies provide trading services and potentially technical knowhow to raise farm surplus. They choose a price p_s to pay farmers for both services and do not compete with private firms in price setting through the market.[3]

To examine the policy shift from the state to private companies, we define $\kappa \in [0, 1]$ as the probability of being able to sell to state companies. When κ approaches one, farmers can potentially sell all their farm produce to the state at their set price p_s. When

[3]Under bilateral Nash bargaining, the "price" paid by the state is $p_s = (1 - \beta_s)(m_s + m)p$.

κ approaches zero, farmers just have agribusinesses and traders to sell to. A drop in κ, as mentioned earlier, will summarize a shift in policy away from state companies to an agribusiness-led model of development of crop markets. To examine the impacts of such policy shifts, we first discuss the sorting of farmers by crops and buyers, and then proceed to determining the prices paid by buyers to farmers.

3.3. **Sorting.** We build in the empirical observation that bigger farmers sell to agribusinesses while smaller farmers sell to traders. On average, households selling policy crops to agribusinesses are larger than those selling to traders, while households selling to the state are slightly bigger than those selling to traders but also more varied in size (Table 1).[4] As is standard in the international trade literature, this can be incorporated by assuming that the sunk costs of selling to an agribusiness are higher than those for selling to other buyers. For brevity, sunk costs for selling to other buyers are set to zero while those for agribusinesses are $f > 0$. Further, bargaining weights and intermediation productivities are assumed to be ordered such that agribusiness and state purchases are viable for some farmers to keep the problem interesting.

TABLE 1. Sorting of Farmers by Buyer: Income from Policy Crops in 2000 and 2004 ('000 Ksh)

Buyer types	Obs	Mean	Median
Agribusiness	304	91.48	50.37
Trader	1,350	17.80	6.27
State	704	20.21	3.00

The government's target share of policy crop purchases from the market is κ, which is fully taken up by farmers when state prices are higher than Cournot trading prices. This holds in many settings including ours, as discussed in the Appendix, and will ensure that there are some sales to state companies by farmers of policy crops. The average farmgate price for policy crops is therefore

$$\bar{p} = \kappa p_s + (1 - \kappa)\, p_i \tag{3.1}$$

which will be used to summarize the market conditions faced by farmers when selling their policy crops. The expected "price" received by farmers selling to agribusinesses is

$$p_a = (1 - \beta_a)\, pm_a + \bar{p} \tag{3.2}$$

[4]Controlling for year fixed effects and crop-season fixed effects, the coefficients from regressing income from policy crops on indicators for agribusiness and traders are 39.81 (19.96) and -47.12 (30.26) respectively.

which consists of the surplus share and the going rate for trading services.[5]

Having defined the prices, farmers sort as follows into their cropping and intermediation choices. Farmers with productivity lower than

$$\varphi_i \equiv 1/\bar{p} \tag{3.3}$$

earn less in policy crops than in other crops, so they devote their land to other crops. Farmers with productivity higher than φ_i prefer to grow policy crops. They choose agribusinesses if their productivity is higher than

$$\varphi_a \equiv f/\left(p_a - \bar{p}\right) \tag{3.4}$$

so that they can meet the scale needed to justify the sunk investments. To sum up, the lowest productivity farmers grow other crops, the medium productivity farmers choose to grow policy crops but do not take up agribusiness services and the most productive farmers grow policy crops and invest in agribusiness services.

3.4. **Cournot Pricing.** Having determined the cropping patterns and the sorting of farmers by intermediaries, the price of trading services can be determined by solving for a symmetric equilibrium. The supply of policy crops to the private market is

$$Q = (1-\kappa)\int_{\varphi_i}^{\infty} \varphi dG\left(\varphi\right) = (1-\kappa)\frac{k}{k-1}\varphi_{\min}^{k}\bar{p}^{k-1}.$$

Therefore the perceived elasticity of demand for trading services is

$$\partial \ln q_i/\partial \ln p_i = (k-1)\left(1-\kappa\right)\left(p_i/\bar{p}\right)\left(Q/q_i\right).$$

Cournot oligopsonists choose their optimal farmgate price such that the markdown on intermediated world prices is equal to the inverse of their perceived demand elasticity:

$$\left(pm - p_i\right)/p_i = \partial \ln q_i/\partial \ln p_i.$$

Substituting for the demand elasticity under a symmetric equilibrium, the optimal price paid by oligopsonistic firms is

$$p_i = \frac{N\left(k-1\right)pm - \kappa p_s/\left(1-\kappa\right)}{N\left(k-1\right)+1}. \tag{3.5}$$

In the benchmark case of perfect competition and no state companies, farmers receive the world price, net of intermediation costs. Under infinite entry ($N \to \infty$) or a perfectly equal land distribution ($k \to \infty$), prices do not change the extent to which farmers alter their supply to intermediaries, so the full world price is transmitted to

[5]The qualitative results are similar when agribusinesses are assumed to pay for their trading services through Nash bargaining as well, but the expressions become much more tedious.

farmers. When intermediaries are oligopsonistic (finite N and k), farmers receive a smaller share of the price net of trade costs. Finally, holding entry fixed, prices paid are lower when market size is smaller (due to higher government involvement κ).

3.5. **Entry.** Free entry of intermediaries ensures average profits are driven down to entry costs. Ignoring the integer constraint, free entry in trading services gives

$$(1-\kappa)\frac{k}{k-1}\varphi_{\min}^{k}\left(pm-p_i\right)\varphi_i^{-k+1}/N=F \tag{3.6}$$

where

$$pm-p_i=\frac{pm+\kappa p_s/\left(1-\kappa\right)}{N\left(k-1\right)+1}$$

is the markdown in farmgate prices arising from oligopsonistic pricing. Similarly, free entry into agribusiness operations ensures average profit from agribusiness activities is driven down to entry costs,

$$\frac{k}{k-1}\varphi_{\min}^{k}\left(1-\kappa\right)\left(pm_a-\left(p_a-\bar{p}\right)\right)\varphi_a^{-k+1}/M=F_a. \tag{3.7}$$

To ensure that the number of firms exceeds one, we assume entry costs are not too high to completely preclude entry into the crop market.[6]

Having discussed the entry conditions, the equilibrium of the economy can be specified in terms of the optimal cutoffs, optimal prices and optimal entry. These are given jointly by the cutoff equations 3.3 and 3.4, the pricing equations 3.1, 3.2 and 3.5 and the free entry equations 3.6 and 3.7.

3.6. **Incomes.** We are interested in examining income changes experienced by farmers as a result of a policy shift away from state companies towards private companies in development of crop markets. As mentioned earlier, this can be summarized by a drop in the probability of being able to sell to state companies κ, so we discuss comparative statics of incomes with respect to κ. Much of the analysis will summarize income changes in terms of changes in market conditions, $\partial \ln \bar{p}/\partial \ln \kappa$, which will be a useful statistic to understand the welfare implications of the policy change.

Incomes of farmers selling policy crops to agribusinesses is

$$I_a=\int_{\varphi_a}^{\infty}\left(p_a\varphi-f\right)dG.$$

[6]Conditions to ensure this in terms of primitives are in the Appendix.

Substituting for the relative productivity distribution of policy crops, incomes from agribusinesses is

$$I_a = \frac{k}{k-1}\varphi_{\min}^{k} f^{-k+1}\left(p_a - \bar{p}\right)^{k-1}\left(\frac{1}{k}\left(p_a - \bar{p}\right) + \bar{p}\right).$$

Then it can be shown that income changes from agribusinesses take the same sign as the change in market conditions because

$$\partial \ln I_a / \partial \ln \kappa = \frac{\bar{p}}{\frac{1}{k}\left(p_a - \bar{p}\right) + \bar{p}}\left(\partial \ln \bar{p} / \partial \ln \kappa\right).$$

Average price $\bar{p}$ summarizes market conditions for policy crops and a drop in average price shows reduced earnings from policy crops on both the extensive and intensive margins of farm earnings from agribusinesses.

