THE RISE OF AGRIBUSINESSES AND ITS DISTRIBUTIONAL CONSEQUENCES

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Abstract. Crops are often modelled as homogenous products that are exchanged in perfectly competitive markets. While this may be true of world commodity markets, smallholder farmers face high trade barriers in selling their crops at home and abroad. Selling to agribusinesses with better intermediation technologies can enable smallholder farmers to overcome these barriers. This has provided a rationale for policies encouraging agribusinesses. We document the reliance of farmers on intermediaries and find that farmers selling to agribusinesses differ systematically from others. We incorporate these stylised facts into a flexible theoretical framework to study the aggregate and distributional consequences of the rise of agribusinesses. The rise of agribusinesses brings productivity gains to farmers, but it also skews the distribution of buyers of farm produce towards larger firms with greater buyer power. Taking the theory to data, we quantify behind-the-border barriers to trade embedded in a national policy which encouraged agribusiness participation. We combine this with microdata on household-crop incomes and find that the policy led to a reduction in incomes of small farmers. Losses were concentrated among farmers who sold to agribusinesses and in villages with a comparative advantage in policy-affected crops. On average, their incomes fell by 6 per cent with no offsetting gains in non-farm channels of income. Profit margins of agribusinesses specialised in policy-affected crops rose, in line with the theoretical channel. The findings contribute to the academic and policy debate on the impacts of integration and market power on the size and distribution of the welfare gains from trade.

JEL Codes: F1, F6, Q1, O1.
Keywords: Agribusiness, market power, intermediated trade, middlemen, oligopsony.

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1. Introduction

Trade rarely takes place directly between producers and final consumers of products. 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. There are few examples where the role of intermediation takes on greater significance for economic welfare than in agricultural markets faced by smallholder farmers (Antras and Costinot 2011).

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. 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 trade barriers in selling their crops to markets at home and abroad. 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 directly access world markets for their produce. They face large behind-the-border barriers to trade and sell through intermediaries such as traders, cooperatives and agribusinesses.

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. 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 (UNCTAD 2009). The rise of agribusinesses has provided a way of reducing the barriers that farmers face when accessing markets for their crops. Policies to encourage agribusiness-led development of crop markets are high on the agenda of many policy-makers. For example, under the New Alliance with high-income countries, ten countries in Africa have taken on commitments to reform legislations for seeds, land, contract enforcement, and taxes to ease consolidation and operation of large commercial farms. Many of these investments are for non-food crops, including cotton, biofuels and rubber, or for projects explicitly targeting export markets. More recently, India has introduced policies that provide a legal basis for contract farming across the country, with the aim of developing a national market for commodities and boosting the country's agricultural exports.

These market reforms and agribusiness policies are expected to stimulate growth in smallholder agriculture through better technology and market development. They therefore provide the potential to lift millions of low-income households out of poverty. However, after decades of such policies being tried, there is growing concern that much of agriculture, especially in the poorest parts of the world, has shown few signs of the radical transformation that was hoped for. Market reforms could have contributed to creating a dual structure in farming activities, with few large agribusinesses that have the scale and capital to access world markets and many small farmers who continue to face low yields, low prices for their produce or high barriers to market access. While case study evidence on either side of the debate abound, systematic analysis of agribusiness-led development of crop markets is remarkably thin despite widespread plans for agribusiness policies across the world.[1]

This paper examines the welfare impacts of the rise of agribusinesses and policies to encourage agribusiness-led development of crop markets. Deploying a high-quality panel of farming households, we first document that agribusinesses now make up a significant share of sales by farmers in many countries. The data underscore the reliance of farmers on intermediaries and shows that farmers selling to agribusinesses differ systematically from others. In particular, farmers who sell to agribusinesses are larger in terms of income and often acreage. We incorporate these stylised facts into a flexible theoretical framework to study the aggregate and distributional consequences of the rise of agribusinesses. The model features comparative advantage and heterogeneous farmers who sort into different types of intermediaries. Agribusinesses provide farmers with productivity gains that raise their marketable surplus. However, the rise of agribusinesses also skews the distribution of buyers of farm produce towards larger firms with greater buyer power. This gives rise to a policy tradeoff whereby policies to encourage agribusiness participation raise farmer welfare through productivity gains and better access to crop markets. But they result in a distributional tension from increased buyer power when entry responses are muted due to investment outlays, which raises the endogenous market size per agribusiness after the policy change. The effects are particularly pronounced in areas that have a comparative advantage in policy-affected crops because of their greater reliance on the crops.

The model therefore provides rich but tractable general equilibrium comparative statics which enable applications to real-world data. A large theoretical literature has examined the role of intermediaries in the gains from trade, but the focus has been on modelling the microfoundations of intermediation, which are difficult to apply to large-scale data (such as national surveys of households and firms) that are typically available for analysis

[1]See surveys by Barrett and Mutambatsere (2008), Collier and Dercon (2014), Dillon and Dambro (2017)

in international trade. The theoretical framework overcomes this problem by drawing on advances in monopolistic competition models of international trade (Melitz and Redding 2015), generalising them to intermediation and oligopsonistic market power of intermediaries, and embedding them in an economy where comparative advantage across different crops determines cropping patterns, intermediary decisions and welfare impacts of policies on intermediated trade.

The theory is applied to examine real-world impacts of large national-level policies to encourage agribusiness participation. This has been rare due to severe measurement and application challenges associated with agribusinesses in particular, and behind-the-border barriers to trade, more generally. We alleviate the measurement challenges by codifying policies for behind-the-border barriers to trade with agribusinesses (BTBs, for brevity). The national policy we examine changed different types of BTBs and covered the vast majority of crop markets in an economy (Kenya) that is largely reliant on agriculture. The policy lends itself well to codification for various reasons. First, it maps directly onto the number of sections of legislation repealed, mostly related to easing of investment and licensing requirements for intermediaries. Second, it is comprehensively documented in legal texts which were changed quickly within a couple of years to introduce new parliamentary acts. We personally read every law and categorized it by the stage of activity and the number of sections changed in the legal text.

Being a comprehensive and economically significant policy, it enables empirical examination of the welfare impacts of the rise of agribusinesses. Exploiting variation in policy changes across different crops, we find that removal of BTBs raised the likelihood of farmers selling the policy-affected crop to agribusinesses. Microdata on household-crop incomes of farmers and profit margins of agribusiness firms (which are compiled manually from company accounts) show that the BTB policy led to increased profit margins for agribusinesses and reduced crop incomes for households that sold the policy-affected crops to agribusinesses. On average, profit margins went up by about 5 per cent among agribusinesses who specialised in policy-affected crops, compared to other agribusiness firms. The policy affected incomes of farmers selling to agribusinesses in villages with a comparative advantage in the policy-affected crops. These farmers saw a 6 per cent reduction in their overall farm incomes, which translated into lower asset ownership or durable consumption. It did not however affect non-durable consumption or non-farm activities like labour force participation and business enterprises. Overall, the policy of reduced barriers for agribusiness operations partially reversed itself because farmers became less likely to sell to agribusinesses a few years after the BTB policy change.

The rest of the paper is organized as follows. After connecting our findings to other strands of the literature, Section 2 documents stylised facts on intermediation by agribusinesses. Section 3 embeds the stylised facts in a theoretical framework which determines cropping, intermediation and comparative statics for welfare. Section 4 goes from the theory to an empirical model. Section 5 discusses the data sources and presents the empirical results. Section 6 concludes.

Related Literature. We build on a nascent strand of the literature in international trade that seeks to model and quantify behind-the-border barriers to trade. In their Handbook chapter, Bown and Crowley (2016) highlight that despite their increasing importance for policymakers or negotiators, research on BTBs remains highly underdeveloped. Unlike tariffs and border barriers (for example, Conconi et al 2018), there are no comprehensive data sets on BTB policies. Non-tariff barriers to trade, including BTBs, are notoriously difficult to measure even in settings where data constraints are less binding, such as trade in industrial goods among developed countries. Our empirical setting is unique in terms of coverage and depth of non-tariff barriers, and the findings contribute to theory and empirics on the welfare consequences of behind the border policies.

The paper connects to a growing literature that has examined 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 key 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. Modelling progress has been made to study various policy scenarios for intermediated trade (for example, Tomar 2018, Bergquist et al. 2019, Chatterjee 2019), but theory and evidence on agribusinesses remains scarce.

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 consumers of products sold by imperfectly competitive intermediaries. As imported products still make up small shares of consumption baskets of many low-income households, our theoretical and empirical analysis apply to much larger welfare outcomes as they pertain to the bulk of income-generating activities of low-income households.

On the income side, a large body of work in development and agricultural economics has examined farmer-buyer interactions. Much of this analysis has focused on specific crops and experimental evidence which usually precludes analysis of large firms and national policy changes. Recent work has examined the role of trade in farming (for example, Dippel et al. 2016, Bustos et al. 2020, see Atkin and Khandelwal 2019 for a survey) and we contribute to this literature by examining agribusinesses. In terms of large firms, Dragusanu and Nunn (2020) and Macchiavello and Morjaria (2020) examine the farmer-mill link in coffee production. We focus instead on agribusinesses and policies to encourage their participation.

2. Stylised Facts

In this section, we highlight two key stylised facts about intermediation in crop markets for smallholder farmers. The facts are drawn from the World Bank's Living Standard and Measurement Surveys for panels of households from Ethiopia (2004, 2006) and Malawi (2010, 2013, 2016) and from the Rural Household Survey of Kenya (2000, 2004 and explained in more detail later).

2.1. **Stylised Facts.**

1. Small farmers often piggy-back on agribusinesses and other intermediaries to sell their produce in crop markets at home and abroad. Since the rise of supermarket chains, agro-industrialization, and export-oriented reforms, there has been a substantial increase in contract farming and outgrower schemes between agro-industrial firms and farmers in low-income countries. Table 1a shows the share of different buyer types for the pooled sample of 6,695 households growing 87 distinct crops with 19,203 distinct household-crop observations in Ethiopia (2,459 households), Malawi (2,770 households) and Kenya (1,466 households) over the last two decades. Over four-fifths of farm sales are made to intermediaries, including cooperatives, traders and agribusinesses. Agribusinesses now constitute about a sixth of crop sales by farmers. Table 1b focuses on Kenya for which we have a panel spanning over a decade. Agribusinesses grow from having less than a fifth to double of that in terms of market share in crops sales of small farmers (with less than fifty acres of land).

The broad facts are supported by case study evidence which documents a trend towards globalization in agriculture over the years. Examples of the rise of agribusinesses in smallholder farming include potato farming for Pepsi Co in Punjab, tobacco production for the British American Tobacco company, contract farming in Senegalese groundnut production, vegetable farming for European supermarkets by farmers in Madagascar, production for supermarket supply chains in Latin America, Asia and Africa, commercial farming of

TABLE 1. Facts 1 and 2: Intermediation and Agribusinesses in Crop Markets

(A)

Buyer types	Market share of Buyer Type %
Consumer	19.83
Cooperative	21.90
Trader	43.72
Agribusiness	14.55

(B)

Year	Market share of Agribusiness in Kenya %
2000	19.8
2004	21.5
2007	21.5
2010	37.8

(C)

Buyer types	Farm Income (Constant USD)	Farm Area (Acres)
Sell to Agribusiness (894)	1,708	7.6
Sell to Other Buyers (8695)	569	4.2

export crops in Kenya and commercial farming of cash crops like sugar, cotton and tea in Europe and Central Asia, contract farming of high-value crops (such as strawberries, melons and frozen vegetables) between Mexican farmers and agribusinesses that export to the United States and pineapple and banana farming in Central America for exports to the United States and Europe.[2]

2. Farmers selling to agribusinesses have higher incomes and larger farms. A less well-documented fact is that farmers who sell to agribusinesses have higher incomes and larger farms. Table 1c shows that the 894 households that sell to agribusinesses in the pooled sample have an average farm income of USD 1,708 per year (in 2010 values), compared to USD 569 for the 8,695 households that do not sell to agribusinesses at all. Farmers selling to agribusinesses have, on average, 7.6 acres of land, compared to 4.2 for households that sell to other buyers.

Following the vast literature on exporter premia, these patterns can be examined more systematically by regressing income (or acreage) on buyer type. Table 2 documents the premia for households who sell to agribusinesses. Columns 1 and 2 of Table 2 regress household incomes and acreage respectively on an indicator for whether the household sell crops to agribusinesses. Farmers who sell to agribusinesses have farm incomes that are 109 per cent higher and acreage that is 43 per cent larger, than those for farmers who do not engage with agribusinesses. Columns 3 and 4 regress crop income and crop prices received by the farmer on an indicator for whether the farmer sold that crop to an agribusiness. Even at the household-crop level, we find that farmers who sold to

[2]For case studies, see Runsten 1994, Goodman and Watts 1997, Warning and Key 2002, Robbins and Ferris 2003, Reardon and Timmer 2007, Minten et al. 2009, Minot 2011.

agribusinesses have substantially higher incomes (Acreage is not always available at the household-crop level). However, prices do not show statistically significant differences across farmers by buyer type.

TABLE 2. Fact 2: Premia for Farmers Piggy-backing on Agribusiness

	(1) $\ln Income_{ht}$	(2) $\ln Acreage_{ht}$	(3) $\ln Income_{cht}$	(4) $\ln Price_{cht}$
Sold to Agribusiness	1.0932***	0.4294***	0.6891***	0.0570
	(0.0603)	(0.0434)	(0.1446)	(0.0953)
Crop-Country-Year FE	No	No	Yes	Yes
Country-Year FE	Yes	Yes	No	No
N	9507	9482	23399	23399
R^2	0.183	0.0153	0.338	0.563

The dependent variable in Column 1 is the income from all crops of household h in year t, acreage of fields of household h in Column 2, income from crop c in Column 3 and price received for crop c in Column 4. The RHS is an indicator for selling to agribusinesses which is A_{cht} for crop c and $A_{ht} = \max_c A_{cht}$ for the household. Agribusiness is defined as private company/business in the World Bank LSMS for Ethiopia and Malawi (distinct from local merchant/trader/parastatal/market), and as large company/miller/processor/exporter in the Rural Household Surveys of Kenya. Country-year fixed effects are included in Columns 1 and 2, while crop-country-year fixed effects are included in Columns 3 and 4. Standard errors are clustered by households in parentheses in Columns 1 and 2 and by crop in Columns 3, 4 and 5. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The vast majority of crops grown by farmers also show up in the world trade database as an export of the country. Almost all sales to agribusinesses are of crops that are exported by the country. Including an indicator for export crops and its interaction with the indicator for selling to agribusinesses, the income premia is estimated to be 96 per cent at the household level and 87 per cent at the household-crop level.

3. From Stylised Facts to Theory

This sub-section develops a theoretical framework to embed the stylised facts above into the microstructure of intermediation in crop markets to examine the welfare impacts of agribusiness-led development of crop markets. We determine cropping patters, intermediation decisions and comparative statics of welfare to various policies like, increased integration and agribusiness-led development of crop markets.

The model considers a small open economy that takes world crop prices p_c as given. The small open economy consists of villages which are characterised by a productivity distribution for market crops. Farmers in the villages are endowed with units of land on which they can grow market crops or a consumption numeraire. They draw their productivity in market crops from the village productivity distribution. Farmers do not have direct access

to world crop markets and rely on intermediaries to sell their produce. Intermediation to take the produce to the market is provided by Traders and Agribusinesses who compete oligopsonistically. 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 policies to encourage agribusiness activities.

3.1. **Theoretical Framework.**

3.1.1. *Farmers.* There is a continuum of farmers in each village, indexed by i, with L_{iv} units of land each. Farmers have linear utility for a numeraire good and therefore maximize farm earnings.

Farmers draw their productivity φ_{cv} for market crop c per unit of land. The relative productivity vector φ_{cv} for each $c = 1, ..., L_{iv}$ is drawn from a Pareto productivity distribution $G_{cv}(\varphi) = 1 - (\varphi_{\min,cv}/\varphi_{cv})^k$ where $\varphi_{cv} \geq \varphi_{\min,cv} > 0$ and $k \geq 1$. Then comparative advantage of a village in crop c (relative to the consumption good) is reflected in higher values of $\varphi_{\min,cv}$. And inequality in the relative productivity of land (as measured by the Gini index for land productivity in market crops) is summarised by lower values of the Pareto shape parameter k.

Farmers observe their productivity vector and choose whether to plant market crops or the consumption numeraire for each unit of land. If they choose to grow market crops, they then decide whether to just trade their produce in the crop market or to engage with agribusinesses. Agribusinesses improve the quality of farmers' marketable produce. Obtaining quality gains requires investments by farmers, denoted by $f > 0$. As is standard in the international trade literature, this will generate the stylised fact of income premia for households selling to agribusinesses.

Let p_{tcv} denote the price that farmers receive from selling to traders (without engaging in agribusiness activities) and let p_{acv} denote the price received from agribusinesses. Then a farmer with productivity draw φ_{cv} chooses to grow crop c over the consumption good if

$$\varphi_{cv} \geq 1/p_{tcv} \equiv \varphi_{tcv} \tag{3.1}$$

where φ_{tcv} is the threshold productivity for choosing to grow crop c. Farmers choose to engage with agribusinesses for marketing crop c if

$$\varphi_{cv} \geq f/\left(p_{acv} - p_{tcv}\right) \equiv \varphi_{acv} \tag{3.2}$$

where φ_{acv} is the threshold productivity for choosing agribusinesses over traders. As long as agribusinesses pay more than traders $p_{acv} > p_{tcv}$ (which will be determined in equilibrium later), higher fixed investment costs would enable more productive farmers

to reap scale economies and sell to agribusinesses who provide quality gains that cannot be realised otherwise.

3.1.2. *Intermediaries.* As our focus is on the inability of farmers to access crop markets directly, village economies are assumed to be segmented so that farmers cannot arbitrage price differences across them. There are N_{cv} intermediaries of crop c in village v who provide trading services to farmers in a Cournot oligopsonistic fashion. Each trading firm pays an entry cost of F_T units of the numeraire consumption good to commence trading services. Profit from providing trading services to farmers is

$$\pi_{tcv} = (p_c m_{tcv} - p_{tcv}) q_{tcv} L_v$$

where p_c denotes the world price of crop c, $0 \leq m_{tcv} \leq 1$ is the intermediation productivity which acts like the inverse of an iceberg trade cost, p_{tcv} is the Cournot price paid to farmers by trading firms, q_{tcv} is the quantity sold to firm t (per unit of land) and $L_v \equiv \sum_i L_{iv}$ is the size of the village in terms of land available for farming (which is the sum of all units of farmland across all farmers in the village).

There are M_{cv} agribusinesses who incur entry costs F_A to compete in a Cournot oligopsonistic way in agribusiness activities, such as marketing, processing and exporting. Agribusinesses provide farmers with technical services to transform their produce into more marketable surplus through, for example, quality control, knowhow or processing facilities. Realising quality or productivity gains in marketable farm surplus is often a key motivation for agribusiness-friendly policies across the world. Let m_{acv} denote the productivity gain from engaging with an agribusiness. Profit from providing agribusiness services to farmers is

$$\pi_{acv} = (p_c (m_{tcv} + m_{acv}) - p_{acv}) q_{acv} L_v$$

where $0 \leq m_{acv} \leq 1 - m_{tcv}$ is the quality gain from agribusiness activities, p_{acv} is the price paid to farmers by agribusinesses and $q_{acv} L_v$ is the quantity bought by agribusiness a from all farmers in the village.

3.1.3. *Prices.* The price of trading services can be determined by solving for a symmetric Cournot equilibrium.

Firm t chooses quantity q_{tcv} that it buys from farmers to maximise profits π_{tcv}, taking the quantities of all other traders as given. From the first-order condition for profit maximisation, the optimal farmgate price equates the markdown on intermediated world prices paid by traders to the inverse of their perceived elasticity of supply:

$$(p_c m_{tcv} - p_{tcv}) / p_{tcv} = \partial \ln q_{tcv} / \partial \ln p_{tcv}.$$

The perceived elasticity of supply can be determined from the crop market clearing condition. The total demand for crops from all traders must equal the total supply of the crop in the market. The total quantity of crop c supplied by farmers in village v is

$$q_{cv}L_v = \int_{\varphi_{tcv}}^{\infty} \varphi L_v dG(\varphi) = \frac{k}{k-1}\varphi_{\min,cv}^{k} p_{tcv}^{k-1} L_v.$$

In equilibrium, $q_{cv}L_v = (q_{tcv} + q_{-t,cv}) L_v$ where $q_{-t,cv}$ denotes the average supply to all traders other than t. Taking $q_{-t,cv}$ as given, firm t's perceived elasticity of supply is

$$\partial \ln q_{tcv} / \partial \ln p_{tcv} = (k-1)(q_{cv}/q_{tcv}).$$

In a symmetric equilibrium, $q_{cv} = N_{cv} q_{tcv}$. Substituting for the latter and the perceived supply elasticity in the first-order condition for profit maximisation, the optimal trading price paid to farmers is

$$p_{tcv} = \frac{N_{cv}(k-1) p_c m_{tcv}}{N_{cv}(k-1)+1}. \tag{3.3}$$

In the standard benchmark case of perfect competition ($N \to \infty$), farmers receive the full world price, net of intermediation costs. A less apparent result is that a perfectly equal land distribution ($k \to \infty$) also results in the full world price (net of intermediation costs) being transmitted to farmers. This arises because prices no longer change the extent to which farmers alter their supply to intermediaries. When intermediaries are oligopsonistic (finite N and k), farmers receive a smaller share of the price net of trade costs, $p_{tcv} < p_c m_{tcv}$.

Proceeding similarly, the supply of crops to agribusinesses is

$$q_{acv} + q_{-a,cv} = \frac{k}{k-1}\varphi_{\min,cv}^{k} f^{-k+1} (p_{acv} - p_{tcv})^{k-1}$$

In a symmetric Cournot equilibrium, the price paid by agribusinesses to farmers, over and above the trading price, takes a similar form:

$$p_{acv} - p_{tcv} = \frac{M_{cv}(k-1)}{M_{cv}(k-1)+1} p_c m_{acv} \tag{3.4}$$

where $\frac{M_{cv}(k-1)}{M_{cv}(k-1)+1}$ is the markdown on the world price, net of agribusiness intermediation costs. As earlier, under perfect competition among agribusinesses or a perfectly equal land distribution, prices paid to farmers show full pass-through of the productivity gains from agribusiness activities. Outside of this benchmark, farmers receive a positive but marked down share of the productivity gains from investments to improve quality. We summarise these results in Remark 1 below.

Remark 1. *Prices received by farmers rise with the number of of traders and agribusinesses in the crop market. In the benchmark case of perfect competition among intermediaries or a perfectly equal land distribution, farmers receive the full world price (net of intermediation costs).*

3.1.4. *Entry.* Free entry of intermediaries ensures average profits are driven down to entry costs of trading, $F_T > 0$. Ignoring the integer constraint, free entry in trading services gives

$$\frac{k}{k-1}\varphi_{\min,cv}^{k}\left(p_c m_{tcv} - p_{tcv}\right)\varphi_{tcv}^{-k+1}L_v/N_{cv} = F_T \tag{3.5}$$

Similarly, free entry into agribusiness operations ensures average profit from agribusiness activities is driven down to the additional entry costs undertaken for these activities ($F_A > 0$),

$$\frac{k}{k-1}\varphi_{\min}^{k}\left(p_c m_{acv} - \left(p_{acv} - p_{tcv}\right)\right)\varphi_{acv}^{-k+1}L_v/M_{cv} = F_A \tag{3.6}$$

It can be shown that the LHS of both entry conditions is decreasing in the number of firms and ranges from zero to infinity, which ensures existence of a well-defined equilibrium. To ensure that the number of firms exceeds one, entry costs are assumed to be not too high to preclude entry into the crop market.[3]

3.1.5. *Equilibrium.* 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 3.1 and 3.2 , the pricing equations 3.3 and 3.4, and the free entry equations 3.5 and 3.6. Resource clearing is subsumed in these conditions, which together define the general equilibrium for the village economy given a set of world crop prices.

3.2. **Theoretical Results.** Having discussed the equilibrium conditions, this sub-section highlights key theoretical predictions regarding farm incomes, the gains from trade and behind-the-border barriers to trade. It then develops these theoretical predictions in terms of comparative statics across various crop markets than can be taken to the data in the next section.

3.2.1. *Incomes.* A farmer with L_i units of land and productivity vector φ earns $I_{iv} \equiv \sum_{c=1}^{L_i} I\left(\varphi_{cv}\right)$ in farm income where $I\left(\varphi_{cv}\right) = \max\left\{\max_{j\in a,t}\left\{p_{acv}\varphi_{cv} - f, p_{tcv}\varphi_{cv}\right\}, 1\right\}$ and prices are determined by the equilibrium pricing conditions. To understand the overall welfare gains across all farmers in a village economy, the model enables aggregation

[3]In terms of primitives, $F_T, F_A \leq \varphi_{\min}^{k}\frac{(k-1)^{k-2}}{k^{k-1}}\left(p_c m_{tcv}\right)^{k}$.

of individual welfare changes. In particular, aggregate welfare of farmers in village v is $I_v = \sum_i \sum_{c=1}^{L_i} \left(1 + \frac{\varphi_{\min,cv}^k}{k-1}\left(p_{tcv}^k + f^{-k+1}\left(p_{acv} - p_{tcv}\right)^k\right)\right)$ which includes the incomes earned from agribusinesses, traders and the consumption good. Clearly, increases in the prices received by farmers from traders and agribusinesses raise farm incomes but they are in turn determined by world prices, intermediation productivity and the number of intermediaries in the village. Equilibrium conditions from section 3.1.5 therefore need to be examined together to arrive at comparative statics for farm incomes and overall welfare. Remark 2 below summarises these key comparative statics.

Remark 2. *As long as $m_{acv}/m_{tcv} < f$, the highest productivity farmers sort into selling to agribusinesses. Medium productivity farmers sell to traders while the lowest productivity farmers sort into the consumption good. The number of intermediaries (N_{cv} and M_{cv}) and the incomes received by farmers rise with the intermediation productivities (or world prices) of market crops, the comparative advantage of the village in market crops $\varphi_{\min,cv}$ and the market size of the village L_v.*

We focus on characterising the comprehensive case where farmers selling to traders and agribusinesses co-exist, as in the stylised facts of Section 2 and under $m_{acv}/m_{tcv} < f$ in Remark 2 which ensures agribusiness and trader viability. Then the sorting pattern follows from equilibrium conditions which ensure $M_{cv} \leq N_{cv}$. This gives $\varphi_{acv} \geq \varphi_{tcv}$ because only farmers with high enough scale are able to incur the fixed costs of engaging with agribusinesses who provide an income premium from quality improvements. When fixed costs are low ($f < m_{acv}/m_{tcv}$), on the other hand, less productive farmers can also sell to agribusinesses and sorting does not arise.

Having solved for the equilibrium prices, entry and sorting, we examine key comparative statics for farm incomes, summarised in Remark 2. The first comparative static we consider is the welfare gains from trade, which can be interpreted as a rise in intermediation productivity for the economy (higher m_{acv}, m_{tcv} or both as they are equivalent to the inverse of standard iceberg transport costs). Higher intermediation productivity raises farm incomes directly through the rise in net world price which determines the size of the pie in each crop market. It also raises farm incomes indirectly because more intermediaries enter when net world prices are higher (assuming there are no further fixed or sunk costs to exporting, which will be discussed later). This can be seen from the optimal pricing and free entry conditions. Differentiating them with respect to intermediation productivity shows $d \ln N_{cv} = \frac{N_{cv}(k-1)+1}{2N_{cv}(k-1)-(k-2)}$ which is positive for all $N_{cv} \geq 1$. Analogous expressions arise for comparative statics of agribusiness entry M. As the size of the pie available in a crop market rises, more intermediaries enter the crop market and this results in higher prices for farmers due to increased intermediary competition. Therefore farmers

experience a rise in incomes through a direct increase in the size of the pie and an indirect increase in the share of the pie available to them.

A rise in intermediation productivity increases farmer income and results in overall gains from trade across all farmers in the village economy because

$$dI_v = \sum_i \sum_{c=1}^{L_i} \frac{\varphi_{\min,cv}^k}{k-1} \left(k p_{tcv}^k d\ln p_{tcv} + f^{-k+1} k \left(p_{acv} - p_{tcv}\right)^k d\ln\left(p_{acv} - p_{tcv}\right) \right).$$

The RHS contains prices paid to farmers, which rise directly and indirectly with better intimidation productivity. This results in overall welfare gains in the village. Intermediaries continue to make zero profits through free entry and increased entry offsets the rise in their ex post profits through the direct effect of an increase in the size of the pie.

Remark 2 also shows that farm incomes rise with comparative advantage as embodied in better relative productivity draws for market crops $\varphi_{\min,cv}$ and with absolute advantage arising from bigger markets L_v. From the equilibrium conditions, it can be seen that comparative advantage and absolute advantage work in ways similar to a rise in intermediation productivity. They directly raise farm incomes through greater production and therefore an increase the size of the pie. They indirectly raise farm incomes by fostering greater entry and competition among traders and agribusinesses. Villages with a comparative advantage in a crop have higher prices for farmers. These direct and indirect channels move in the same direction, so that comparative and absolute advantage raise farm incomes and provide welfare gains to farmers. Intermediaries continue to earn zero profits under free entry and overall welfare gains arise for the village from a deepening of its comparative or absolute advantage in market crops.

3.2.2. *Behind the Border Barriers to Trade (BTBs).* The model can be applied to examine welfare impacts of the rise of agribusinesses – an equilibrium with no agribusinesses versus an equilibrium which has agribusinesses. To understand this, it is instructive to consider the extreme case where only traders exist in the initial equilibrium ($M = 0, N > 0$) and only agribusinesses exist in the new equilibrium ($M = N > 0$). Then the new equilibrium will result in higher revenues for market crops due to the direct productivity gains from agribusinesses with better intermediation technologies. The indirect effect would be to increase investments into agribusiness activities, which entail an increase in the scale of agribusiness operations and hence an increase in the level of profits that these firms must generate to break even. In part, this is driven by the seminal insight of Melitz (2003) where exporting entails fixed investment costs and firms must increase their scale to meet these expenses.

In this setting, the new channel is oligopsonistic pricing, which arises because of the endogenous supply of farm produce to agribusinesses. Endogenous supply of farm produce implies that market size per intermediary firm and hence buyer power can increase with the rise of agribusinesses. This occurs when the rise in investment costs for new agribusiness activities is relatively large compared to the productivity gains from these activities. Then entry of intermediaries is more muted than the farm supply response due to investment outlays, resulting in a distributional tension between farmers and their agribusinesses. As investment costs increase, firms pay lower prices to farmers because they must generate higher profits to justify these investments. Agribusinesses scale up and this channel raises buyer power in the crop markets faced by farmers. Overall, the incomes received by farmers depend on the strength of the productivity gains relative to the increase in investment costs across all intermediaries. These forces in turn affect the cropping choices, sorting patterns and overall incomes of farmers. The key results are summarised below and details are provided for this specific case in the Appendix and for a more general case in the sub-section that follows.

Proposition 3. *The rise of agribusinesses affects farm incomes directly and indirectly through entry of intermediaries. Directly, agribusinesses increase the size of the pie through productivity gains in marketable produce. Indirectly, agribusinesses reduce the share of the pie available to farmers because increased investment outlays raise their buyer power, compared to traders before.*

Moving to an agribusiness model directly increases agribusiness entry and expands the size of the pie in the crop market through productivity gains. Farmers respond by increasing production of market crops and sales to agribusinesses. Increased supply of the crop together with greater entry of firms indirectly determines the size of the market per firm and hence the buyer power after the policy change. The net impact on farm incomes is positive or negative, based on this tradeoff between productivity gains and buyer power. When productivity gains are relatively higher than the investment costs of agribusinesses and farmers, the direct channel dominates the indirect channel and farm incomes rise in the new equilibrium. The next sub-section shows this explicitly for a more general case where entry barriers for agribusinesses are reduced.