Proceeding similarly, incomes of farmers from policy crops across all buyers sum up to

$$I = \int_{\varphi_a}^{\infty}\left(\left(p_a - \bar{p}\right)\varphi - f\right)dG + \int_{\varphi_i}^{\infty}\bar{p}\varphi dG = \frac{k}{k-1}\varphi_{\min}^{k}\left(\bar{p}^{k} + f^{-k+1}\left(p_a - \bar{p}\right)^{k}/k\right).$$

Changes in income from policy crops again take the sign of changes in market conditions because

$$\partial I / \partial \kappa = \frac{k^2}{k-1}\varphi_{\min}^{k}\left(\bar{p}^{k-1} + f^{-k+1}\left(p_a - \bar{p}\right)^{k-1}\right)\left(\partial \bar{p} / \partial \kappa\right).$$

To solve for these incomes changes, we therefore need to determine how market conditions change ($\partial \bar{p} / \partial \kappa$). This can be derived by totally differentiating the pricing and entry conditions, which describe the equilibrium in the economy (equations 3.1 to 3.7). The change in market conditions turns out to be

$$\partial \ln \bar{p} / \partial \ln \kappa = \frac{\kappa\left(p_s - pm\right)}{\bar{p}}\frac{N\left(k-1\right)+1}{N\left(k-1\right)+1-k/2}.$$

The sign of the average price change therefore depends on the difference between state prices and the efficiency of traders ($p_s - pm$). When traders are relatively inefficient $p_s > pm$, a reduction in state purchases worsens market conditions because farmers must resort to inefficient oligopsonistic traders who pay less. In this case, farmers directly get a lower farmgate price and firms engaged in trading and agribusiness activities gain at the expense of farmers. In the long run, reduction in the role of the state also encourages entry. Increased profit opportunities encourage entry which in turn dampens some of the fall in prices. The net effect of these forces is dominated by the direct effect, which raises firm profits at the expense of farm earnings. This negative income effect is reinforced through the extensive margin. Lower prices reduce the size of the market for policy crops which in turn dampens further entry. In contrast, when

traders are sufficiently efficient $pm > p_s$, the direct effect of a reduction in the role of the state is smaller than the indirect effect from entry of firms which raises the price received by farmers.

Summing up, incomes from policy crops, including for farmers who engage with agribusinesses, fall after the policy shift when traders are relatively inefficient and vice-versa. This will be the first part of the empirical application, which examines the incomes earned by farmers in policy crops, relative to other crops, and we summarize it in Proposition 1 below.

Proposition 1. *When traders are relatively inefficient, incomes of farmers from policy crops fall with a policy shift towards private sector-led intermediation (lower κ). Agribusiness profits rise till they are eroded away through greater entry after the policy shift. The opposite results hold for relatively efficient traders.*

Our empirical setting corresponds with relatively inefficient traders and we will show in section 4 that incomes from policy crops are lower after the policy change in the empirical application. More generally, however, the theoretical framework can be extended to also allow for rent sharing in agribusiness activities to be affected by competition among agribusinesses. Then prices paid to farmers for making agribusiness investments rise with a reduction in state purchases. This is because the increase in market size for agribusinesses encourages entry and therefore the surplus share that they pay to farmers. There are then two opposing forces affecting farm incomes after the rollback in state participation – average prices $\bar{p}$ change as described earlier but agribusiness prices $p_a - \bar{p}$ rise due to increased competition among firms. Moreover, if the policy shift is additionally considered to have reduced entry costs for agribusiness activities F_a, then the positive competitive forces that raise the rents paid to farmers are reinforced. Which force dominates, changes in trading prices or rent sharing from agribusinesses, depends on the shares and elasticities of each activity in farm incomes, and is therefore an empirical question.[7] This will be implemented through a difference-in-difference specification, which compares farm earnings and firm profits from policy crops and other crops, before and after the policy change.

3.7. **Comparative Advantage and Incomes.** We are ultimately interested in examining how changes in agricultural intermediation policies impact the overall welfare of farmers. A natural metric for farmer welfare is the total income across all crops.

[7]For example, Macchiavello and Morjaria (2015) find competition among coffee mills in Rwanda undermined relational contracts between mills and farmers, leading to lower farmer welfare.

Aggregating up farm incomes across crops, the total income from farming is

$$Y = \int_{\varphi_a}^{\infty} \left(\left(p_a - \bar{p} \right) \varphi - f \right) dG + \int_{\varphi_i}^{\infty} \bar{p} \varphi dG + \int_{\varphi_{\min}}^{\varphi_i} dG = 1 + \frac{1}{k-1} \varphi_{\min}^{k} \left[\bar{p}^k + f^{-k+1} \left(p_a - \bar{p} \right)^k \right].$$

The change in farm income again takes on the sign of the average price change because

$$Y'/Y \equiv \partial \ln Y / \partial \ln \kappa = \left(\frac{k}{k-1} \varphi_{\min}^{k} \bar{p}^k / Y \right) \left(\partial \ln \bar{p} / \partial \ln \kappa \right)$$

where the first term in parenthesis on the RHS corresponds to the share of farm incomes arising from trading of policy crops. If the total farm income is compared over time, then incomes are expected to fall or rise after the policy shift, depending on how average prices respond to the policy shift. But simply using time variation in incomes makes it difficult to ascribe the income change to the policy shift, rather than to other time varying changes in the economy. We therefore minimize concerns regarding time-varying factors other than the policy shift affecting incomes by using the theoretical framework to guide empirical examination. In particular, we compare farm incomes by comparative advantage in policy crops. Farmers with a higher comparative advantage would be more reliant and more affected by policies pertaining to those crops.

Following recent work using agronomical databases to determine crop choices, farm income changes can be compared across villages with higher or lower comparative advantage in the policy crops. The theoretical framework implies such a comparison. For example, comparing two villages that differ in $\varphi_{\min}$, it can be shown that income shares from policy crops, entry and average prices for policy crops are higher in comparative advantage villages. Looking further at how incomes in the two villages evolve after the policy shift, it can be shown that income changes depend on the extent to which the shares of policy crops in incomes and the responsiveness of average prices to state purchases differ by comparative advantage. Comparative advantage villages have higher shares of their incomes from policy crops. Furthermore, the responsiveness of their average price change to state purchases is also larger, (except under a very unequal productivity distribution). The price effect, in either case, does not overturn the first order effect of large income shares from policy crops which make these villages more exposed to the policy change. Specifically,

$$\partial \ln Y' / \partial \ln \varphi_{\min} = \frac{k}{2} \frac{N-1}{\left(N \left(k-1 \right) + 1 - k/2 \right)^2} \left(k - \frac{N-2}{N-1} \right) > 0$$

for all $k \geq 1$. Therefore, when the national government reduces its purchases (κ falls), comparative advantage villages see bigger total income changes, even after accounting

for different pricing and entry strategies of firms across villages. This prediction, summarized in Proposition 2 below, can be taken to the data and implemented through a standard difference-in-difference strategy, which compares total incomes in comparative advantage villages and other villages, before and after the policy shift.

Proposition 2. *Farmers in villages with a comparative advantage in policy crops (higher $\varphi_{\min}$) face bigger impacts on their total incomes.*

Having provided a theoretical framework to understand income changes, the next section proceeds to empirically examining Propositions 1 and 2.

4. Empirics

This section starts with examining Proposition 1, which relates incomes earned at the crop level by households before and after the policy shift. The impacts on crop incomes from all buyers and from agribusinesses are discussed in turn. Then it proceeds to examining the profits of agribusinesses, by their specialisation in policy crops, before and after the policy shift. The final sub-section examines Proposition 2, which compares income and welfare impacts at the level of the household across comparative advantage villages and other villages.

4.1. Crop Incomes and Policy.

To operationalize Proposition 1, we implement a difference-in-difference (DiD) analysis comparing incomes received from policy crops with other crops, before and after the policy shift. Let c index crops (example, dry maize) and g index the group - Policy crops or Other crops - to which each crop belongs. Let $Post_t$ be an indicator for the period after the policy shift which consists of the main and short cropping seasons for the year 2006-2007 (from July 2006 to June 2007), while the period before consists of the main and short seasons in 1999-2000 and 2003-2004. Then $Income_{cghst}$ (in Ksh) is the income received for crop c in group g by household h in season s of year t, which is specified as follows:

$$Income_{cghst} = \beta\, Post_t Policy_g + \alpha_{cs} + \alpha_h + \alpha_t + \varepsilon_{cghst} \tag{4.1}$$

$Policy_g = 1$ for the 18 crops that experienced a policy shift from the Strategy for Revitalizing Agriculture in 2004 and 0 otherwise. β is the coefficient of interest which is negative when incomes from policy crops fall relative to other crops after the policy shift and ε is an error term. Crop-season fixed effects are included to account for time-invariant differences in incomes across crops in each season, and standard errors

are clustered by crops.[8] Year fixed effects account for general macroeconomic changes in the country. Household fixed effects ensure that we are examining income changes within households.

We start with documenting summary statistics for the DiD analysis and then proceed to the specification in equation 4.1 to control for various unobservables. Table 2 contains the mean incomes earned by households across Policy crops and Other crops in the Pre and Post periods. In each year, there are over 1,400 crop-household-season observations for policy crops and over 5,300 for other crops. Households earn more from policy crops than other crops (Policy-Other Difference), but this difference becomes smaller after the policy shift. Incomes from policy crops fall by 8,500 Ksh after the policy shift, while those from other crops that did not experience a policy shift fell by just 1,800 Ksh. This gives a DiD estimate of 6,600 Ksh, showing much bigger incomes losses from policy crops relative to other crops.

As the policy was enacted in mid-2004, there may have been anticipation effects in that year. It is reassuring however that the corresponding DiD estimate for changes from 2000 to 2004 is -4.83 (3.27) which is negative but smaller in magnitude and statistically insignificant. Further, comparing 2000 and 2007, the DiD estimate is unchanged at -6,600 Ksh.

TABLE 2. Pre-Post Incomes from Policy-Affected Crops and Other Crops

Crops	Household Income from Crop ('000 Ksh)		
	Pre	Post	Post−Pre
Policy crops	23.5	15.0	-8.5 (2.7)
Other crops	6.4	4.6	-1.8 (0.4)
Policy−Other	19.3 (7.5)	10.4 (4.8)	**DiD = -6.6 (2.6)**

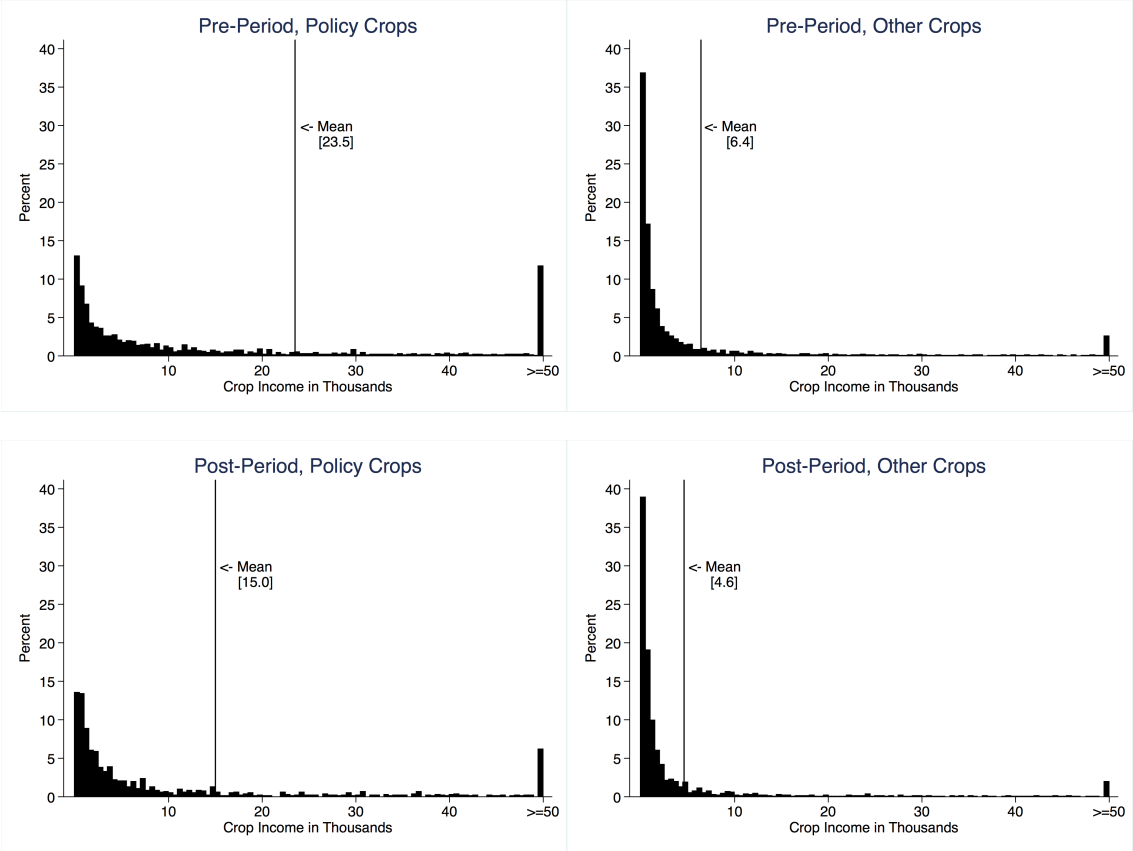
Standard errors clustered by crop in parentheses

While Table 2 provides the average income effect of the policy, Figure 4.1 shows the full distributions of incomes earned by households across Policy and Other crops in the Pre and Post periods. For visualisation purposes, crop incomes above 50,000 Ksh are top coded. Figure 4.1 shows quite starkly that the entire income distribution for policy crops shifts to the left for policy crops, but not as much for other crops after the policy shift.

Table 3 contains results for the regression specification in equation 4.1. Column 1 is a benchmark specification with just time fixed effects. Column 2 is the baseline result for $\partial I/\partial \kappa$, which shows a 4,590 Ksh reduction in income from policy crops after the

[8]Alternative fixed effects (crop and season-time separately) and clustering (group level; crop and household levels) give qualitatively similar results.

FIGURE 4.1. Pre-Post Incomes from Policy-Affected Crops and Other Crops



policy shift, relative to other crops. Column 3 replaces the crop-season and household fixed effects with crop-season-household fixed effects to find bigger income losses when looking at just the intensive margin of each crop *within* each household. Column 4 shows results are qualitatively similar when the specification is changed to log of income on the LHS or when the sample is restricted to exclude households that do not appear in 2007 in Column 5. Finally, Column 6 fills in zeros into the dataset to ensure that there is a balanced panel of crop-household-season-year observations, which amounts to counting households and crops the same number of times. This of course changes the coefficient but the qualitative result of reduced incomes from policy crops is confirmed for the balanced panel too.

To examine the robustness of our baseline results, Table 4 examines other explanations that may account for the observed drop in incomes from policy crops. Columns 1 and 2 control for world prices to ensure that the results are not driven by a greater fall

TABLE 3. Baseline Results: Crop Income and Policy

	Dependent variable: Household Income from Crop ('000 Ksh)					
	(1)	(2)	(3)	(4) Log Income	(5) 2007 hh	(6) Balanced
$Post_t \cdot Policy_g$	-6.47***	**-4.59*** **	-7.83***	-0.20***	-4.96***	-1.99**
	(2.55)	(1.37)	(2.72)	(0.09)	(1.42)	(0.825)
$Policy_g$	16.86***					
	(6.56)					
Crop-Season FE α_{cs}	No	Yes	α_{chs}	Yes	Yes	Yes
Household FE α_h	No	Yes	α_{chs}	Yes	Yes	Yes
Year FE α_t	Yes	Yes	Yes	Yes	Yes	Yes
N	21,247	21,183	11,580	21,183	19,816	77,148
Number of crops	117	106	71	106	105	117
R^2	0.021	0.377	0.799	0.585	0.389	0.164

Standard errors clustered by crop in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

in world prices of policy crops. World prices are obtained from unit values in COMTRADE data for all countries other than Kenya and an indicator for drop in world prices is constructed for crops that saw a drop in their world price between 2003 and 2006. The latter accounts for the potential role of intermediaries in reducing negative world price shocks to farmers (Allen and Atkin 2016). It should be noted that the coefficient cannot be interpreted as a conventional pass through rate because the LHS is income. If log prices received are on the LHS, then the coefficient on log world price is close to one when fixed effects are included and 0.14 otherwise. While a high world price pass through rate may be interpreted as evidence for competitive agricultural markets, it is noteworthy that large price wedges between consumers and producers can coexist with high measured passthrough rates (Dillon and Dambro 2017, Grant and Startz 2019).