3.2.3. *Agribusiness Entry Barriers.* To examine Proposition 3, we will apply it to a setting where policies to promote agribusinesses were put into place. To aid the empirical analysis later, we first generalise the model to account for different stages of agribusiness activities. We then map the policy to reductions in entry costs and to the ability to operate in different stages of agribusiness activities. Finally, we determine the comparative statics for welfare arising from these policies.

To enable a flexible formulation to take to the data, let s index stages of agribusiness activity for a given crop. Without loss of generality, s rises with the distance to the world market. Then the closest stage, $s = 1$, refers to exporting to the world market. Stages further away from the world market, like processing of produce and buying of produce from the farmgate, imply that there will be more stages available for agribusinesses to provide their services as they come sequentially afterwards. For example, if an agribusiness buys from the farmgate then it can also provide the farmer with services such as processing, marketing and exporting which come after the procurement stage. This will be reflected in the sum paid to farmers for providing services at that stage and afterwards.

To formalise this, let $\delta_{s'c} \geq 0$ denote whether agribusinesses are allowed to operate at stage s' of the crop's journey from the farmgate to the world market. When $\delta_{s'c}$ is zero, agribusinesses are not allowed to operate at stage s'. More generally, when agribusinesses are allowed to operate up to stage s, the price premium paid to farmers by agribusinesses is

$$p_{acv} - p_{tcv} = \sum_{s'=1}^{s} \delta_{s'c} \frac{M_{cv}(k-1)}{M_{cv}(k-1)+1} p_c m_{s'acv}$$

The additive formulation across stages, starting with the closest to the world market, reflects the cumulative nature of services provided by agribusinesses and provides a simple way of summarising entry barriers across different stages of agribusiness activities. As the intermediation productivity is allowed to vary across stages, crops and villages, this formulation does not constrain responses to relaxing of different entry barriers and captures the sequential nature of the crop journey from the farmgate to world markets, as emphasized in the global value chain literature in other settings (such as Antras and Chor 2013).

As earlier, having determined the Cournot oligopsonistic prices, free entry of intermediaries into trading and agribusiness activities determines the entry patterns and hence the equilibrium allocations and prices. The free entry condition for trading takes a form similar to equation 3.5, as the generalisation to multiple stages does not matter for traders. The free entry condition for agribusinesses in each crop market is now generalised to

$$\frac{k}{k-1} \varphi_{\min}^{k} \left(\sum_{s'=1}^{s} \delta_{s'c} p_c m_{s'acv} - (p_{sacv} - p_{tcv}) \right) \varphi_{acv}^{-k+1} L_v / M_{cv} = \kappa_c \left(F_A + \delta_{sc} F_s \right)$$

where reductions in κ_c can be interpreted as relaxing of policy-induced entry barriers. As explained earlier, $\delta_{s'c}$ indicates the ability to operate in stage s' of agribusiness activities (with $1 \leq s' \leq s$) and δ_{sc} refers to the ability to operate at stage s closest to the farmgate. F_s refers to the investment costs that must be incurred by agribusinesses to provide

services up to stage s. If $F_s = \sum_{s'=1}^{s} F_{s'}$ it has the simple interpretation that agribusinesses must incur investment costs for each stage of the crop's journey. (Alternative formulations with separable investment costs at each stage give qualitatively similar results so we do not explicitly model entry into each stage separately). Instead, F_s is allowed to vary by s so that it can be interpreted as the cumulative investment costs across all operational stages up till s. Collectively, therefore $\{\kappa_c, \delta_c\}$ summarise the national crop-level BTB policies regarding agribusinesses and we examine the comparative statics of equilibrium outcomes with respect to changes in κ and δ.

From the optimal pricing and free entry conditions, it may be shown that the change in agribusiness entry is

$$\frac{2M_{cv}\left(k-1\right)-\left(k-2\right)}{M_{cv}\left(k-1\right)+1}d\ln M_{cv} = -d\ln\kappa_c + k\sum_{s'=1}^{s}\frac{\delta_{s'c}m_{s'acv}}{\sum_{s'=1}^{s}\delta_{s'c}m_{s'acv}}d\ln\delta_{s'c} - \frac{\delta_{sc}F_s}{F_A+\delta_{sc}F_s}d\ln\delta_{sc} \tag{3.7}$$

which takes the sign of the RHS and can be positive or negative. Entry of agribusinesses rises directly with reductions in entry costs κ_c. As agribusinesses are allowed to start operations at stage s, there are productivity gains and increased investments into new activities. When the productivity gains are higher than the increased investment costs, competition among agribusinesses raises the incomes received by farmers. The opposite holds when the investment costs are high relative to the productivity gains from the activity. Entry responses are then more muted than the rise in farm supply to agribusinesses due to productivity gains. Market size per firm rises to justify the increased investment outlays and buyer power with respect to individual farmers increases.

Substituting for the change in entry into the change in optimal prices, it can be shown that the prices received by farmers selling to agribusinesses change by $d\ln p_{sacv} = \left(1-p_{tcv}/p_{sacv}\right)\tilde{\kappa}$ where the first term on the RHS is positive (as agribusinesses pay a premium over traders). The second term $\tilde{\kappa}$ rises with entry and productivity gains but falls with investment costs because:

$$\tilde{\kappa} \equiv -d\ln\kappa_c + \frac{2\left(M_{cv}\left(k-1\right)+1\right)}{2M_{cv}\left(k-1\right)-\left(k-2\right)}\sum_{s'=1}^{s}\frac{\delta_{s'c}m_{s'acv}}{\sum_{s'=1}^{s}\delta_{s'c}m_{s'acv}}d\ln\delta_{s'c} - \frac{\delta_{sc}F_s/\left(F_A+\delta_{sc}F_s\right)}{2M_{cv}\left(k-1\right)-\left(k-2\right)}d\ln\delta_{sc}$$

Therefore, prices rise on account of the direct impact of productivity gains from agribusinesses and fall with the indirect channel of increased investment costs which entail higher firm scale and hence greater market power for agribusinesses. To understand these opposing forces more clearly, it is useful to compare them with welfare changes from reductions in trade costs. Across-the-border trade barrier reductions are equivalent to increases in the intermediation productivity in our setting (recall that the intermediation productivity is an inverse measure of iceberg trade costs). When intermediation productivity rises, the comparative statics are similar but $\tilde{\kappa} \equiv \frac{2(M_{cv}(k-1)+1)}{2M_{cv}(k-1)-(k-2)}\sum_{s'=1}^{s}\frac{\delta_{s'c}m_{s'acv}}{\sum_{s'=1}^{s}\delta_{s'c}m_{s'acv}}d\ln\delta_{s'c}$.The first term disappears as there is no entry barrier reduction. However the first and the

second terms take the same sign for reductions in entry barriers ($-d\ln\kappa_c, d\ln\delta_{s'c} > 0$). And the crucial point is that the third term, which takes the opposite sign, disappears. This is because there is no accompanying increase in investment costs. As a result, the distributional tension does not arise and reduction in trade costs provides positive gains from trade to farmers.

On the other hand, behind-the-border barriers to trade by their very nature entail domestic investments which activate the third component and create a force for increased buyer power. Then entry responses are muted by the increased investment outlays and market size per firm rises. Overall, prices received by farmers can then fall, leading to lower incomes from changes in BTB policies that provide small productivity gains relative to investment costs.

In terms of the Melitz (2003) model, the policy can be interpreted as a move from autarky to an open economy. Moving to an open economy in the Melitz model is equivalent to a reduction in iceberg trade costs together with an increase in the number of countries that firms can sell to, and hence new fixed costs of exporting (reduced τ and increased nf_x in Melitz notation). In that setting, markups are constant so firm profits and consumer incomes move together. This ensures welfare gains for consumers are always positive when moving to an open economy. In our setting, income gains need not be positive because the oligposonistic markdowns respond to changes in intermediation productivity and new fixed costs. Markdowns, and hence farmer incomes, rise with better intermediation technology but fall with new fixed costs. Which force dominates determines whether there are welfare gains for farmers or not when the policy is put into place.

As farmers differ in their productivity draws which in turn determines who they sell to, BTB policies also change the sorting patterns of farmers. The share of farmers selling to agribusinesses φ_{acv} rises when $\tilde{\kappa} > 0$ and vice-versa. These farmers and the ones that continue to sell to agribusinesses experience a rise in incomes for $\tilde{\kappa} > 0$. Others however do not experience income changes because the BTBs do not affect their cropping choices and prices received in the trading market. The latter is a stark prediction which turns out to hold empirically in our setting, but as we discuss briefly below, it can be easily generalised to allow for direct impacts and feedback effects across markets.

3.2.4. *Model Generalisations.* The model can be generalised to include additional channels for farmers not selling to agribusinesses. We explore this in an earlier working paper where farmers and traders use the same resources as agribusinesses to pay for their fixed costs of production and entry. Additionally, we allow for productivity spillovers from agribusiness activity to farm surplus sold to other buyers. Then entry of agribusinesses increases investment costs for farmers and traders as well. Again, the relative strength of

the productivity spillovers and the rise in investment costs determines the change in farm incomes and trader profits.

Finally, the model can also be generalised to include a role for BTB policies that reduce the market share of state parastatals. When farmers can sell to state companies that typically pay higher prices than private traders, BTB policies raise farm incomes through productivity gains from agribusinesses but reduce them through higher market (or bargaining) power of agribusinesses compared to state companies. Again, the productivity versus investment cost changes determine the extent to which farmers gain or lose from the policies. We refer the readers to the working papers for further details of generalisations (Dhingra and Tenreyro 2017, 2020) and proceed to the empirical application of Proposition 3.

4. From Theory to Empirics

Having provided a theoretical framework to understand income changes, this section proceeds to empirically examining the relationships in section 3. It starts with a discussion of the theoretical predictions for the impacts of BTB policies on incomes and profits. Then it explains the estimating equations to study these impacts.

4.1. **BTB Policy Impacts.**

A first insight into income responses from the model is that they differ across the productivity distribution. This poses challenges for empirical examination because household-crop productivity is typically unobservable, especially for crops that are not grown. Just like productivity of all potential products of a multiproduct firm is difficult to observe or infer, household-crop productivity is difficult to ascertain from available surveys. Farm productivities are therefore not directly observable and reflect farm choices that are likely to be endogenous to the impacts of crop policies on farm incomes.

However, the application to crop markets makes it possible to exploit village-crop productivity. A growing literature uses agroecological data from FAOSTAT to define the potential yields across major world crops based on soil, weather and other climactic conditions of the area (example, Nunn and Qian 2011). This provides a measure of mean potential yields for different village-crops, which map on to comparative advantage or more specifically, the average relative productivity of a village-crop $\bar{\varphi}_{cv} \equiv \frac{k}{k-1}\varphi_{\min,cv}$. We therefore provide general equilibrium comparative statics of village-level income responses to entry barriers across crops, and examine them with household-crop and household microdata across villages that differ in their comparative advantage across crops.

The income premium across all farmers selling to agribusinesses is

$$I_{acv} \equiv \int_{\varphi_{acv}}^{\infty} \left(\left(p_{sacv} - p_{tcv} \right) \varphi - f \right) dG\left(\varphi \right)$$

Solving for incomes and substituting for the agribusiness productivity threshold, $I_{acv} = \varphi_{\min,cv}^{k} f^{-k+1} \left(p_{sacv} - p_{tcv} \right)^{k} / \left(k - 1 \right)$. Therefore the change in farm incomes from selling to agribusinesses is

$$I_{acv}^{'} \left(\kappa_c, \delta_c \right) = k I_{acv} \tilde{\kappa}$$

which takes the sign of $\tilde{\kappa}$. As discussed earlier, the sign of $\tilde{\kappa}$ depends crucially on the extent of productivity gains relative to investment costs across various stages of agribusiness activity. Defining the absolute magnitude of the income changes as $\Delta I \equiv \left| I_{acv}^{\prime} \left(\kappa_c, \delta_c \right) \right|$, it can be shown that the income change is higher in magnitude for villages with a comparative advantage in the crop. In particular, the absolute change in income with respect to the relative potential mean productivity of the village in a crop is

$$d \ln \Delta I_{acv} / d \ln \bar{\varphi}_{cv} = 1 + \left(\frac{k}{M_{cv} \left(k - 1 \right) + 1} - \frac{2 M_{cv} \left(k - 1 \right)}{2 M_{cv} \left(k - 1 \right) - \left(k - 2 \right)} \right) d \ln M_{cv} / d \ln \bar{\varphi}_{cv}.$$

As the comparative advantage of a village in a crop rises, its income dependence on the crop also rises. This implies that the absolute magnitude of the income change in the village is greater compared to other villages that have lower relative productivity in the crop. The first two terms on the RHS reflect these forces. The first term is the one-for-one rise in crop volumes on account of higher relative productivity in the crop. The second term is the higher payment received by farmers for crops in comparative advantage villages, which arises because larger and more productive villages have higher entry of intermediaries and hence higher income payments to farmers. Finally, the last term on the RHS works against these forces because entry of intermediaries does not increase prices as fast in comparative advantage villages, which already have higher prices to begin with. The last term on the RHS however is dominated by the first-order effects of higher incomes from these crops. Comparative advantage villages therefore experience income changes of a larger magnitude because of the direct effect of higher income reliance on these crops which overwhelms the indirect effect of more muted entry and price responses in these villages. Finally, substituting for the change in entry with respect to comparative advantage, $d \ln \Delta I_{acv} / d \ln \bar{\varphi}_{cv} = 2 \frac{M_{cv}(k-1)+1}{2 M_{cv}(k-1)-(k-2)} \left(1 - \frac{M_{cv}(k-1)}{2 M_{cv}(k-1)-(k-2)} \right)$ which is greater than zero. To sum up, as BTB policies are put into place, the income premium received by farmers selling to agribusinesses takes the sign of $\tilde{\kappa}$ and the absolute magnitude of this income response is larger in comparative advantage villages.

Having determined the income changes, we turn to the profits from agribusiness activities. Summing across all crops and villages that an agribusiness sells to, the change in

gross average profit of an agribusiness is $\sum_c \sum_v \pi_{acv} d\ln \pi_{acv}(\kappa_c, \delta_c)$. Recall that $\pi_{acv} = \frac{k}{k-1}\varphi_{\min}^{k}\left(\sum_{s'=1}^{s} \delta_{s'c} p_c m_{s'acv} - (p_{acv} - p_{tcv})\right)\varphi_{acv}^{-k+1} L_v / M_{cv}$, so the change in agribusiness profits with respect to entry barriers consists of the direct change in prices received from world markets ($\sum_{s'=1}^{s} \delta_{s'c} p_c m_{s'acv}$) when agribusinesses are allowed to operate in new stages of activities. This component summarises the increase in the size of the pie available in the village economy after the BTB policy change. Another direct effect arises from entry of agribusinesses which reduces the market size available to an individual agribusiness ($1/M_{cv}$ in the profit function). Finally, agribusiness profits are also affected indirectly through the prices paid to farmers and their consequent cropping choices. The latter in turn are determined by productivity gains and entry patterns in the economy, which give rise to the buyer power channel.

To illustrate clearly the distributional tension that can arise with BTB policies, the change in profits can be expressed in terms of changes in the profit margin (profit per unit of sales) and overall farmer incomes from agribusinesses. Let the profit margin of an agribusiness be

$$\mu_{cv} \equiv \left(\sum_{s'=1}^{s} \delta_{s'c} p_c m_{s'acv} / (p_{acv} - p_{tcv}) - 1\right)$$

Then the change in profit of an agribusiness is $d\ln \pi_{acv} = d\ln I_{acv} + 2 d\ln \mu_{cv} / (1 - \mu_{cv})$. The first term on the RHS summarises the mechanism that increases in the size of the pie always raise both farm incomes and agribusiness profits. The second term on the RHS summarises the distributional tension that arises from market power of agribusinesses, which raises agribusiness profits at the expense of farmer incomes. In particular, the change in the profit margin is

$$d\ln \mu_{cv} = -(1 - \mu_{cv})\, d\ln M_{cv}.$$

Margins fall with entry changes, which in turn depend on the productivity gains relative to investment outlays for agribusiness activities. When productivity gains are larger than the investment costs in new activities ($\tilde{\kappa} > 0$), we get the standard result where farm incomes rise and profit margins fall as more agribusinesses enter for high enough productivity gains. On the other hand, when productivity gains are small relative to the investment costs in new activities ($\tilde{\kappa} < 0$), it can be shown that farm incomes fall as farmers face bigger intermediaries with greater buyer power. Profit margins rise and the increase in the size of the pie is not enough to overcome the distributional tension which reduces farm incomes. (This is the additional buyer power effect which is held fixed in the Melitz model through constant markups).