Larger negative productivity shocks to policy crops, example through bad weather, could lower income from policy crops relative to other crops. To ensure that this is not driving our baseline results, Column 3 controls for the share of harvest that got spoiled during the season-year for each crop. This is constructed as the average share of harvest for the crops that got spoiled across all households, which is reported in the survey, and including this barely changes the coefficient on the policy variable.

It could be that households receive lower revenues from policy crops but that they save on related costs of planting and harvesting, which shows up as higher net incomes from policy crops. We observe how much households pay in cash for fertilisers and land preparation. Column 4 reports incomes from policy crops, net of fertilizer and land

preparation costs, and the estimated policy coefficient falls very slightly.[9] To account for input costs more comprehensively, the section on household welfare will in any case contain more comprehensive measures of household earnings and welfare later.

Finally, following the work of Suri (2011) on fertilizer adoption in Kenya, Column 5 excludes coastal provinces where the income data for 2004 might suffer from measurement error. Like in Suri's work, the findings we report are robust to exclusion of these areas.

TABLE 4. Robustness: Crop Income and Policy

	Dependent variable: Household Income from Crop ('000)				
	(1) World Price	(2) Fall	(3) Crop Spoilage	(4) Net Income	(5) No Coast
$Post_t \cdot Policy_g$	-4.50***	-4.64***	-4.52***	-4.33***	-4.96***
	(1.35)	(1.35)	(2.26)	(1.38)	(1.42)
$World\,Price_{ct}$	8.42**	9.69**			
	(4.16)	(4.12)			
$Fall_{ct} World\,Price_{ct}$		-32.89**			
		(14.02)			
$Post_t \cdot Share\,Spoil_{cst}$			15.38		
			(20.78)		
$Share\,Spoil_{cst}$			-3.86		
			(30.62)		
Crop-Season FE α_{cs}	Yes	Yes	Yes	Yes	Yes
Household FE α_h	Yes	Yes	Yes	Yes	Yes
Year FE α_t	Yes	Yes	Yes	Yes	Yes
N	20,393	20,393	21,183	21,183	19,816
R^2	0.381	0.382	0.377	0.367	0.389
Adjusted R^2	0.330	0.329	0.323	0.316	0.343

Standard errors clustered by crop in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Finally, we conducted a number of checks, available upon request for brevity, that we summarize here. One concern is that Kenya is large in the world market for tea and that the growth in incomes from tea, which had previously undergone a shift from state ownership of the main buying agency to worker control, might be driving the results (through higher growth of other crops). Excluding tea from the sample in fact slightly increases the magnitude of our estimated coefficient from -4.6 in the baseline to -5.

Another concern is that even among policy crops, there are a couple of extreme market structures. In particular, coffee is overwhelmingly sold to cooperatives (due to a long

[9]The survey contains some other costs such as seed costs but often these are imputed from in kind or credit transactions. Including these mostly makes the coefficients larger in magnitude, but we do not report these in the baseline due to concerns over measurement of these variables.

tradition of non-governmental agencies in this sector) while sugar is overwhelmingly sold to agribusinesses (due to the need for immediate processing of the harvest). Excluding coffee barely moves the estimated policy coefficient as just about 5 per cent of the sample constitutes coffee. Alternatively, we include an interaction term between an indicator for coffee and the policy variable - $Post_t Policy_g Coffee_c$. The estimated coefficient on the interaction is -0.32 (with a standard error of 2.67). This suggests the policy shift showed negligible income reductions when the buyers, who are largely cooperatives, do not exert monopsony power. Excluding sugar changes the policy coefficient to -3.88 (1.16), which is qualitatively similar to the baseline but somewhat smaller.

There is another concern that our baseline results might reflect what happened in maize markets, which is the main food crop grown by households and also the chief source of income for the previous President Moi's home base. Excluding maize still gives negative income impacts of the policy, and the estimated coefficient increases in magnitude to -5.8. Therefore, the robustness exercises reveal that crop-specific peculiarities do not seem to be the driving force behind our baseline results.

4.2. **Crop Incomes, Policy and Agribusiness.** To examine differences across agribusiness and other buyers, let $Agribusiness_{chst} = 1$ when the crop is sold mainly to an agribusiness, which refers to large companies, exporters, millers and processors in the survey.[10] Theoretically, income reduction from the policy shift is lower for farmers selling through agribusinesses, because average trading prices fall more than rents from agribusinesses. This raises the share of agribusinesses in income from policy crops after the policy shift (I_a/I rise with lower κ). However, incomes from policy crops fall for farmers selling to agribusinesses and other buyers. Allowing for heterogeneity in the policy coefficient across purchases made by agribusinesses and other buyers, the specification in equation 4.1 can be extended as follows:

$$\begin{aligned} Income_{cghst} =& \beta_a Post_t Policy_g Agribusiness_{chst} + \gamma_1 Policy_g Agribusiness_{chst} \\ &+ \beta\, Post_t Policy_g OtherBuyers_{chst} + \gamma_2 Policy_g OtherBuyers_{chst} \\ &+ \gamma_3 Post_t Agribusiness_{chst} + \gamma_4 Agribusiness_{chst} \\ &+ \gamma_5 Post_t OtherBuyers_{chst} + \gamma_6 OtherBuyers_{chst} \\ &+ \alpha_{cs} + \alpha_h + \alpha_t + \varepsilon_{cghst} \end{aligned}$$

[10]As our focus is on a policy shift from state to private-sector purchases, co-operatives, boards and worker controlled agencies like the National Cereals and Produce Board or the Kenya Tea Development Agency Holdings Limited are excluded from the agribusiness category.

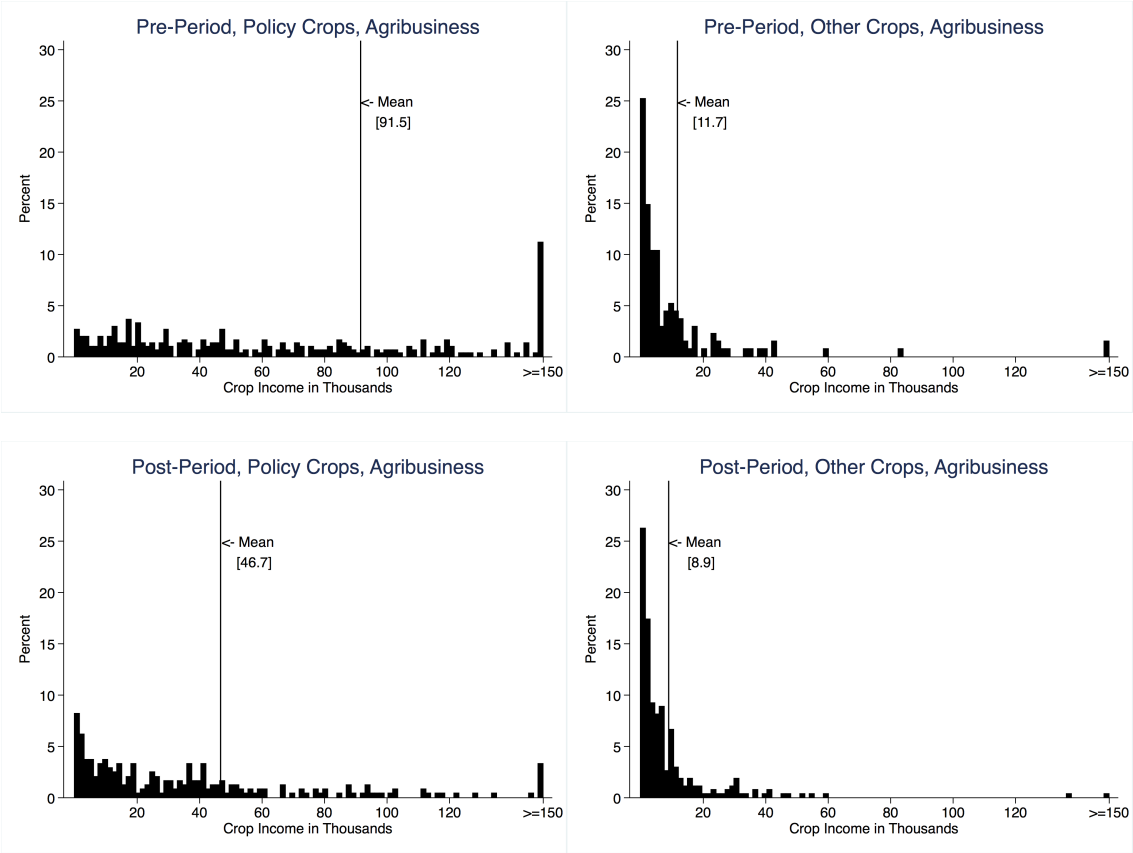
where β_a would be the estimated income impact of the policy for households who sell the crop mainly to agribusinesses and β would be the estimated income impact of the policy for households selling the crop to buyers other than agribusinesses.

The share of agribusinesses rises during the period and agribusinesses become the majority buyer of policy crops. The share of agribusinesses in farm purchases rises from 40 per cent to 51.5 per cent in policy crops. Other crops also see a rise in agribusiness shares from 2 per cent to 9.8 per cent, but the levels remain much lower. Regressing an indicator for agribusiness purchases on $Post_t Policy_g$ and the set of fixed effects (crop-season, household and time), the estimated coefficient on the policy variable is 5 per cent, which rises to 9 per cent when the contribution of each crop to total farm income of the household is used as weights for the regression. Following the discussion on robustness, when $Post_t Policy_g Coffee_c$ is included in the regression, the estimated likelihood of agribusiness purchases rises to 8.2 per cent (unweighted) and 12.3 per cent (weighted by crop share).

Households selling to agribusinesses experience a drop in income from policy crops after the policy shift, as expected. This can be seen in Figure 4.2, which plots the distributions of incomes for households selling to agribusinesses. Households selling to agribusinesses have much higher incomes from policy crops, but they also experience much bigger reductions in their incomes from policy crops. The distribution of income from policy crops shifts to the left while incomes from other crops shows a much more muted shift to the left, after the policy shift. The finding of large income losses for households selling policy crops to agribusinesses is consistent with the large 40 per cent reduction in cotton yields that farmers faced when outgrower schemes failed in Zambia (Brambilla and Porto 2011).

Table 5 shows the income impact of the policy after separating out purchases made by agribusiness and other buyers. For crops sold to agribusinesses, Column 1 shows households experience an average 34,000 Ksh reduction in income from policy crops after the policy shift, relative to other crops. The magnitude is much larger because sales of policy crops to agribusinesses also tend to be much larger, as expected from the sorting patterns of households to agribusinesses. This can be seen from the γ_1 coefficient on $Policy_g Agribusiness_{chst}$ which is 46,000 Ksh. Households selling to other buyers are also impacted negatively. The magnitude is much smaller at 3,690 Ksh, reflecting their much lower levels of crop incomes. Evaluated at the mean incomes of households selling to agribusinesses and to other buyers, the estimated income elasticity at the mean of the $Post_t Policy_g$ variable is -7 per cent for households selling to agribusinesses and -11 per cent for those selling to other buyers. Looking just at the intensive margin of

FIGURE 4.2. Incomes from Agribusinesses for Policy-Affected Crops and Other Crops



household-crops in Column 2, reduction in crop incomes are of a similar magnitude for agribusinesses but larger for households selling to other buyers.

Columns 3 to 5 restrict the agribusiness indicator to households that sold to agribusinesses before and after the policy shift. This has the advantage that the set of households selling to agribusinesses is kept the same over the pre and post periods. Results are very similar to those in Columns 1 and 2, showing that the negative results are not driven simply by changes in the set of households that sell to agribusinesses. Column 5 shows additionally that incomes, net of cash spent on fertiliser and land preparation costs, also shows similar negative income effects for households engaging with agribusinesses. Therefore, the reduction in farm revenues is not undone by greater input support from agribusinesses to farmers.

4.3. **Agribusiness Profit Margins.** The theoretical framework can be used to empirically examine the mechanism driving income losses for farmers after the policy shift.

TABLE 5. Agribusiness, Policy and Crop Incomes of Households

	Dependent variable: Household Income from Crop ('000 Ksh)				
	All Agribusiness Households		Continuing Agribusiness Households		
	(1)	(2)	(3)	(4)	(5) Net income
$Post_t \cdot Policy_g \cdot Agribusiness_{chst}$	**-33.93*** **	-31.52***	-34.87***	-38.15***	-34.50***
	(10.89)	(7.47)	(7.13)	(12.37)	(7.95)
$Post_t \cdot Policy_g \cdot OtherBuyers_{chst}$	**-3.69*** **	-5.60***	-5.15***	-5.66***	-4.93***
	(1.24)	(1.66)	(1.26)	(1.32)	(1.26)
$Policy_g \cdot Agribusiness_{chst}$	46.20***	25.05*	57.33		57.77
	(9.61)	(15.17)	(39.25)		(39.62)
$Post_t \cdot Agribusiness_{chst}$	2.54	6.39	7.59***		6.84***
	(2.07)	(4.47)	(2.64)		(2.15)
$Agribusiness_{chst}$	1.02	-10.34**	0.00		0.19
	(1.71)	(4.81)	(1.11)		(1.09)
Crop-Season FE α_{cs}	Yes	α_{chs}	Yes	α_{chs}	Yes
Household FE α_h	Yes	α_{chs}	Yes	α_{chs}	Yes
Year FE α_t	Yes	Yes	Yes	Yes	Yes
N	21,183	11,580	21,183	11,580	21,183
R^2	0.383	0.799	0.382	0.799	0.373

Standard errors clustered by crop in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The mirror image of the fall in average prices for farmers is that firm profit margins rise because they get to keep a bigger share of the pie. This directly speaks to the question of the division of the gains from trade in Proposition 1, and we compile new data to examine the mirror image of firm profit margins.

As is well-known, intermediary data are scarce, particularly in developing economies. We therefore put together a primary data source on profit margins of agribusinesses listed on the Nairobi stock exchange. We first looked up names of all publicly listed firms through Datastream for each year from 1999 to 2007. Then we manually downloaded their financial reports, which they are mandated to declare annually.[11]

There are 12 companies which operate during the period with an average annual revenue of 5.2 billion Ksh. These are very large firms by Kenyan standards, with even the minimum annual revenue being 9.8 million Ksh and the largest being as high as 47.3 billion Ksh. The companies include multinational firms like Limuru (Unilever) and

[11]Orbis is another source of information with which we cross-check the firm names. A potential shortcoming of Orbis is that it does not typically keep track of firms that get de-listed so that historical company information is available just for firms that survive to recent years. This does not seem to be a first order concern in our setting because only two firms that appear in Datastream get "de-listed" during the period. Kenya National Mills was de-listed in 2003 but it was a subsidiary of Unga Group, which is in our dataset. Unilever Tea Kenya appears to be de-listed but this is due to Unilever operating an outgrower company, Limuru Tea Plc, which is in our dataset.

Kakuzi (UK-based Camellia Plc) and domestic conglomerates like the Unga group and Uchumi supermarkets, which are well-recognized brands in Kenya.

Although firms report their accounts in different ways, two key variables are available consistently over time and across firms. The first key variable is the profit margin of the firm (profit before tax reported by the company divided by its revenue), which is our dependent variable. The median profit margin of companies is 5.5 per cent and the mean is 3.9 per cent. There is a wide range of margins, so we conduct robustness exercises later by trimming the outlier values.

The second key variable is the cropping segment in which the company operates, which is available from company sales reports and sales descriptions. Segment refers to Beer and Beverages, Coffee, Horticulture, Sisal, Cotton spinning and services, Sugar made from cane, Tea, Maize milling, Wheat production, Poultry feeds and Animal health, or All of these. If the segment includes policy crops, then $1_{seg,g=1} = 1$ and 0 otherwise. The policy exposure of company j can be defined as the share of sales in policy-affected segments in the pre period (1999-2004),

$$Policy_j = \sum_{seg} 1_{seg,g=1} Sales_{seg,g,j} / Total\, Sales_j.$$

The median policy exposure is 18 per cent and the mean is 33 per cent. Table 6 contains the list of companies, their segments and their policy exposure values. Most companies specialize in one segment so they get values of 0 or 1. For companies that operate in more than one segment, the policy variable reflects the sales share of policy-affected crops. Uchumi Supermarkets operates in all segments, so we assign it the average share of policy crops in the economy.