We can also trace out the changes in sorting patterns of farmers by examining φ_{acv}, the productivity threshold for selling to agribusinesses. When the income premium rises with BTB policies, more farmers sort into selling to agribusinesses and they experience a gain through higher productivity from the switch and from greater entry of agribusinesses. The opposite occurs for $\tilde{\kappa} < 0$, which induces exit of farmers from selling to agribusinesses. As entry barriers in trading do not change, trading prices and hence cropping patterns of farmers that never sell to agribusinesses remain unaffected.

We summarise these results below in Proposition 4.

Proposition 4. *Farm income premia and the share of farmers selling to agribusinesses rise with BTB policies when new agribusiness activities provide relatively high productivity gains ($\tilde{\kappa} > 0$) and vice-versa. Farmers in villages with a comparative advantage (in the crops that experience BTB policy changes) face bigger absolute impacts on their total incomes from BTB policies.*

Profit margins of agribusinesses reflect the distributional consequences of oligpsonistic pricing. Profit margins fall with BTB policies for relatively high productivity gains (under $\tilde{\kappa} > 0$), but they rise when productivity gains are relatively lower ($\tilde{\kappa} < 0$).

The first part of the empirical application will specify the activities that were opened up to agribusiness activity and examine how farm incomes are affected and differentially by comparative advantage. This applies the microeconomic comparative static to household-crop data to determine differential impacts in household-crop incomes across villages. The second part of the empirical application accounts for spillovers, such as cropping of consumption goods in the model and non-farming channels (that are not explicitly in the model), to determine the impacts of BTB policies on total household welfare. Finally, we examine the mechanism of distributional conflict using firm data on profit margins of agribusinesses.

4.2. **Incomes and Profits.** To operationalize Proposition 4, we implement a difference-in-difference analysis comparing incomes received from policy-affected crops, relative to other crops, before and after the policy shift. We do the analysis separately for farmers that sell to agribusinesses versus other buyers. Let $Post_t$ be an indicator for the period after the policy shift which occurred in 2004. Then I_{chmt} is the income received for crop c by household h in season m of year t, which is specified as follows:

$$I_{chmt} = \beta_1 \cdot Post_t \cdot BTB_c \cdot \bar{\varphi}_{cv} + \alpha_{chm} + \alpha_t + \varepsilon_{chmt} \tag{4.1}$$

where BTB_c is the crop-level BTB policy change which is coded as $\sum_{s=1}^{3} s \cdot BTB_{sc}$ with BTB_{sc} denoting the number of sections of legislations repealed for stage s of crop c.

Following the theory, the stages of agribusiness activities are coded inversely to distance from farmgate. In particular, s is one for BTBs related to marketing, warehousing, selling and exporting of crops, two for milling and processing BTBs, and three for buying BTBs (Later robustness checks are conducted to show that key results hold for alternative specifications, such as equal weighting across all stages). Comparative advantage $\bar{\varphi}_{cv}$ is the village-level mean potential yield for the crop and ε is an error term.

β_1 is the coefficient of interest which determines the impact of BTBs on crop incomes of households after the policy shift. Household-crop-season fixed effects α_{chm} are included to examine income changes within a household-crop-season. Season is included together with crops in the specification to account for differences in crop units across seasons, and standard errors are clustered by crops which is the level of variation of the policy. This first specification determines the microeconomic impact on crop incomes, accounting for differential responses across farmers selling to different buyers and across villages with different levels of comparative advantage in BTB crops.[4]

While equation 4.1 studies the micro channels for BTB impacts down to the crop level, it does not provide a way of summarising the total impact on households across all crops. Total income of the farmer from all crops is I_{ht} which can be examined as follows:

$$I_{ht} = \beta_2 \cdot Post_t \cdot \sum_c (BTB_c \cdot \bar{\varphi}_{cv}) + \alpha_h + \alpha_t + \varepsilon_{ht} \tag{4.2}$$

where α_h and α_t are household and year fixed effects and ε is the error term. The key RHS variable is the sum of the BTB policy across all major crops, weighted by the mean potential yield of the crop. The household-level coefficient of interest is β_2 which is the estimated income change for the household from BTB policies. It can differ from β_1 in equation 4.1 as most farmers grow multiple crops and it is reasonable to assume that cropping patterns and incomes could respond to BTB policy changes (for example, through cropping choices of farmers in the model). Household fixed effects are included to examine changes within households and standard errors are clustered by village.

One concern with the theory is that it focuses on farm incomes and does not account for non-farm operations (except through the consumption good). Allowing farmers to own a second factor (say labour) which is used in both farming and non-farming activities would create spillovers from farm incomes to non-farm income. These can be examined through similar specifications:

[4]Alternative fixed effects (crop and season-time separately) and clustering (crop and household levels) give qualitatively similar results in the application.

$$Y_{ht} = \beta_3 \cdot Post_t \cdot \sum_c (BTB_c \cdot \bar{\varphi}_{cv}) + \alpha_h + \alpha_t + \varepsilon_{ht} \tag{4.3}$$

where Y_{ht} is income from non-farm sources which we will measure in different ways (for example, wages, income net of input costs and consumption measures).

The mirror image of impacts on farm incomes is the profits of agribusiness firms. To examine the second part of Proposition 4, let μ_{jt} denote the profit margin (Profit before Tax divided by Sales) of agribusiness j in year t which is specified as follows:

$$\mu_{jt} = \beta_4 \cdot Post_t \cdot \sum_c (BTB_c \cdot S_{cj}) + \alpha_j + \alpha_t + \varepsilon_{jt} \tag{4.4}$$

where c refers to the crop segments that firm j operates in and S_{cj} is the sales share of crop segment c in firm j's sales before the policy shift. Most agribusinesses specialise in a single crop and do not change crop specialisation over time. However, there are a couple of large agribusiness firms that operate in more than one crop segment within a year. Summing across crop segments, then gives the key RHS variable of firm-level BTB policy changes. The coefficient of interest is β_4 which determines the impact of BTBs on agribusiness profit margins. When β_1 and β_4 differ in sign, the BTB policy gives rise to a distributional tension between farmers and agribusinesses. Firm fixed effects α_j are included to examine changes within a firm and regressions are weighted by average initial sales of the firm to arrive at sales-weighted profit margin estimates. Standard errors are clustered by main crop segments.

Having specified the estimating equations, we first describe the data for the application and then proceed to estimation results.

5. Empirical Application

This section starts with a description of the data on households and agribusinesses and then discusses the context and policy application. We then proceed to a summary of key empirical findings and estimation of equations 4.1, 4.2, 4.3 and 4.4.

5.1. **Data.** This sub-section describes the household data and firm data used in the application.

5.1.1. *Household Data.* The model is applied to Kenyan agriculture, which 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 economy where agriculture makes up 25 per cent of GDP and 75 per cent of the labor force. In 2005, mean consumption of rural households in Kenya was USD 1,176 (World Income Inequality

Database/Kenya Integrated Household Budget Survey consumption data). 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. In 2004, BTB policies were adopted to encourage large-scale agribusinesses in developing crop markets for farmers.

Information on cropping patterns and incomes 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 and follow them over time (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, 2007 and 2010 to gather information for June of the previous year to May of the survey year. Households report farming activities during the main and short cropping season of each year. Attrition rates of the panel are low – over 90 per cent of the households are resampled. This is particularly important because standard datasets of rural households in low-income countries can have high attrition rates (for example, 50 per cent in certain World Bank 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. 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.

Aggregating up across all fields, the income earned per household-crop-buyer is defined as 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. Buyers include consumers, traders, state companies/cooperatives and agribusinesses. Agribusinesses in the survey refer to large companies, exporters, miller, processors or supermarkets.[5]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 sales are characterised by an indicator for the buyer type for each household-crop-season-year observation. For analysis of household welfare, the household-crop information across all crops is aggregated up to the level of the household to arrive at total farm income. We also consider

[5]As our focus is on profit-maximising firms, 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.

non-farm channels through which the BTB policy may have impacted households, such as wages and business enterprises, which are reported for the household annually. Household consumption is available from purchase records and asset values recorded in the survey for each year.[6]

5.1.2. *Agribusiness Data.* As is well-known, data on intermediaries 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 agricultural firms through the Capital Markets Authority of Kenya for each year from 1999 to 2010. Then we manually collected sales and profit data (and any restatements) from their audited financial reports for each year. Listed companies are mandated to declare their annual audited reports by law, and we therefore have all the listed agricultural companies in the country. Alternative sources of company records, such as Orbis, do not have the coverage that we get by manually compiling the dataset.[7]

There are 13 companies which operate in almost all years since their start, with an average annual revenue of 6.2 billion KSh per firm. The companies include multinational firms like Limuru (Unilever) and British American Tobacco Company 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). The median profit margin of companies is 5.7 per cent and the mean is 6.8 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

[6]Asset refers to the current purchase price of the asset or the current market value of the asset as is. It includes the value of houses, 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.

[7]Datastream and Orbis are other sources of information with which we cross-check the firm names. Datastream gives a similar listing but Orbis does not contain all the information. 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. Two firms that appear in Datastream during the period but seemingly do not appear in our database are Kenya National Mills and Unilever Tea Kenya. This is because the former files joint accounts with its parent company Unga Group, which is in our dataset. Unilever is also in our dataset but it is called Limuru Tea Plc, which is an outgrower company for Unilever in Kenya.

and Beverages, Coffee, Horticulture, Sisal, Cotton spinning and services, Sugar made from cane, Tea, Maize milling, Wheat production, Poultry feeds and Animal health and nutrition, or All of these. The crop-level exposure of company j is defined as the sales shares S_{cj} of each crop segment in the pre period (1999-2004). Table 3 contains the list of companies, their segments and BTB values. Uchumi operates in multiple segments because it is a supermarket, so we assign it the most common BTB for vegetables and fruits, and we examine robustness of key results to this assignment.

TABLE 3. Policy Exposure of Agribusinesses: Sales Shares in Policy-Affected Segments

Agribusiness Name	Crop Segment	BTB_j
British American Tobacco Company	Tobacco	0
East African Breweries Limited	Beer and beverages	0
Unga Group Plc	Animal Health and Nutrition	0
Kenya Orchards Plc	Horticulture	1
Uchumi Supermarkets Plc	All	1
Kapchorua Tea Kenya	Tea	2
Limuru Tea Company Limited	Tea	2
Williamson Tea Kenya Plc	Tea	2
Mumias Sugar Company Limited	Sugar	3
Rea Vipingo Plantations Limited	Sisal	5
Kakuzi Plc	Coffee, Horticulture and Tea	9.985
Sasini Plc	Coffee and Tea	9.997
Eaagads Limited	Coffee	48

5.2. **BTB Policy and Context.** Having discussed the data sources, we proceed to describing the context and the policies that were put in place during the period.

Agricultural growth in Kenya had stagnated by the 1980s and state presence had expanded to state 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 intermediation costs of traders and state companies were higher in Kenya than best practices elsewhere. Moreover, horticulture and floriculture, which had been open to private sector operations, had experienced high growth rates (see Machhiavello and Morjaria 2015). They however

made up a small share of farmer incomes, which led to the view that the success of the growing sectors could be scaled up by encouraging agribusinesses in crop markets.

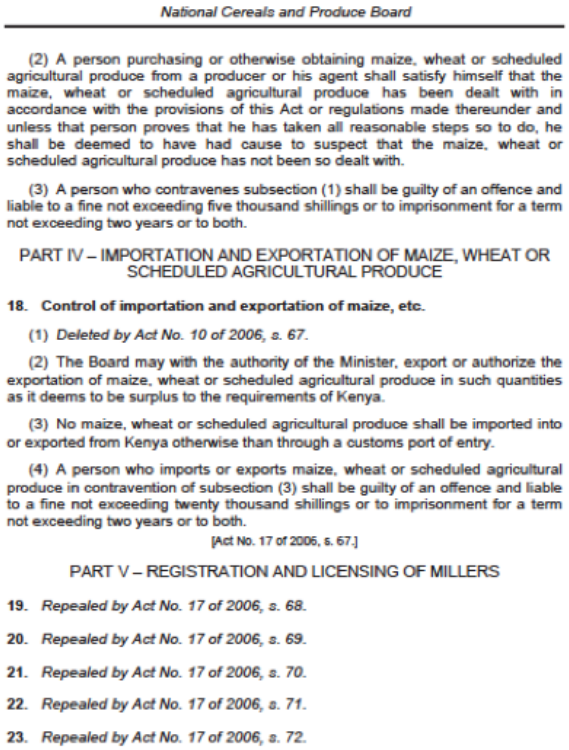
In March 2004, the Strategy for Revitalising Agriculture (SRA) was launched, proposing a "radical reform" of the role of the state within Kenyan agriculture. In particular, President Kibaki outlined the broad strategy as follows: The strategy emphasizes the creation of an environment to promote private sector-led agricultural development.... 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. The launch of this strategy was 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).

Agribusinesses operated in Kenya before 2004, but their operations were constrained by government policy. After the launch of the new policy, within a couple of years, licensing and investment restrictions were relaxed in many different stages of agribusiness activities across various crops. For example, the Investment Promotion Act (31st December 2004) entitled any investment certificate holders the license to mill maize, establish sisal factories and deal in coffee. These were enshrined as amendments in the Acts and they lend themselves well to codifying measures based on the number of sections that were deleted/repealed/amended. We read every law (and its antecedents) to categorise and count the number of sections changed in the legal texts at each stage of agribusiness activity. A section largely corresponds to a specific requirement that needs to be fulfilled for that stage of the activity.

A typical example of the codified legislation is produced here to fix ideas, and very few exceptions arise as most legal text have straightforward deletions of sections. The original National Cereals and Produce Board (NCPB) Act is our focus in this example as it covers some of the most important crops - maize and wheat. The NCPB Act 1985 contained, for instance, sections 19 to 23 which were amended under The Licensing Laws (Repeals and Amendment) Act 2006, reproduced in Figure 5.1 and further detailed in Figure 6.1 in the Online Appendix. In particular, these sections referred to (19) Registration and licensing of millers, (20) Licences, (21) Expansion of Mills, (22) Allocation of produce to millers, and (23) Duration and renewal of registration, which were repealed in 2006 and affected all NCPB crops (maize, wheat, rice and cashews which are available as a schedule to the Act). Based on the legal texts in the Figure, Milling BTBs for NCPB crops are coded as 5 for the number of sections 19-23 that are removed from registration and licensing

requirements. (Other changes in different BTBs for these crops are also added in from various legislations.)

FIGURE 5.1. Behind The Border Barriers: Example of National Cereals and Produce Board Act



National Cereals and Produce Board

(2) A person purchasing or otherwise obtaining maize, wheat or scheduled agricultural produce from a producer or his agent shall satisfy himself that the maize, wheat or scheduled agricultural produce has been dealt with in accordance with the provisions of this Act or regulations made thereunder and unless that person proves that he has taken all reasonable steps so to do, he shall be deemed to have had cause to suspect that the maize, wheat or scheduled agricultural produce has not been so dealt with.

(3) A person who contravenes subsection (1) shall be guilty of an offence and liable to a fine not exceeding five thousand shillings or to imprisonment for a term not exceeding two years or to both.

PART IV – IMPORTATION AND EXPORTATION OF MAIZE, WHEAT OR SCHEDULED AGRICULTURAL PRODUCE

18. Control of importation and exportation of maize, etc.

(1) *Deleted by Act No. 10 of 2006, s. 67.*

(2) The Board may with the authority of the Minister, export or authorize the exportation of maize, wheat or scheduled agricultural produce in such quantities as it deems to be surplus to the requirements of Kenya.