Having defined the key variables, the impact of the policy shift on agribusiness profits can be estimated as follows: $Profit\, Margin_{jt} = \beta \cdot Post_t \cdot Policy_j + \alpha_t + \alpha_j + \epsilon_{jt}$ where α_j refers to firm fixed effects. The coefficient of interest is β, which captures the extent to which profit margins rise more for firms that are more exposed to the policy based on their crop specialisation. Table 7 contains the results. In our baseline specification of Column 3, profit margins of firms that were specialized in policy crops rises by 15 per cent more than firms that were specialised in other crops. If Uchumi supermarkets is excluded from the sample, the estimated coefficient falls slightly to 13 per cent. Column 4 reports results using *initial* firm revenues as regression weights. This raises the estimate to 26.4 per cent as higher revenue firms tend to have higher profits. Finally, Columns 5 and 6 restrict profit margins to absolute values lower than

TABLE 6. Policy Exposure of Companies: Sales Shares in Policy-Affected Segments

Company	Segment	$Policy_j$
Kapchorua Tea Kenya Plc	Tea	0
Kenya Orchards Plc	Horticulture	0
Limuru Tea Company Limited	Tea	0
Williamson Tea Kenya Plc	Tea	0
Uchumi Supermarkets Plc	All	0.11
Kakuzi Plc	Coffee, Horticulture, Tea	0.18
Sasini Plc	Coffee, Horticulture, Tea	0.17
Rea Vipingo Plantations Limited	Sisal, Cotton Spinning	0.40
Eaagads Limited	Coffee	1
East African Breweries Limited	Beer and beverages	1
Mumias Sugar Company Limited	Sugar from cane	1
Unga Group Plc	Maize milling, Wheat production, Poultry feeds and Animal health	1

4.5 per cent (which is broadly a 1 per cent trim at the top and bottom). Results remain robust to this, though with slightly smaller coefficients.

TABLE 7. Profit Margins of Listed Firms by Specialisation in Policy-Affected Crop Segments

	Dependent Variable: Profit Margin$_{jt}$ = (Profit Before Tax/Revenue)$_{jt}$					
					|Margin| < 0.45	
	(1)	(2)	(3)	(4) Weighted	(5)	(6) Weighted
$Post_t \cdot Policy_j$	0.149**	0.153**	**0.148****	0.264**	0.151***	0.239***
	(0.065)	(0.061)	**(0.065)**	(0.052)	(0.045)	(0.067)
$Post_t$	-0.098**	-0.087*				
	(0.045)	(0.044)				
$Policy_j$	-0.031					
	(0.049)					
Constant	0.064*					
	(0.031)					
Company FE α_j	No	Yes	Yes	Yes	Yes	Yes
Year FE α_t	No	No	Yes	Yes	Yes	Yes
N	99	99	99	99	96	96
Ncompanies	12	12	12	12	12	12
R^2	0.039	0.230	0.352	0.662	0.462	0.763

Standard errors clustered by company j in parentheses. Columns 4 and 6 are weighted by company sales.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

At the mean policy exposure level of 0.33, the estimated rise in profits is 5 per cent (unweighted) to 9 per cent (weighted) greater for agribusinesses specialising in the policy crops. We conclude that the shift to an agribusiness model reallocated profits away from farmers towards agribusiness firms. It is striking that despite an expansion in market size for private-sector firms, incumbent agribusinesses saw a rise in profit margins after the policy shift.

4.4. **Household Welfare.** Proposition 2 explains that households with a comparative advantage in policy crops would have a greater income dependence on these crops and experience a greater reduction in income. We therefore examine household level outcomes by their comparative advantage in policy crops.

Comparative advantage in policy crops can be measured following a growing literature that uses agroecological data from FAOSTAT to define the potential yields across crops based on soil, weather and other climactic conditions of the area (example, Nunn and Qian 2011). FAOSTAT provides data on potential yields for major crops of the world since the 1960s. This covers 35 crops from our sample, which make up 88 per cent of all farm incomes which can be mapped on to 90 per cent of households (who make up 92 per cent of farm incomes).

The finest level of geographical disaggregation at which we can map households in our sample is the village. There are 107 distinct villages which can all be mapped on to the FAO potential yield data. We use the mean potential yields for rain-fed, low input use agriculture for the 1961-2000 baseline of FAOSTAT for all available crops in each village. As discussed in the theoretical section, cropping choices depend on the price and productivity of households ($p\varphi$). For each village, we construct the difference in potential yield values across policy and other crops as

$$Potential\,Yield_v \equiv \sum_{c \in Policy\,crops} p_c \varphi_{cv} - \sum_{c \in Other\,crops} p_c \varphi_{cv}$$

where p_c is the world price of crop c and φ_{cv} is its mean potential yield in village v. We categorise villages into those with above and below median $Potential\,Yield_v$, and CA_v is an indicator for villages with above median $Potential\,Yield_v$. Proposition 2 can therefore be operationalized as a DiD regression comparing household outcomes in villages based on their comparative advantage in policy crops CA_v.

For outcome Y_{hvt} of household h in village v at time t, the DiD can be implemented as a regression through the following specification:

$$Y_{hvt} = \beta_0 Post_t CA_v + \alpha_h + \alpha_t + \varepsilon_{hvt} \tag{4.2}$$

Year fixed effects α_t account for common year shocks while household fixed effects ensure we are comparing changes in outcome Y within a household. The LHS outcomes are total net income (income from farming, businesses and livestock, net of fertiliser and land preparation costs) and various measures of household consumption to determine the welfare impacts of the policy shift.

Total net income provides a summary measure of the household's economic position for the year. To capture the welfare implications of the income decline from policy crops, we use survey responses on household purchases and assets to gauge the extent to which household consumption was affected by the policy shift. The survey contains two key sources of consumption data – expenditures on fruit and vegetables based on monthly recall which is available for 2004 and 2007 but not 2000 (*Expenditure*) and values of assets owned by the household in each survey year (*Asset*).

Expenditures on fruit and vegetables have the advantage that they are unlikely to be Giffen goods, but they are likely to capture just a small share of overall household consumption or welfare. In contrast, assets represent a large share of households' lifetime consumption but they miss out on essential services like education and health expenditures which are important for welfare of low-income households. Therefore, we supplement the income, expenditure and asset variables with survey responses to credit needs of households later.[12]

TABLE 8. Household Income from Policy-Affected Crops and Consumption Patterns by Comparative Advantage of Household's Village

	Total Net Income ('000)			Fruit & Veg Expenditure ('000)			Assets ('000)		
	Pre	Post	Post-Pre	Pre	Post	Post-Pre	Pre	Post	Post-Pre
CA Villages	104.7	75.9	-28.8	1.6	2.3	0.7	163.9	143.2	-20.7
			(6.6)			(0.1)			(9.0)
Other Villages	68.6	55.5	-13.1	1.9	2.3	0.5	129.6	140.5	10.9
			(5.3)			(0.2)			(6.7)
			DiD			**DiD**			**DiD**
CA-Other	36.0	20.4	**-15.6**	-0.3	-0.1	**0.2**	34.3	2.7	**-31.6**
	(12.6)	(13.5)	**(8.4)**	(0.2)	(0.2)	**(0.2)**	(19.9)	(20.4)	**(11.1)**

Standard errors clustered by village v in parentheses.

[12]Asset refers to the current purchase price of the asset as is or the current market value of the asset as it is. It includes the value of (residential), bicycle, stores, motorcycle, poultry , car, piggery , truck, zero-grazing units, tractor, wheel barrow, trailer, chaf cutter, ploughs for tractor, radio, harrow/tiller, TV, ridger/weeder, solar panels, planter, battery, boom sprayer, land line telephone, sheller, mobile phone, combine harvester, weighing machine, generator, pestle and mortar, power saw, water tanks, grinder, beehive, jaggery unit, water pump, cane crusher, borehole, donkey, dam, oxen, well, animal traction plough, irrigation equipment, cart, cattle dip, spray pump, water trough and other specified assets.

Table 8 shows summary statistics for total net income before and after the policy shift by comparative advantage of villages to which the households belong. Following from the household-crop level income results reported earlier, the household-level results show that the policy shift lowered total net household income from policy crops by 28.8 ('000 Ksh) in comparative advantage villages, compared to 13.1 in other villages. Comparative advantage villages have higher household incomes as well as bigger income losses from the policy shift, as expected. The DiD estimate is an average fall of 15.6 for CA villages, compared to other villages, which is 15 per cent of the mean of total net incomes for CA villages. For the period before the policy shift, the DiD estimate from 2000 to 2004 is reassuringly smaller in magnitude and statistically insignificant (-9 with a standard error of 5.5).

To interpret the magnitudes of these findings, it is useful to put it in the context of rural household incomes from the World Income Inequality Database. In 2005, mean consumption of rural households in Kenya was USD 1,176 (WIID/KIHBS consumption data). The Ksh/USD exchange rate is about 100, so the loss is about USD 288 and USD 131 in CA and Other villages, which amounts to a DiD estimate which is 13 per cent of mean annual consumption. (We do not have a comparable consumption variable in the survey).

Accounting for fixed effects and regressing incomes from policy crops on a $Post_t$ indicator, there is an overall reduction of 22,600 Ksh in total net incomes after the policy shift. Including $Post_t \cdot CA_v$ in the regression to estimate equation 4.2, Column 1 of Table 9 shows the incomes losses are concentrated in villages with a comparative advantage in policy crops. Households in CA villages see their incomes from policy-affected crops decline by 18,700 Ksh more than households in other villages. Trimming the top and bottom 1 per cent of observations lowers the coefficient because the outliers at the top have very high incomes.

Table 8 shows expenditure on fruit and vegetables does not vary systematically across villages by comparative advantage and nor does it move much after the policy shift. Column 3 of Table 9 confirms this finding. In contrast, asset purchases fall in comparative advantage villages by over 20,000 Ksh compared to a rise of over 9,000 Ksh in other villages, as shown in Table 8. There are a few outlier values (with greater than 3.5 million Ksh) in assets, which are trimmed to ensure that results are not driven by their large values. Columns 5 and 6 of Table 9 show estimation results for equation 4.2 with and without the top trim. On average, total assets fall by 24,740 Ksh, which suggests a much bigger dampening of asset purchases from the reduction in incomes.

TABLE 9. Income and Consumption of Households by Comparative Advantage in Policy-Affected Crops

	Total Net Income		Fruit & Veg Exp		Assets		Ed/Med/Hh
	(1)	(2) Trim	(3)	(4) Top trim	(5)	(6) Top trim	(7)
$Post_t \cdot CA_v$	-18.70**	-10.20**	0.35	0.42	-32.63	-24.74**	0.08**
	(7.62)	(5.28)	(0.38)	(0.38)	(23.71)	(11.61)	(0.03)
Household FE α_h	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE α_t	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3,540	3,533	2,378	2,372	3,539	3,533	3,540
Nhouseholds	1,227	1,213	1,189	1,186	1,227	1,225	1,227
R^2	0.743	0.816	0.704	0.641	0.899	0.713	0.426

Standard errors clustered by village v in parentheses.

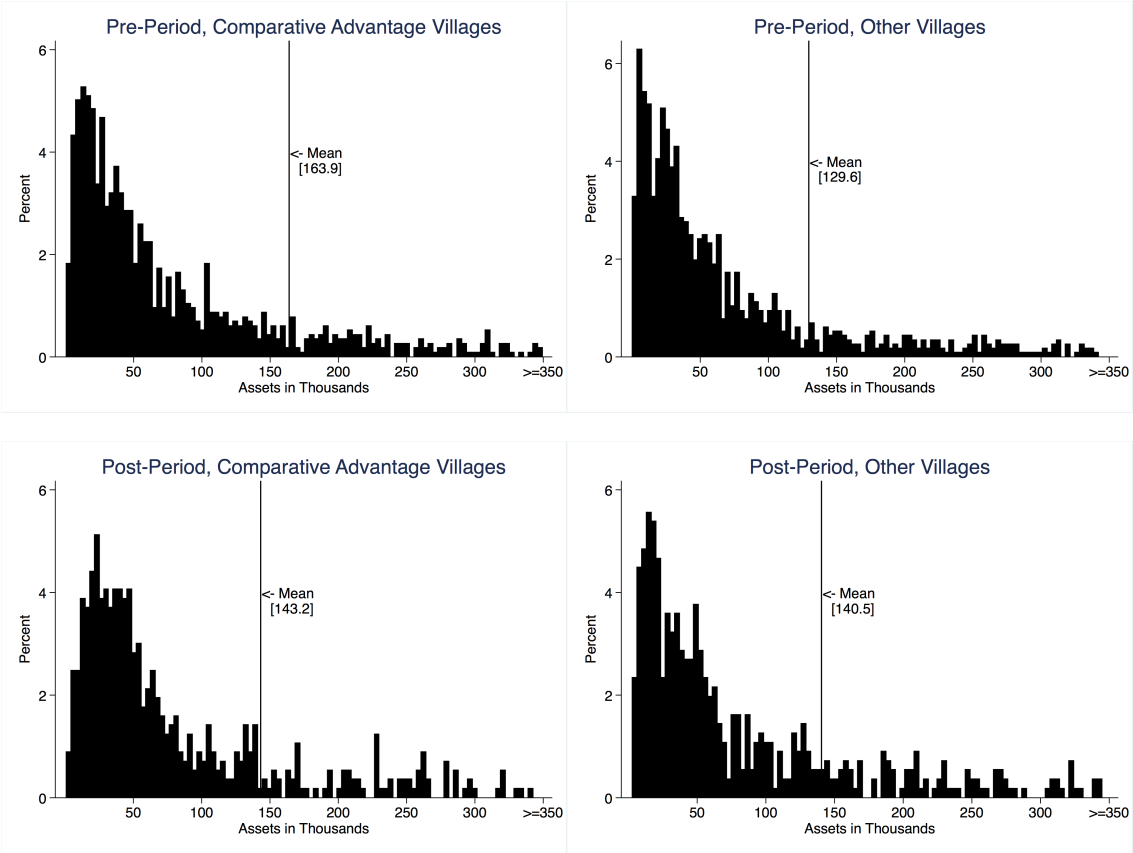
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Column 4 shows expenditures on fruit and vegetables for the trimmed sample for comparability. The DiD estimate for the pre period from 2000 to 2004 is -0.4 (0.5) for fruit and vegetable expenditures and 10.1 (15.0) for assets.

The asset estimates need to be interpreted with caution. They do not necessarily mean that households are permanently poorer by this amount, rather it shows a bigger divestment effect in assets which include durable consumption like bicycles and houses as well as income-generating assets like agricultural equipment. Large investment responses are similar to Brooks and Donovan (2017) which finds that Nicaraguan households who gained about C$380 in labour market earnings from bridge construction invested much more - over C$650 - in agricultural inputs. Finally, Figure 4.3 enables visualisation of the entire distribution of assets across villages by comparative advantage. There is a leftward shift in the distribution of assets across households in comparative advantage villages, but a slight rightward shift in other villages.

Households in the survey were asked if they tried to obtain credit and the purpose for which this was sought. We define $Credit_{hvt} = 1$ if the household responds affirmatively to having sought credit for the purposes of school fees, medical or household consumption. A caveat is in order, however, because the wording of the credit questions are slightly different in the 2007 survey where the purpose of credit was recorded for credit obtained. That being said, as long as the difference in responses due to the changed wording are similar across villages, the DiD would be informative of changes in credit needs arising from the policy shift. The fraction of households requiring credit rises from 0.14 to 0.28 in comparative advantage villages, and from 0.18 to 0.24 in other villages. Estimating equation 4.2, Column 7 of Table 9 shows that there is an 8 per

FIGURE 4.3. Household Assets by Comparative Advantage of Villages, Before and After the Policy Shift



cent higher likelihood of seeking credit for education, medical and household needs in comparative advantage villages, compared to other villages.