(3) No maize, wheat or scheduled agricultural produce shall be imported into or exported from Kenya otherwise than through a customs port of entry.

(4) A person who imports or exports maize, wheat or scheduled agricultural produce in contravention of subsection (3) shall be guilty of an offence and liable to a fine not exceeding twenty thousand shillings or to imprisonment for a term not exceeding two years or to both.

[Act No. 17 of 2006, s. 67.]

PART V – REGISTRATION AND LICENSING OF MILLERS

19. *Repealed by Act No. 17 of 2006, s. 68.*

20. *Repealed by Act No. 17 of 2006, s. 69.*

21. *Repealed by Act No. 17 of 2006, s. 70.*

22. *Repealed by Act No. 17 of 2006, s. 71.*

23. *Repealed by Act No. 17 of 2006, s. 72.*

We codify non-tariff barriers to trade by systematically compiling the full list of legislations during the period (which is available from the Kenya National Assembly, and cross-verified through FAOLEX and ECOLEX). This consists of 22 different pieces of legislation (among the universe of Acts available between 2004 to 2006), which are codified in a similar way (there are just a couple of changes that come afterwards by 2008). The crops where Acts were repealed include different varieties of maize, coffee, wheat, cotton, sugarcane, sisal, pyrethrum, cashewnuts, rice and certain varieties of fruit, vegetables and flowers. A full list of Crops and Acts for the BTB construction is provided in the Online Appendix in Table 19 and here we summarise key statistics of crop-level BTBs.

As shown in Table 4, while 26 of the 128 crops experience no change in BTBs, the bulk of crops experience policy changes, ranging from just one section of legislation being removed to over dozens being removed for crops such as cotton. Crops with BTBs larger than one make up over 70 per cent of household farm incomes in the pre-policy period (2000 and 2004). Many of the 128 crops however make up a very small fraction of farm incomes. Focusing on 35 major crops that are reported by the FAOSTAT and which make

TABLE 4. Summary Statistics for Crop BTBs

(A)

Crop-level BTB (BTB_c)	Obs	Mean	S.D.	Min	Median	Max
All crops	128	8.04	11.35	0	2	96
Major crops	35	8.82	11.80	0	3	96

(B)

Crop-level BTB (BTB_c)	Number of Crops		Income Share		Top Crops
	All	Major	All	Major	(BTB values in parenthesis)
BTB = 0 crops	26	12	6.0	4.6	Beans Fodder Barley
BTB = 1 crops	72	11	21.6	17.0	Bananas Tomatoes Cabbage
BTB >1 crops	30	12	72.4	78.4	Maize (16) Tea (2) Wheat (16)
					Sugarcane (3) Coffee (48)

(C)

Crop Characteristic in Pre-Period	p-value of F-stat	
	All crops	Major crops
Farmers Selling to Agribusiness	0.75	0.62
Market Share of Agribusiness	0.28	0.89
Mean Price of Crop across Farmers	0.63	0.75
World Prices (Current and Lagged)	0.92	0.35
World Price Variance (5 years)	0.75	0.51
Acreage	0.75	0.53

Crop-level BTB is $BTB_c \equiv \sum_s s \cdot BTB_{sc}$ where $s = 1$ for Marketing/Warehousing/Selling/Exporting, 2 for Milling/Processing and 3 for Buying and BTB_{sc} is the number of sections of legislations regarding agribusiness requirements that are repealed/deleted/amended at each stage for the crop between 2005-2006. Summary statistics in panel a are weighted by initial farm income from the crop. Crop characteristics refer to the pre-period values for the share of farmers selling to agribusinesses, the share of agribusinesses in crop income, the world price of the crop in the year and the year before, the variance in world prices over the past 5 years and the total acreage of the area cultivated with the crop. The p-values refer to F-statistics from a crop-level regression of BTB on crop characteristic and year fixed effects in the pre-period.

up 88 percent of farm incomes in Kenya, the mean BTB value is about 9 with substantial variation in BTB values across crops affected by the policy.

Notably, the variation in BTBs is not systematically correlated with various crop characteristics in the pre-policy period. Table 4c reports the p-value for the F-statistic from a regression of crop-level BTB on the crop characteristic and year fixed effects in the pre-policy period. As reflected in the high p-values, crop-level BTBs are not systematically explained by crop characteristics - the share of farmers selling to agribusinesses, the

market share of agribusinesses in crop incomes, mean price of crop received by farmers, the current and one-year lagged world prices of the crop (and therefore also the growth in world price of the crop), the variance in world prices of the crop and the acreage of the area cultivated with the crop. This suggests that the policy was not specifically targeted by these crop characteristics and later we will explore other control variables to examine the BTB policy channel.

5.3. **Summary Glance at BTBs, Incomes and Profits.** Having described the data and policy context, we first show that the policy had its desired impact of increasing farmer engagement with agribusinesses. We then provide a visual representation of income and profit changes during the period, before moving on to the estimation described in the previous section.

TABLE 5. BTB Policies and The Rise of Agribusinesses

	Dependent variable: Share of Households Selling to Agribusiness	
	(1) All farmers	(2) All farmers who grow the crop
$Post_t \cdot BTB_c$	0.0006**	0.0030**
	(0.0003)	(0.0015)
$Pre_t \cdot BTB_c$	-0.00002	-0.0009
	(0.0003)	(0.0012)
Crop FE α_c	Yes	Yes
Year FE α_t	Yes	Yes
N	351	351
R^2	0.722	0.753

The dependent variable in Column 1 is the share of households who sell the crop to agribusinesses, $\sum_h A_{cht} / \sum_h 1_{ht}$ where A_{cht} is an indicator for household h selling crop c to agribusinesses in year t and in Column 2 is $\sum_h A_{cht} / \sum_{h \text{ grows } c} 1_{ht}$ where the denominator is the number of households who sell the crop. $Post_t$ is an indicator for 2007 and 2010 while Pre_t is an indicator for 2004 and $Post_t = Pre_t = 0$ for 2000. Crop-level BTB is $BTB_c \equiv \sum_s s \cdot BTB_{sc}$ where $s = 1$ for Marketing/Warehousing/Selling/Exporting, 2 for Milling/Processing and 3 for Buying and BTB_{sc} is the number of sections of legislations regarding agribusiness requirements that are repealed/deleted/amended at each stage for the crop between 2005-2006. All crops are included but some are not sold at all in the pre or post periods. Standard errors are clustered by crop in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.3.1. *The Rise of Agribusinesses.* As expected, the BTB policy increased the market share of agribusinesses in farm sales of crops that were affected by the policy. To examine differences across agribusinesses and other buyers, Table 5 shows results from a regression of the share of households selling the crop to agribusinesses on the $Post_t \cdot BTB_c$ variable for all crops sold in the pre and post periods. The RHS also includes $Pre_t \cdot BTB_c$ where

TABLE 6. Household-Crop-Season Results: BTB Policies and The Rise of Agribusinesses

	Dependent variable: Sell to Agribusiness A_{chmt}							
	(1)	(2) Pre	(3)	(4) Pre	(5)	(6) Pre	(7a) $A_{ch}=1$	(7b) $A_{ch}=0$
$Post_t \cdot BTB_{cv}$	0.0045**		0.0010***		0.0009***		0.0026*	0.0017***
	(0.0018)		(0.0002)		(0.0003)		(0.0014)	(0.0001)
$Pre_t \cdot BTB_{cv}$		0.0018		0.0003		0.0002		
		(0.0022)		(0.0003)		(0.0003)		
$1_{t=2010} \cdot BTB_{cv}$							-0.0034**	-0.0007***
							(0.0017)	(0.0001)
Crop-Season FE	Yes	Yes	Yes	Yes	Household-Crop-Season FE			
Household FE	No	No	Yes	Yes	Household-Crop-Season FE			
Post/Pre FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	62,072	31,036	62,072	31,036	62,072	31,036	2,512	59,560
R^2	0.472	0.647	0.190	0.382	0.373	0.622	0.305	0.307

The dependent variable is an indicator A_{chmt} which equals 1 for household h selling crop c to agribusinesses in season m of year t on a balanced panel of household-crop-season-year observations. $Post_t$ is an indicator for 2007 and 2010, Pre_t is an indicator for 2004, $1_{t=2010}$ is an indicator for 2010 and $Post_t = Pre_t = 0$ for 2000. Village-Crop level BTB is $BTB_{cv} \equiv BTB_c \cdot \bar{\varphi}_{cv}$ and Crop-level BTB is $BTB_c \equiv \sum_s s \cdot BTB_{sc}$ where $s = 1$ for Marketing/Warehousing/Selling/Exporting, 2 for Milling/Processing and 3 for Buying, BTB_{sc} is the number of sections of legislations regarding agribusiness requirements that are repealed/deleted/amended at each stage for the crop between 2005-2006, and $\bar{\varphi}_{cv}$ is the mean potential crop yield of the village v of the household. The sample in 7a are households who sold the crop to agribusinesses in the pre-policy period $A_{ch} = 1$ while in 7b are other households with $A_{ch} = 0$ in the pre-policy period. Standard errors are clustered by crop in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Pre_t is an indicator for survey year 2004 (before the policy change), which does not show pre-trends in the share selling to agribusinesses. Column 1 shows a rise in the share of farmers who grow the crop and sell it agribusinesses. Looking at the shares of farmers, among those who sell the crop at all, Column 2 shows that agribusiness engagement rises. For each section of legislation repealed, the share of households selling to agribusinesses rises by 0.3 pp from its earlier share of 0.0784.

As many of the crops are small in shares, Table 6 focuses on the 35 major crops and regresses an indicator for households selling the crop to agribusinesses A_{chmt} on $Post_t \left(\sum_c BTB_c \cdot \bar{\varphi}_{cv}\right)$ in the odd-numbered columns. As earlier, we see a rise in the share of farmers selling to agribusinesses. The even-numbered columns contain the same regression for just the pre-period years, where $Pre_t = 1$ for 2004 and 0 for 2000, to examine pre-trends in agribusiness activity. Columns 1 and 2 show results for regressions weighted by crop incomes for the household to account for the importance of various

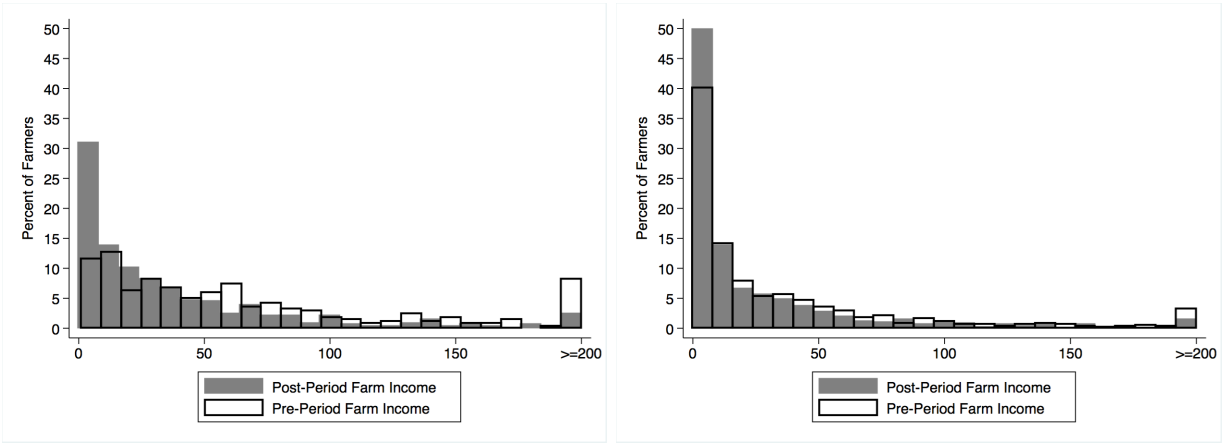
crops. Column 3 adds in household fixed effects and Column 5 adds in household-crop-season fixed effects for the full sample period. It shows that households move towards crops that they sell to agribusinesses and even looking within a household-crop, there is a greater likelihood for households moving toward agribusinesses. Columns 4 and 6 confirm that similar exercises in the pre-period generate estimates which are much smaller in magnitude and statistically insignificant.

Finally, Columns 7a and 7b show a striking finding: farmers were also more likely to stop selling to agribusinesses towards the end of the period in 2010. This is shown separately for farmers who sold to agribusinesses in the pre-policy period ($A_{ch} = 1$) in 7a and for other farmers who did not sell to agribusinesses before in 7b, with the latter showing smaller responses as it has fewer agribusinesses to begin with. The exit of farmers from agribusiness sales is consistent with a deterioration in incomes received from agribusinesses. In particular, the policy reduces sunk entry costs which encourages farmers to sell to agribusinesses. As agribusinesses move into liberalised activities, new investment outlays are needed to provide these services and agribusinesses reduce their payments to farmers to maintain their profit levels. While this interpretation is consistent with the model, an alternative interpretation is that farmers move out into potentially higher-income non-farm activities and new crops. The household level analysis will therefore examine various income impacts of the policy change.

5.3.2. *Household Income Patterns.* To provide an initial overview of the main empirical patterns, which are examined more systematically later, this sub-section starts with summary descriptions of the income changes experienced by households during the policy period.

Figure 5.2 shows the distribution of household farm incomes before and after the policy change, for affected farmers (Panel a) and other farmers (Panel b) separately. The grey bars in Panel a show the initial distribution of farm incomes across affected households - those that are in villages that grow policy-affected crops and who sold policy-affected crops to agribusinesses before the policy change (in 2000 or 2004). This distribution of farm incomes shifts to the left in the periods after the BTB policy shift (2007 and 2010), showing a reduction in farm incomes for households that sold to agribusinesses before the policy changes. Panel b shows that the distribution of farm incomes across other households (who did not sell policy-affected crops to agribusinesses or were in villages that experienced no BTB policy changes as they did not grow the policy-affected crops). The distribution of farm incomes of other households shows that incomes changed but much less so, and the empirical analysis later examines these findings more systematically by estimating household-crop and household-level equations 4.1, 4.2 and 4.3.

FIGURE 5.2. Household Farm Incomes by Agribusiness and Crop Specialisation of Village, Before and After the BTB Policy



(A) Policy-Affected Farmers (B) Other Farmers

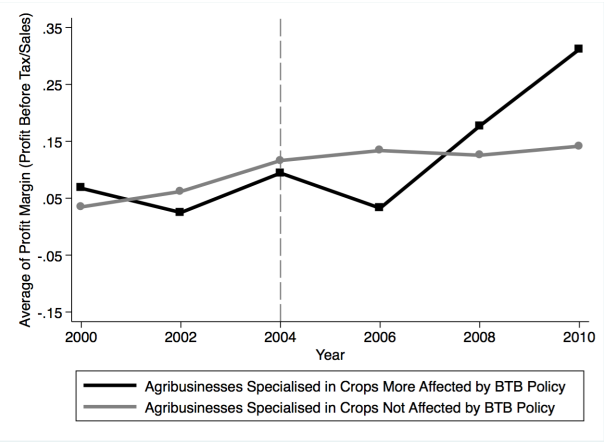
Farm Income refers to the total income from sales of crops of the household and the sample consists of all households who sold to agribusinesses before the BTB policy change of 2004. The grey bars refer to the post-policy period (2007 and 2010), while the black-outline bars refer to the pre-policy period farm incomes of these households (2000 and 2004). Panel a consists of the sample of farmers who sold to agribusinesses before the BTB policy change in villages that had at least one BTB policy change across the crops which can be grown in the village according to FAOSTAT potential yields. Panel b consists of all other farmers, who did not sell to agribusinesses before or who belong to villages experiencing no BTB policy change across crops that can be grown in the village according to FAOSTAT potential yields.

5.3.3. *Agribusiness Profit Trends.* Figure 5.3 summarises the evolution of agribusiness profit margins. The black line is the average profit margin of agribusinesses that specialise in policy-affected crops. Their profit margin rises sharply after a couple of years from the BTB policy announcement in 2004. Other agribusinesses also see a rise in average profit margin, but this is much flatter (grey line). This suggests that policy-affected agribusinesses saw a rise in profit margins, suggesting a distributional tension arising from the BTB policy. A more systematic analysis with estimation of the profit margin equation 4.4 follows later in subsequent sections.