Proceeding as earlier, we can examine how welfare measures differed across households who sell to agribusinesses relative to others. Let $Agribusiness_h = 1$ if household h sells policy crops to agribusinesses in the periods before and after the policy shift. Then equation 4.2 can be extended as follows:

$$\begin{aligned} Y_{hvt} =& \beta_0 Post_t CA_v + \beta_1 Post_t CA_v Agribusiness_h \\ &+ \gamma_0 Post_t Agribusiness_h + \alpha_h + \alpha_t + \varepsilon_{hvt} \end{aligned}$$

and β_1 would be the additional welfare impact on households who continue to sell to agribusinesses. Table 10 shows that β_1 does not turn out to be statistically different from zero. Even though households selling to agribusinesses suffer larger crop level

income losses, they have much higher incomes and other sources of funds so that their consumption does not suffer much more.

TABLE 10. Income and Consumption of Households by Agribusiness Purchases and Comparative Advantage

	(1) Total Net Income	(1) Fruit & Veg	(2) Assets	(3) Ed/Med/Hh Credit
$Post_t \cdot CA_v$	-17.56**	0.53	-24.40**	0.07**
	(7.93)	(0.38)	(11.87)	(0.04)
$Post_t \cdot CA_v \cdot Agribusiness_h$	-12.88	-1.11	-17.67	0.08
	(21.33)	(0.82)	(54.48)	(0.14)
$Post_t \cdot Agribusiness_h$	11.87	-1.20**	-9.63	0.01
	(7.39)	(0.58)	(15.62)	(0.07)
Household FE α_i	Yes	Yes	Yes	Yes
Year FE α_t	Yes	Yes	Yes	Yes
N	3,540	2,372	3,533	3,540
Nhouseholds	1,227	1,186	1,225	1,227
R^2	0.642	0.642	0.713	0.426

Standard errors clustered by village v in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Summing up, overall household incomes fall more in villages with a comparative advantage in policy crops. These households are still able to afford similar levels of their daily food expenditures but their big ticket purchases suffer. The value of the assets they own falls much more and there is some evidence suggesting that their credit needs for education, health and household consumption rises. Therefore, many low-income rural households experience a decline in welfare after the shift in policy to an agribusiness model in crop markets.

5. Conclusion

Policies to encourage agribusiness-led development of crop markets have often been proposed as a way of raising agricultural productivity and reducing poverty. A number of proposals are on the table in several countries to adopt such policies. Yet there is limited evidence on the impact of these policies on low-income farming households.

Theoretical work has shown that farmers can lose out from policies to promote intermediation when entering intermediaries have greater market power. This paper applies this insight to policies to promote agribusiness entry into crop markets. Taking the theory to data from Kenya, the paper shows that Kenyan households experienced a greater reduction in incomes from crops that saw a shift from state to agribusiness-led intermediation in farming.

As state companies withdrew from intermediation to make way for agribusinesses, profit margins of agribusiness firms specialising in the policy-affected crops grew much more than those of firms specialising in other crops. Despite policies to increase competition, large agribusiness firms that specialised in the policy crops saw a 5 to 8 per cent greater increase in their profit margins. The policy shift therefore raised firm profits at the expense of farm incomes for households.

Overall incomes and consumption of households fell, and the income losses were concentrated in villages specialising in the policy-affected crops (owing to greater comparative advantage from agroecological factors). Households in villages with a comparative advantage in policy-affected crops saw bigger overall income losses, with the difference being equivalent to 13 per cent of average annual consumption of rural households in Kenya. These households adjusted to the income loss by drawing down on the value of the assets that they owned.

To sum up, the results provide evidence for long-standing concerns in the literature that commercialisation of agriculture, via agribusinesses that wield monopsony power, need not raise income earning opportunities for small farmers. The results also confirm the lesson taken by the Kenyan government from this experience. In the revised version of their agricultural strategy in 2010, policymakers reflected on how smallholder farmers could suffer when "liberalisation is carried out where there is no critical mass and enough capacity for the private sector to grow" (ASDS 2010). As long panels start to evolve, further work can provide a better understanding of the conditions that can enable agribusiness intermediation to translate into productivity gains for low-income farmers.

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Appendix

Equilibrium. To ensure that there is more than one entrant in the market for policy crops, we make the following assumption in terms of primitives:

Assumption: Entry costs are low enough for at least one firm to enter. Specifically, $N \geq 1$ *if* $Fk^{k-1}/\left(k-1\right)^{k-2} \leq \left(\left(1-\kappa\right)pm + \kappa p_s\right)^k \varphi_{\min}^k$.

This condition can be seen from the optimal pricing and free entry equations 3.5 and 3.6. Solving for the equilibrium number of firms providing trading services,

$$(N(k-1))^{k-2}(N(k-1)+1)^{-k} = F((1-\kappa)pm + \kappa p_s)^{-k}/k\varphi_{\min}^{k}.$$

The LHS of this equation is always decreasing in $N(k-1)$. We therefore get a unique equilibrium value for the number of firms, which can be substituted into the other equilibrium conditions. To ensure positive intermediary prices, we also assume $pm > \kappa p_s/(1-\kappa)(k-1)$ to keep the problem interesting.

Summary Statistics.

TABLE 11. Household-Crop-Season-Time Summary Statistics

	Obs	Mean	S.D.	Min	Mdn	Max
$Income_{cghst}$('000)	21247	8.94	45.56	0.0	1.07	2915
$Post_t$	21247	0.32	0.47	0	0	1
$Policy_g$	21247	0.21	0.41	0	0	1
$Fall_{ct}$	21247	0.18	0.41	0	0	1
$World\,Price_{ct}$(USD)	20458	0.57	0.49	0.05	0.37	4.10
$ShareSpoil_{cst}$	21247	0.003	0.01	0	0	0.29
$Agribusiness_{chst}$	21247	0.04	0.21	0	0	1
$Agribusiness_{ch}$	21247	0.01	0.11	0	0	1

TABLE 12. Household-Time Summary Statistics

	Obs	Mean	S.D.	Min	Mdn	Max
$Total\,Net\,Income_{ht}$ ('000)	3540	79.87	213.98	-43.70	34.82	6574
$Fruit\,\&\,Veg\,Expenditure_{ht}$	3540	1.96	3.39	0	0.95	84.37
$Assets_{ht}$ ('000)	3539	164.16	687.97	0.60	54.15	31378
$Ed/Med/Hh\,Credit_{ht}$	3540	0.19	0.39	0.00	0	1
CA_v	3540	0.51	0.50	0	1	1
$Agribusiness_h$	3540	0.07	0.25	0	0	1

5.1. **Trader Prices.** Proposition 1 shows that income losses arise for relatively inefficient traders. This can be written in terms of trader and state prices as $p_i/p_s < \frac{N(k-1)-\kappa/(1-\kappa)}{N(k-1)+1}$. To empirically examine this condition, we specify the price paid to farmers as $\ln Price_{cghst} = \beta Trader_{cghst} + \alpha_t + \alpha_{cs} + \epsilon_{cghst}$ for prices received for policy crops sold by households to small traders or state companies in the period before the policy shift.

Column 1 of Table 13 shows prices paid by traders are 64 per cent lower than those paid by state companies, on average. Controlling for time dummies and crop-season dummies, quantile regressions of prices received by farmers show a similar picture, with trader prices being 82 per cent lower at the median, 53 per cent lower at the 25th percentile and 74 per cent lower at the 75th percentile. Trading prices are therefore substantially lower than those paid by the state, which suggests that the condition for income losses is met in our empirical setting.

TABLE 13. Prices of Small Traders and State Companies in Policy-Affected Crops in 2000 and 2004

	Dependent variable: Log of Price$_{cghst}$ Paid for Crop			
	(1) OLS	(2) Q50	(3) Q25	(4) Q75
$Trader_{cghst}$	-0.637**	-0.823**	-0.531***	-0.742***
	(0.280)	(0.064)	(0.147)	(0.040)
Crop-Season FE α_{cs}	Yes	Yes	Yes	Yes
Year FE α_t	Yes	Yes	Yes	Yes
N	2,047	2,052	2,052	2,052
R^2/Pseudo R^2	0.203	0.213	0.206	0.310

Standard errors in parentheses, clustered by crop in Column 1.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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