5.4. **Results.** This sub-section starts with equation 4.1 examining household-crop incomes. Then it moves to equations 4.2 and 4.3 for household-level impacts on farm incomes and non-farm incomes. Finally, it shows results for profit margins of equation 4.4.

5.4.1. *Household-Crop Incomes: All Farmers.* We start by estimating equation 4.1 to examine the impact of BTB policies on household-crop incomes. The odd-numbered

FIGURE 5.3. Agribusiness Profit Margins by Crop Specialisation, Before and After the BTB Policy



Average Profit Margin refers to the average of profit margins (defined as Profit Before Tax as a share of Sales) across firms in each group. The black line refers to the group of agribusiness firms who, between 1999-2004, had specialised in crops that had more than one section of legislation repealed by the BTB policy change after 2004. The grey line refers to agribusinesses who specialised in crops that had no BTB policy change. Profit margins are averaged across two-year periods to match the corresponding household survey years.

columns of Table 7 contain the baseline specification of equation 4.1, with and without interactions for farmers selling to agribusinesses in the pre-policy period. The even-numbered columns add in the full set of interactions for the policy variables.

Column 1 shows results for the balanced panel of all households across all major crops. Zeros are added here for crops that the household does not sell. Column 3 reports the same for the unbalanced panel (conditional on selling the crop). In each case, there is a negative coefficient on the variable of interest $Post_t \cdot BTB_c \cdot \bar{\varphi}_{cv}$ but it is statistically insignificant.

Following the theory, Columns 2 and 4 include interactions of the BTB policy variable with an indicator for whether the household sold any of their crop to agribusinesses in the pre-policy period (2000 or 2004). These are households that are observed to have sorted into agribusiness sales before the policy change and their crop incomes fall when the BTB policy is put into place. Other households are those who newly enter into selling the crop to agribusinesses and those who never sell to agribusinesses. These households also see a drop in crop incomes, but it is at least an order of magnitude lower and statistically indistinguishable from zero when crops that continue to be grown in both periods are considered in Column 4.

TABLE 7. BTB Policy and Household-Crop Incomes

	Dependent variable: Crop Income of Farmers (in '000 KSh)			
	Balanced Panel		Unbalanced Panel	
	(1)	(2)	(3)	(4)
$Post_t \cdot BTB_{cv}$	-0.0792	-0.0495*	-0.1866	-0.1041
	(0.0553)	(0.0267)	(0.3113)	(0.1020)
$Post_t \cdot BTB_c$	-0.0286	-0.0272	-0.1309	-0.0999
	(0.0197)	(0.0187)	(0.0777)	(0.0704)
$Post_t \cdot \bar{\varphi}_{cv}$	-0.6657	-0.1538	-3.6495	0.5371
	(0.7438)	(0.2019)	(3.9937)	(1.8710)
$Post_t \cdot BTB_{cv} \cdot A_{ch}$		-0.5102***		-1.8646***
		(0.1029)		(0.6100)
$Post_t \cdot BTB_c \cdot A_{ch}$		-0.0443		-0.4512
		(0.1116)		(0.6372)
$Post_t \cdot \bar{\varphi}_{cv} \cdot A_{ch}$		-5.0272		-9.0178***
		(0.4463)		(1.8923)
Household-Crop-Season FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	62,072	62,072	10,815	10,815
R^2	0.544	0.547	0.634	0.639

The dependent variable is Crop Income I_{chmt} from selling crop c for household h in season m of year t for all major crops. Columns 1 and 2 refer to a balanced panel of household-crop-season-year observations while Columns 3 and 4 refer to the unbalanced panel of positive sales of the crop by the household. $Post_t$ is an indicator for 2007 and 2010, Pre_t is an indicator for 2004 and $Post_t = Pre_t = 0$ for 2000. Village-Crop-level BTB is $BTB_{cv} \equiv BTB_c \cdot \bar{\varphi}_{cv}$ and Crop-level BTB is $BTB_c \equiv \sum_s s \cdot BTB_{sc}$ where $s = 1$ for Marketing/Warehousing/Selling/Exporting, 2 for Milling/Processing and 3 for Buying, BTB_{sc} is the number of sections of legislations regarding agribusiness requirements that are repealed/deleted/amended at each stage for the crop between 2005-2006, and $\bar{\varphi}_{cv}$ is the mean potential crop yield of the village v of the household. $A_{ch} = 1$ for households who sold the crop to agribusinesses in the pre-policy period, and 0 otherwise. Standard errors are clustered by crop in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

To determine the magnitude of crop income changes, we can compute the elasticity for the unbalanced panel which would give the within household-crop changes for crops that are produced in both pre and post policy periods. Estimated at the mean crop incomes for each group, the elasticity of crop incomes to a change in BTB policy (from 0 to 1) is on average -2.75 per cent for households selling to agribusinesses, compared to less than -1 per cent for other households which is statistically indistinguishable from zero. The household-level analysis therefore will focus on households that were exposed to selling to agribusinesses before the policy change in villages that grow policy-affected crops.

TABLE 8. BTB Policy and Household-Crop Incomes of Farmers Selling to Agribusinesses in the Pre-Policy Period

	Dependent variable: Crop Income of Farmers Selling to Agribusiness (in '000 KSh)					
	Sell to Agribusinesses in Pre-Period			Sell to Agribusinesses in Pre and Post		
	(1)	(2)	(3)	(4)	(5)	(6)
$Post_t \cdot BTB_{cv}$	-0.6814***	-0.6235***		-1.2779***	-1.3900***	
	(0.1355)	(0.0965)		(0.1474)	(0.0962)	
$Post_t \cdot BTB_c$		0.0224			0.1121	
		(0.1041)			(0.1712)	
$Post_t \cdot \bar{\varphi}_{cv}$		-1.9881			4.5107	
		(3.1945)			(7.0685)	
$Pre_t \cdot BTB_{cv}$			0.0515			0.1008
			(0.5565)			(1.2316)
Hh-Crop-Season FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	2,512	2,512	1,256	960	960	480
R^2	0.550	0.550	0.603	0.565	0.565	0.599

The dependent variable is Crop Income I_{chmt} from selling crop c for household h in season m of year t for all major crops. $Post_t$ is an indicator for 2007 and 2010, Pre_t is an indicator for 2004 and $Post_t = Pre_t = 0$ for 2000. Village-Crop-level BTB is $BTB_{cv} \equiv BTB_c \cdot \bar{\varphi}_{cv}$ and Crop-level BTB is $BTB_c \equiv \sum_s s \cdot BTB_{sc}$ where $s = 1$ for Marketing/Warehousing/Selling/Exporting, 2 for Milling/Processing and 3 for Buying, BTB_{sc} is the number of sections of legislations regarding agribusiness requirements that are repealed/deleted/amended at each stage for the crop between 2005-2006, and $\bar{\varphi}_{cv}$ is the mean potential crop yield of the village $v$of the household. $A_{ch} = 1$ for households who sold the crop to agribusinesses in the pre-policy period, and 0 otherwise. Columns 1, 2 and 3 are for the sample of households who sell to agribusinesses in the pre-policy period $A_{ch} = 1$, while Columns 4, 5 and 6 are for the sample of households who sell to agribusinesses in the pre-policy as well as the post-policy periods. Columns 1, 2, 4 and 5 refer to a balanced panels of household-crop-season-year observations, while Columns 3 and 6 refer to the balanced panels restricted to the pre-policy period. Standard errors are clustered by crop in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.4.2. *Household-Crop Incomes: Farmers Selling to Agribusinesses Before.* Table 8 hones down on households who sold the crop to agribusinesses before the policy change $A_{ch} = 1$. These households who sell to agribusinesses in the pre-policy period make up over 24 per cent of the sample. Columns 1 to 3 show results for the balanced panel of crop incomes across all households selling the crop to agribusinesses while Columns 4 to 6 show them for the subset of household-crops that sold to agribusinesses before and continue to sell to agribusinesses after the policy change (2007 or 2010). Columns 1 and 4 show a fall in crop incomes, which are almost double in magnitude for the continuing farmers. Columns 2 and 5 add in the full set of interactions and show that the coefficients are remarkably

stable in sign and magnitude across specifications. Finally, Columns 3 and 6 show that replicating the estimating equations to determine changes in the pre-policy period of 2000 and 2004 does not show the same sign for the policy coefficient and it is an order of magnitude lower than the actual post-policy coefficient. We therefore find evidence for a fall in crop incomes from the BTB policy change for farmers who were exposed to agribusinesses (theoretically, households with $\varphi_{cv} > \varphi_{acv}$ before the policy change).

We can decompose the income fall into the extensive margin of growing crops, the intensive margin of crop incomes and within the latter, the prices received and the quantities sold. Table 14 in the Online Appendix shows that the income drop is largely driven by the intensive margin of incomes. The elasticity of within-household-crop income to a unit BTB policy change (going from 0 to 1) is -2.5 per cent on average. Although not precisely estimated, the contribution of farm quantities and prices is between -1.95 to -2.08 per cent (quantities sold) and between -0.25 to -0.43 per cent (prices received by farmers) respectively.

5.4.3. *Robustness of Household-Crop Incomes: Farmers Selling to Agribusinesses Before.* We conduct a number of robustness checks of Table 8 to ensure that the drop in crop incomes for farmers who were exposed to agribusinesses is not driven by other factors. Overall, Table 12 in the Appendix shows results persist qualitatively and the magnitude of the BTB coefficient remains stable across specifications. The first robustness check in Column 1 puts world prices of the crop on the RHS to ensure that the results are not driven by a greater fall in *world prices* of BTB crops. World prices are obtained from trade-weighted 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 each survey period. The latter accounts for the potential role of intermediaries in reducing negative world price shocks to farmers (Allen and Atkin 2016). As the world price trickle down rate is of interest in itself, we examine the elasticity of crop incomes to world prices at their mean values. The estimated crop income elasticity to world price is 21 per cent, but the protection from fall in world prices is statistically insignificant. Alternative specifications like interactions with comparative advantage $\bar{\varphi}_{cv}$ or inclusion of world price terms for the pre period do not alter the key qualitative results and the magnitude of the BTB coefficient remains highly stable (available upon request). Across these different specifications, the Fall coefficients continue to be imprecisely estimated or to reflect similar trickle down to income as for price increases.

Negative *productivity shocks* to crops, for example, through bad weather, could lower income from policy-affected crops. Column 2 includes the share of harvest that got spoiled during the season-year for each crop interacted with the post-period indicator and this

barely changes the coefficient on the policy variable, compared to the baseline. Column 3 adds in an interaction of post with an index of *distortions* in the crop market in the pre-policy period. The latter is taken from a World Bank study by Winter-Nelson and Argwings-Kodhek (2007) which compiles information on the taxes and subsidies provided to different crops in Kenya. We use values from 1999 to 2004. (The index is reported for 1995-1999 and for 2000-2004 so a weighted average of the values is taken). As expected, higher distortions in the crop market reduce crop incomes for farmers, but this is not precisely estimated. The time period covered in this study includes changes in the power of *state parastatals*. We discuss this in detail, theoretically and empirically, in an earlier working paper (Dhingra and Tenreyro 2020). Here we focus instead on showing that the policy variation in BTBs is much finer and not confounded by these other changes. Column 4 includes an interaction between an indicator for crops which were announced to have reduced state parastatal activity. It suggests an additional drop in crop incomes, with a large estimated elasticity which nonetheless is statistically insignificant. If anything, the BTB policy coefficient remains intact and variations of Columns 2, 3 and 4 including interactions with comparative advantage and the additional RHS variables makes little difference to the BTB coefficient (available upon request).

While the BTB policy altered investment and licensing requirements, it also coincided in the case of three crops, coconut, pyrethrum and tea, with changes in rules for *elections* to the boards of these crops (that in some cases were allowed to buy from farmers). We include an interaction between the post-period indicator and the crops getting election changes on the RHS. This had a clearly positive impact on crop incomes but the scope of the reform was very limited and it leaves the BTB policy coefficient similar to the baseline. Results are similar when the full set of interactions between elections, post and comparative advantage are added (available upon request).

To examine whether the *stage codification* matters, we examine an alternative policy variable where all stages are set to 1 so that the policy variables on the RHS in Column 6 are $Post_t \left(\sum_s BTB_{sc} \cdot \bar{\varphi}_{cv}\right)$ and $Post_t \left(\sum_s BTB_{sc}\right)$ respectively in the first two rows. These results confirm the robustness of the findings. (Note that the magnitude of the coefficient changes as the policy variable has been scaled differently). Another concern is 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. Column 7 restricts the sample to non-maize crop incomes and results remain qualitatively similar. The magnitude of the BTB policy coefficient is somewhat smaller but still economically and statistically significant.

5.4.4. *Household Incomes: Farmers Selling to Agribusinesses Before.* Having examined the microeconomic channel of household-crop incomes, we turn to examining household-level incomes and consumption for these households to ascertain the welfare impacts of the policy through farming and non-farming activities. Estimating equation 4.2 for incomes from farming at the level of the household, Column 1 of Table 9 shows a reduction in incomes from sales to agribusinesses across all crops. The elasticity of household farm incomes from agribusinesses is estimated to be 2.6 per cent of the mean income from agribusinesses (going from a BTB policy change of 0 to 1). Column 2 finds a similar reduction in total income from farming, and a similar-sized elasticity of 2.4 per cent evaluated at the mean farming income for those who sold to agribusinesses. In contrast, estimating equation 4.2 for farm incomes of farmers who did *not* sell to agribusinesses before, the coefficient on $Post_t$ ($\sum_c \sum_s s \cdot BTB_{sc} \cdot \bar{\varphi}_{cv}$) is -0.0199 (with a standard error of 0.0944), which is statistically and economically insignificant with a much smaller elasticity of -0.05 per cent of the mean income for households who did not sell to agribusinesses before.

TABLE 9. BTB Policy and Household Incomes of Farmers Selling to Agribusinesses in the Pre-Policy Period

	Dependent variable: Household Incomes of Farmers Selling to Agribusinesses (in '000 KSh)				
	(1) Agribusiness	(2) Farming	(3) Net Farm Income	(4) Wages	(5) Enterprise
$Post_t \cdot BTB_{cv}$	-0.1096**	-0.2018**	-0.2042**	-0.0475	-0.0986
	(0.5021)	(0.0835)	(0.0875)	(0.0551)	(0.1264)
Household FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
N	1,368	1,368	1,368	1,368	1,368
R^2	0.534	0.537	0.518	0.634	0.498

The dependent variable is Farm Income from Agribusinesses $\sum_c \sum_m I_{chmt} A_{chmt}$ across all crops c and all seasons m for household h in year t in Column 1 (where A_{chmt} is an indicator for sales to agribusinesses), Total Farm Income $\sum_c \sum_m I_{chmt}$ in Column 2, Total Farm Income Net of Fertiliser and Land Preparation purchases in Column 3, Wage Income for the household in Column 4 and Income from Business Enterprises of the household in Column 5. The sample is a balanced panel of household-year observations for all households who sold the crop to agribusinesses in the pre-policy period, $A_{ch} = 1$. $Post_t$ is an indicator for 2007 and 2010. Village-Crop-level BTB is $BTB_{cv} \equiv BTB_c \cdot \bar{\varphi}_{cv}$ and Crop-level BTB is $BTB_c \equiv \sum_s s \cdot BTB_{sc}$ where $s = 1$ for Marketing/Warehousing/Selling/Exporting, 2 for Milling/Processing and 3 for Buying, BTB_{sc} is the number of sections of legislations regarding agribusiness requirements that are repealed/deleted/amended at each stage for the crop between 2005-2006 in all Columns except 6 where s is set to 1 for all stages. $\bar{\varphi}_{cv}$ is the mean potential crop yield of the village $v$of the household. Standard errors are clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.4.5. *Robustness of Household Incomes: Farmers Selling to Agribusinesses Before.* Robustness of results in Table 9 to various control variables is discussed in the Appendix and here we summarise the key findings for the robustness checks. As earlier, inclusion of world price changes, pre-period crop distortions, share of harvest spoiled and election policies does not alter the main findings and provides a range from -0.20 to -0.34 for the estimated BTB policy coefficient. The negative BTB policy coefficient persists across specification which re-code the policy variable to set all stages equal to one and exclude maize incomes. Following Suri (2011), we exclude coastal provinces, where the income data for 2004 might suffer from measurement error, and find that the main finding continues to hold. In early 2008, violence erupted in parts of Kenya after re-election of the government and including an indicator for those who were directly or indirectly affected by the violence leaves the BTB policy coefficient unchanged at -0.20, although the violence itself shows up with a negative coefficient. Allowing the post-period intercept to vary by comparative advantage, we find that the BTB policy loses statistical significance but the coefficient remains highly stable (-0.2337 with a standard error of 0.1590). Going further to allow the post-period intercept to vary by comparative advantage in policy-affected crops, the policy coefficient is again similar to other specifications and more precise in Column 9. This shows that the policy impacts are driven by variation in BTBs within the group of crops that get any BTB policy change and not simply by the share of crops covered by the BTBs.

5.4.6. *Household Welfare: Farmers Selling to Agribusinesses Before.* We start with farm channels that impact household welfare beyond farm incomes and then discuss non-farm channels and consumption.

Column 3 of Table 9 regresses total farm incomes net of fertiliser and land preparation payment costs on the BTB policy variables and continues to find negative income effects from the policy. If interlinked transactions were the source of market power of agribusinesses, we would expect net farm income to respond even more negatively but this does not seem to be the case.

Estimating equation 4.3 for households who sold to agribusinesses, we find that the BTB policy did not increase non-farm sources of incomes, as shown for wage income in Column 4 and for income from business enterprises in Column 5.

To capture spillovers on to consumption, we use survey responses on household purchases and assets to gauge the extent to which household consumption was affected by the policy shift in Table 10. The survey contains two key sources of consumption data – expenditures on crops, fruit and vegetables (which are available for 2004 and 2007 but not 2000), an indicator from seeking credit for household, medical or educational needs,

TABLE 10. BTB Policy and Household Consumption of Farmers Selling to Agribusinesses in the Pre-Policy Period

	Dependent variable: Household Consumption of Farmers Selling to Agribusinesses				
	Food consumption		Credit Needs Indicator	Assets Owned	
	(1) Crops	(2) Fruit-Veg	(3)	(4) All	(5) Agri Assets
$Post_t \cdot BTB_{cv}$	-0.0053	-0.0056	0.0001	-1.346**	-1.0621***
	(0.0072)	(0.0068)	(0.0005)	(0.6746)	(0.3785)
Household FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
N	1,368	1,026	1,368	1,368	1,368
R^2	0.397	0.586	0.370	0.624	0.584

The dependent variable is Purchases of Crops (in '000 KSh) of household h in year t in Column 1, Purchases of Fruit and Vegetables (in '000 KSh) in Column 2, an Indicator for whether the household sought credit for household, medical and education needs in Column 3, Value of All Assets Owned (in '000 KSh) in Column 4 and Value of Agricultural Assets Owned (in '000 KSh) in Column 5. The sample is a balanced panel of household-year observations for all households who sold the crop to agribusinesses in the pre-policy period, $A_{ch} = 1$. $Post_t$ is an indicator for 2007 and 2010. Village-Crop-level BTB is $BTB_{cv} \equiv BTB_c \cdot \bar{\varphi}_{cv}$ and Crop-level BTB is $BTB_c \equiv \sum_s s \cdot BTB_{sc}$ where $s = 1$ for Marketing/Warehousing/Selling/Exporting, 2 for Milling/Processing and 3 for Buying, BTB_{sc} is the number of sections of legislations regarding agribusiness requirements that are repealed/deleted/amended at each stage for the crop between 2005-2006 in all Columns except 6 where s is set to 1 for all stages. $\bar{\varphi}_{cv}$ is the mean potential crop yield of the village $v$of the household. Standard errors are clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

and the values of assets, including agricultural and non-agricultural assets owned by the household in each survey year.

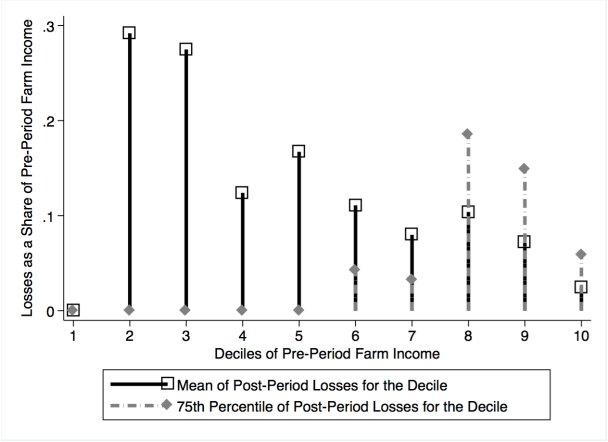
Expenditures on crops, fruit and vegetables could rise when farmers are better off from the policy or fall when farmers increase self-consumption in response to reduced incomes. While the welfare interpretation is hard to gauge, it turns out that these expenditures do not vary systematically with BTB policy changes, as shown in Column 1 of Table 10. Households also do not show increased borrowings to obtain essential services like education and health, which are important for welfare of low-income households (Column 3).[8]

Finally, we examine the value of assets that households own in Columns 4 and 5 which show a reduction that is mostly from a fall in the value of agricultural assets (which form the bulk of assets owned by rural households). The elasticity evaluated at the mean asset holding is -6.5 per cent of initial asset holding (when going from a BTB

[8]A caveat is in order, because the wording of the credit questions are slightly different in the 2007 survey where the purpose of credit was recorded for credit obtained, but the rates look consistent over time.

policy change of 0 to 1). The elasticity needs to be interpreted with caution as it does not necessarily mean that households are permanently poorer by this amount. These are lumpy goods which include durable consumption items and income-generating assets which could produce large divestment initially. Large divestment responses are similar to Kaboski and Townsend (2011) and Brooks and Donovan (2017), which find household consumption and investment responses that move more than one for one with earnings. Further, the findings are consistent with Brambilla and Porto (2011), which finds large losses – 40 per cent – in crop yields from failure of outgrower schemes for cotton farmers in Zambia.

FIGURE 5.4. Post-Period Farm Income Losses by Deciles of Pre-Period Farm Incomes



The x-axis plots the decile of household farm income from the pre-policy period (2000 and 2004). The y-axis plots the farm income losses as a share of pre-policy period household farm income for the decile. The mean in black is the total loss for the decile divided by the total farm income of the decile in the pre-policy period. The grey dotted line is the 75th percentile of income loss (as a share of the household's farm income in the pre-policy period) across all households in the decile. Income losses of farmers that do not sell to agribusinesses in the pre-policy period (2000 and 2004) are zero. Based on Column 2 of Table 9, income losses of farmers that sell to agribusinesses in the pre-policy period are defined as $(.2017739)\cdot\sum_c\sum_s s\cdot BTB_{sc}\cdot\bar{\varphi}_{cv}/\sum_c\sum_m I_{chm}$ where I_{chm} is the income in the pre-policy period from crop c of household h in season m, $s = 1$ for Marketing/Warehousing/Selling/Exporting, 2 for Milling/Processing and 3 for Buying, BTB_{sc} is the number of sections of legislations regarding agribusiness requirements that are repealed/deleted/amended at each stage for the crop between 2005-2006.

Finally, Figure 5.4 enables visualisation of farm income losses from the BTB policy across deciles of pre-policy period farm incomes of households. A first observation is that the lowest decile of farmers did not see losses as they do not participate in agribusiness

activities. Mean losses were in fact zero for the bottom half of the farming households as they rarely participate in agribusiness activities. Among the bottom half, those who do participate in agribusiness activities for some crops experienced farm income losses, which at the top end (75th percentile of losses) made up a substantial share as their incomes were low to start with. The top half of farming households, who in our sample are still smallholders with less than 50 acres of land initially, experienced a mean loss of 7.8 per cent of their initial farm incomes, with the 75th percentile of losses making up shares ranging from 3.2 to 18.5 per cent of the initial farm income of the household.

Summing up, household-crop incomes fell for farmers who were selling the BTB-affected crops to agribusinesses before, especially in villages that have a comparative advantage in these crops. Evaluated at the mean BTB policy value, this translated into a 6.7 per cent drop in farm income from agribusinesses or a similar 6.4 per cent drop in total farm income of the household. These households were still able to afford similar levels of their daily food expenditures but their big ticket purchases suffered. The losses are largely experienced by households with above median farm incomes, but some households even in the bottom half end up with substantial losses in incomes.

5.4.7. *Mechanism: Agribusiness Profits.* To examine the mechanism of distributional tension between farm incomes and agribusiness profits in Proposition 4, we estimate equation 4.4 for agribusiness profit margins in Table 11. In our baseline specification of Column 1, on average, agribusinesses get an estimated 0.83 percentage point increase in profit margin when the BTB policy goes from 0 to 1. Evaluated at the average sales-weighted profit margin in the initial period, the elasticity to a unit increase in BTB is 10 per cent of the initial profit margin of agribusinesses. As the sales-weighted mean of the BTB policy is 0.53 across firms, agribusiness profit margins increase by 0.44 percentage point or 5.3 per cent of the initial margin during the period.

Column 2 examines pre-trends in profit margins, by estimating the profit margin equation for the pre-policy period (1999-2004) and artificially switching the BTB policy on during 2001-2004 (which corresponds to the household survey years). The estimated coefficient turns out to be half in absolute magnitude and statistically insignificant.[9] Columns 3, 4 and 5 conduct robustness checks. Column 3 drops Uchumi supermarkets from the sample to ensure that its assignment to the fruit and vegetable segments is not driving the result. Column 4 drops Kenya Orchards from the sample to ensure coding its profit margin as zero in the two years that it was not listed on the Nairobi stock exchange, does

[9]An unweighted regression takes the pre-period policy coefficient down further to a quarter of its value in Column 2.

TABLE 11. Profit Margins of Listed Agricultural Firms by Specialisation in Policy-Affected Crop Segments

	Dependent Variable: Agribusiness Profit Margin				
	(1)	(2) Pre	(3) No Uchumi	(4) No KOrchards	(5) Winsorize
$Post_t \left(\sum_c BTB_c \cdot S_{cj}\right)$	0.0083**		0.0085***	0.0083**	0.0088**
	(0.0044)		(0.0027)	(0.0036)	(0.0036)
$Pre_t \left(\sum_c BTB_c \cdot S_{cj}\right)$		-0.0045			
		(0.0052)			
Company FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
N	156	78	144	144	156
R^2	0.573	0.522	0.570	0.572	0.655

The dependent variable is the Profit Margin (Profit Before Tax/Sales) of the agribusiness firm during the year. The sample consists of the universe of agricultural companies listed on the Nairobi Stock Exchange between 1999 to 2010. $Post_t$ is an indicator for 2005 to 2010, Pre_t is an indicator for 2001 to 2004 and $Post_t = Pre_t = 0$ for 1999 to 2001. Firm-level BTB is $BTB_c \cdot S_{cj}$ and Crop-level BTB is $BTB_c = \sum_s s \cdot BTB_{sc}$ where $s = 1$ for Marketing/Warehousing/Selling/Exporting, 2 for Milling/Processing and 3 for Buying, BTB_{sc} is the number of sections of legislations regarding agribusiness requirements that are repealed/deleted/amended at each stage for the crop between 2005-2006. S_{cj} is the mean share of crop c in sales across all crops of firm j between 1999 to 2004. Standard errors are clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

not alter the main results. Finally, Column 5 winsorizes the profit margins (to lie between -0.4 to 0.4) to account for outlier values and results remain robust.

One concern may be that profits rise because of economies of scale but there is little evidence for this as discussed in the Online Appendix, where Table 15 shows little systematic relation between firm-crop segment sales and crop BTBs, and between total firm sales and firm-level BTBs. If anything sales drop very slightly (amounting to less than 1 percent on average), which turn out to be statistically insignificant. We conclude that agribusinesses specialised in BTB-affected crops saw a rise in profit margins, with no accompanying increase in sales. Therefore, the mirror image of firm profits shows a distributional tension rather than an increase in the size of the pie from BTB policies.

6. 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 systematic analysis of their impact on low-income farming households.

This paper starts from two observations: first, small farmers often sell their produce in crop markets, domestically or abroad, through agribusinesses or other intermediaries. And second, farmers selling to agribusinesses tend to have relatively larger farms and earn higher incomes. We embed these stylised facts in a flexible theoretical model that features comparative advantage and heterogenous farmers who sort into different types of intermediation. Agribusiness intermediation requires material fixed-investment outlays, while offering higher productivity. Thus, agribusiness intermediation tends to "select" higher income farmers. The model allows us to analyse the welfare impact of policies that reduce entry barriers for agribusinesses. It shows that a rise in agribusiness intermediation increases farm incomes when productivity gains from agribusinesses are large relative to their investment outlays in providing expanded services to farmers. Endogenous entry of agribusinesses, as well as the oligopsonistic incomes that they pay to farmers, depend negatively on these relative investment costs. When behind-the-border barriers to operation of agribusinesses are eased, small productivity gains can be overwhelmed by larger investment outlays, which drive up the endogenous market size per agribusiness firm. Direct entry responses are then more muted, resulting in increased buyer power. The rise of agribusinesses therefore skews the distribution of buyers of farm produce towards larger firms with greater buyer power. This leads to a distributional tension between farmers and firms which need not be offset by an increase in the size of the pie through better intermediation technology. The impact of the policy on farm incomes, whether positive or negative, is larger in villages that have a comparative advantage and hence are more reliant on crops that are affected by the policy.

Taking the theory to data from Kenya, we first codify behind-the-border barriers to operations of agribusinesses for a large national policy change across different crop markets. We show that households selling to agribusinesses experienced a reduction in incomes from crops that saw a shift in policies toward enabling agribusiness operations. This translated into reduced farm incomes which were not offset by increases in non-farm sources of incomes (such as wages). Durable consumption declined during the period and some farmers exited from selling to agribusinesses by the end of the sample period. Manually compiling company accounts of firms listed on the stock exchange, we provide evidence for a rise in agribusiness profit margins for firms that were specialised in crops affected by the policy. Overall, we find that the BTB policy did not have much impact on the bottom half of households by farming income, though there were some large percentage reductions in incomes. This is because many of these households do not participate at all in agribusiness activities. Among the top half of the small farmers, there were income losses of an average of 6 to 7 per cent of initial farm incomes, with a range of 3 to 18 per cent.

The policy shift therefore raised firm profits at the expense of farm incomes for households. The results provide evidence for long-standing concerns that commercialisation of agriculture, via agribusinesses that wield oligopsony 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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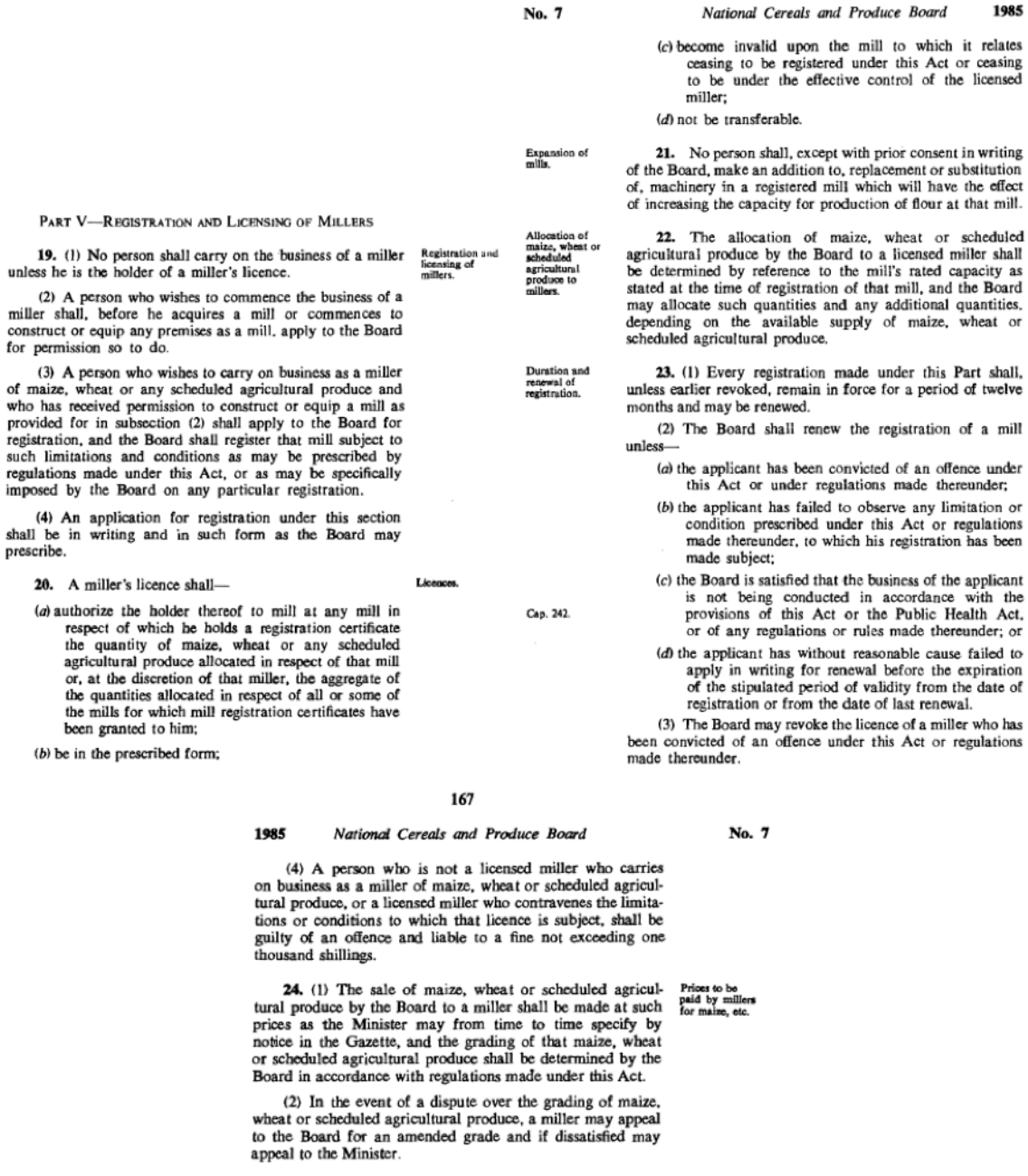
Appendix

To arrive at Proposition 3, note that farm income from selling to an agribusiness is $\frac{M(k-1)}{M(k-1)+1} pm_t \left(\frac{1+m_a/m_t}{f}\right) \varphi - f$ (suppressing cv subscripts). The number of agribsuinesses is determined by free entry which can be re-written as $\frac{k}{k-1}\varphi_{\min}^{k} \frac{1/M}{M(k-1)+1} (pm_t)^k \left(\frac{M(k-1)}{M(k-1)+1}\right)^{k-1} = \left[\left(\frac{1+m_a/m_t}{f}\right)^{-k} (1 + F_A/F_T)/f\right] F_T$. When the term in square brackets on the RHS is larger than one, the number of agribusinesses will be lower than the number of traders in the initial equilibrium. Consequently, prices paid to farmers, holding fixed the initial

intermediation productivity, will also be lower. Small productivity gains will then be consistent with free entry and lower farm incomes, as discussed in section 3.2.2. This can be seen from the RHS which has three key parameters (m_a/m_t, F_A/F_T, f). The equilibrium conditions for the initial and new equilibria only constrain pairs of parameters, so different results can arise based on the unconstrained parameter.

Online Appendix

Figure 6.1. Example of BTB Codification



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(*c*) become invalid upon the mill to which it relates ceasing to be registered under this Act or ceasing to be under the effective control of the licensed miller;

(*d*) not be transferable.

Expansion of mills.

21. No person shall, except with prior consent in writing of the Board, make an addition to, replacement or substitution of, machinery in a registered mill which will have the effect of increasing the capacity for production of flour at that mill.

PART V—REGISTRATION AND LICENSING OF MILLERS

Registration and licensing of millers.

19. (1) No person shall carry on the business of a miller unless he is the holder of a miller's licence.

(2) A person who wishes to commence the business of a miller shall, before he acquires a mill or commences to construct or equip any premises as a mill, apply to the Board for permission so to do.

(3) A person who wishes to carry on business as a miller of maize, wheat or any scheduled agricultural produce and who has received permission to construct or equip a mill as provided for in subsection (2) shall apply to the Board for registration, and the Board shall register that mill subject to such limitations and conditions as may be prescribed by regulations made under this Act, or as may be specifically imposed by the Board on any particular registration.

(4) An application for registration under this section shall be in writing and in such form as the Board may prescribe.

Allocation of maize, wheat or scheduled agricultural produce to millers.

22. The allocation of maize, wheat or scheduled agricultural produce by the Board to a licensed miller shall be determined by reference to the mill's rated capacity as stated at the time of registration of that mill, and the Board may allocate such quantities and any additional quantities, depending on the available supply of maize, wheat or scheduled agricultural produce.

Duration and renewal of registration.

23. (1) Every registration made under this Part shall, unless earlier revoked, remain in force for a period of twelve months and may be renewed.

(2) The Board shall renew the registration of a mill unless—

(*a*) the applicant has been convicted of an offence under this Act or under regulations made thereunder;

(*b*) the applicant has failed to observe any limitation or condition prescribed under this Act or regulations made thereunder, to which his registration has been made subject;

(*c*) the Board is satisfied that the business of the applicant is not being conducted in accordance with the provisions of this Act or the Public Health Act, or of any regulations or rules made thereunder; or

(*d*) the applicant has without reasonable cause failed to apply in writing for renewal before the expiration of the stipulated period of validity from the date of registration or from the date of last renewal.

(3) The Board may revoke the licence of a miller who has been convicted of an offence under this Act or regulations made thereunder.

20. A miller's licence shall— Licences.

(*a*) authorize the holder thereof to mill at any mill in respect of which he holds a registration certificate the quantity of maize, wheat or any scheduled agricultural produce allocated in respect of that mill or, at the discretion of that miller, the aggregate of the quantities allocated in respect of all or some of the mills for which mill registration certificates have been granted to him; Cap. 242.

(*b*) be in the prescribed form;

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(4) A person who is not a licensed miller who carries on business as a miller of maize, wheat or scheduled agricultural produce, or a licensed miller who contravenes the limitations or conditions to which that licence is subject, shall be guilty of an offence and liable to a fine not exceeding one thousand shillings.

Prices to be paid by millers for maize, etc.

24. (1) The sale of maize, wheat or scheduled agricultural produce by the Board to a miller shall be made at such prices as the Minister may from time to time specify by notice in the Gazette, and the grading of that maize, wheat or scheduled agricultural produce shall be determined by the Board in accordance with regulations made under this Act.

(2) In the event of a dispute over the grading of maize, wheat or scheduled agricultural produce, a miller may appeal to the Board for an amended grade and if dissatisfied may appeal to the Minister.

Source: NCPB Act, No. 7 of 1985

TABLE 12. Robustness of BTB Policy and Household-Crop Incomes of Farmers Selling to Agribusinesses in the Pre-Policy Period

	Dependent variable: Crop Income of Farmers Selling to Agribusinesses (in '000 KSh)						
	(1)	(2)	(3)	(4)	(5)	(6) $s=1$	(7) No Maize
$Post_t \cdot BTB_{cv}$	-0.5300***	-0.6277***	-0.6617***	-0.6761***	-0.6177***	-1.1612***	-0.4704***
	(0.1750)	(0.1002)	(0.1103)	(0.1513)	(0.1085)	(0.1860)	(0.0576)
$Post_t \cdot BTB_c$	-0.0546	0.0334	0.0274	0.2363	0.0504	0.1432	0.0197
	(0.2415)	(0.1031)	(0.0949)	(0.1919)	(0.1482)	(0.1678)	(0.0613)
$Post_t \cdot \bar{\varphi}_{cv}$	2.6402	-1.6623	0.6828	4.0115	-1.6625	-2.6436	-3.8896
	(4.3832)	(3.1211)	(3.1971)	(6.7434)	(3.3199)	(3.4763)	(2.3053)
$Post_t \cdot p^w_{ct}$	33.1456**						
	(14.7664)						
$Post_t \cdot Fall_{ct}$	12.2635						
	(9.2885)						
$Post_t \cdot p^w_{ct} \cdot Fall_{ct}$	-17.9861						
	(20.3313)						
$Post_t \cdot Spoiled_{ct}$		0.4775					
		(0.5405)					
$Post_t \cdot Distortion_c$			-0.0749				
			(0.1224)				
$Post_t \cdot Parastatal_c$				-14.1073			
				(11.9393)			
$Post_t \cdot Election_{cv}$					0.1974***		
					(0.0863)		
Hh-Crop-Season FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2,512	2,512	2,512	2,512	2,512	2,512	2,272
R^2	0.551	0.550	0.550	0.550	0.550	0.549	0.529

The dependent variable is Crop Income I_{chmt} from selling crop c for household h in season m of year t for a balanced panel of household-crop-season-year observations for all major crops and for all households who sold the crop to agribusinesses in the pre-policy period, $A_{ch} = 1$. $Post_t$ is an indicator for 2007 and 2010. Village-Crop-level BTB is $BTB_{cv} \equiv BTB_c \cdot \bar{\varphi}_{cv}$ and Crop-level BTB is $BTB_c \equiv \sum_s s \cdot BTB_{sc}$ where $s = 1$ for Marketing/Warehousing/Selling/Exporting, 2 for Milling/Processing and 3 for Buying, BTB_{sc} is the number of sections of legislations regarding agribusiness requirements that are repealed/deleted/amended at each stage for the crop between 2005-2006 in all Columns except 6 where s is set to 1 for all stages. $\bar{\varphi}_{cv}$ is the mean potential crop yield of the village $v$of the household. p^w_{ct} is the lagged export unit value from COMTRADE for all countries except Kenya. $Fall_{ct}$ is an indicator for whether world prices fell compared to the previous survey year. $Spoiled_{ct}$ is the share of the harvest that was spoiled for each crop and year. $Distortion_c$ is the distortion index for Kenyan crops from the World Bank for 1999-2004. $Parastatal_c$ is an indicator for whether the crop was announced to have reduced role for state parastatals, which applies to 18 crops. $Election_c$ is an indicator for crops that saw changes in election requirements for the crop, which applies to 3 crops. Column 6 recodes the BTB variables with $s = 1$ for all stages while Column 7 removes maize transactions from the sample which is the reasons for the drop in sample size. Standard errors are clustered by crop in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

TABLE 13. BTB Policy and Farm Incomes of Households Selling to Agribusinesses in the Pre-Policy Period

	Dependent variable: Farm Income of Farmers Selling to Agribusinesses (in '000 KSh)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Post_t \cdot BTB_v$	-0.3366*	-0.2021**	-0.2086***	-0.2042**	-0.2006**	-0.1983**	-0.3207**	-0.1378***	-0.2989*
	(0.1962)	(0.0847)	(0.0788)	(0.0831)	(0.0828)	(0.0850)	(0.1545)	(0.0933)	(0.1514)
$Post_t \cdot p^w_{vt}$	2.8045								
	(5.1136)								
$Post_t \cdot Fall_{vt}$	6.6501								
	(4.6493)								
$Post_t \cdot p^w_{vt} \cdot Fall_{vt}$	-19.6630								
	(15.1136)								
$Post_t \cdot Distortion_v$		-0.2138							
		(1.011)							
$Post_t \cdot Spoiled_{vt}$			0.2508						
			(0.6724)						
$Post_t \cdot Election_v$				0.1974***					
				(0.0863)					
$Post_t \cdot Violence_h$					-2.4404				
					(8.869)				
$Post_t \cdot 1_{BTB_c>0} \cdot \bar{\varphi}_{cv}$									0.9447
									(1.0986)
$Post_t \cdot \sum_c \bar{\varphi}_{cv}$									0.9447
									(1.0986)
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,368	1,368	1,368	1,368	1,368	1,344	1,368	1,368	1,368
R^2	0.538	0.537	0.537	0.537	0.537	0.536	0.536	0.514	0.537

The dependent variables is income from all crops sold by households $\sum_m \sum_c I_{chmt}$ where I_{chmt} is the income from crop c sold by household h in season m of year t. $Post_t$ is an indicator for 2007 and 2010. Village-Crop-level BTB is $BTB_{cv} \equiv \sum_c \sum_s s \cdot BTB_{sc} \cdot \bar{\varphi}_{cv}$ where $s = 1$ for Marketing/Warehousing/Selling/Exporting, 2 for Milling/Processing and 3 for Buying, BTB_{sc} is the number of sections of legislations regarding agribusiness requirements that are repealed/deleted/amended at each stage for the crop between 2005-2006, and $\bar{\varphi}_{cv}$ is the mean potential crop yield of the village v of the household. $A_{ch} = 1$ for households who sold the crop to agribusinesses in the pre-policy period, and 0 otherwise. The sample of households is those who sell to agribusinesses in the pre-policy period $A_{ch} = 1$. p^w_{ct} is the lagged export unit value from COMTRADE for all countries except Kenya. $Fall_{ct}$ is an indicator for whether world prices fell compared to the previous survey year. $Spoiled_{ct}$ is the share of the harvest that was spoiled for each crop and year. $Distortion_c$ is the distortion index for Kenyan crops from the World Bank for 1999-2004. Crop-level RHS variable X_c is agggregated up to the housheold level as $X_v \equiv \sum_c \bar{\varphi}_{cv} \cdot X_c$. $Violence_h$ is an indicator for whether the hosuehold suffered directly or indirectly from the post-election violence in 2009. $1_{(BTB_c>0)}$ is an indicator for crops that experienced any BTB policy change. Column 6 removes the sample of households that belong to the Coast. Column 7 recodes the BTB variables with $s = 1$ for all stages, Column 8 removes maize incomes from total farm income. Standard errors are clustered by crop in parentheses.

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

TABLE 14. BTB Policy and Household-Crop Incomes of Farmers Selling to Agribusinesses in the Pre-Policy Period

	Dependent variable: Margins of Crop Income of Farmers Selling to Agribusinesses							
	Grow		Log(Income)		Log(Price)		Log(Quantity)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Post_t \cdot BTB_{cv}$	0.0003	-0.0018	-0.0252**	-0.0221*	-0.0043	-0.0025	-0.0208*	-0.0195
	(0.0014)	(0.0011)	(0.0087)	(0.0103)	(0.0025)	(0.0036)	(0.0108)	(0.0126)
$Post_t \cdot BTB_c$		0.0020***		0.0006		-0.0039		0.0046
		(0.0004)		(0.0122)		(0.0038)		(0.0108)
$Post_t \cdot \bar{\varphi}_{cv}$		0.0406***		-0.1186		-0.0236		-0.0960
		(0.0102)		(0.1135)		(0.0037)		(0.0138)
Hh-Crop-Season FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2,512	2,512	577	577	577	577	577	577
R^2	0.523	0.524	0.793	0.793	0.951	0.951	0.897	0.898

The dependent variables are various margins of crop incomes: $Grow_{chmt}$ is an indicator for whether crop c is grown and sold by household h in season m of year t while $Log(Income_{chmt})$, $Log(Price_{chmt})$ and $Log(Quantity_{chmt})$ are respectively the log of income received by the farmer, the log of farm price received and the log of quantity sold by the household for that crop. There is one missing observation for price, so Column 7 and 8 drops that one observation for quantity as well. $Post_t$ is an indicator for 2007 and 2010. Village-Crop-level BTB is $BTB_{cv} \equiv BTB_c \cdot \bar{\varphi}_{cv}$ and Crop-level BTB is $BTB_c \equiv \sum_s s \cdot BTB_{sc}$ where $s = 1$ for Marketing/Warehousing/Selling/Exporting, 2 for Milling/Processing and 3 for Buying, BTB_{sc} is the number of sections of legislations regarding agribusiness requirements that are repealed/deleted/amended at each stage for the crop between 2005-2006, and $\bar{\varphi}_{cv}$ is the mean potential crop yield of the village v of the household. $A_{ch} = 1$ for households who sold the crop to agribusinesses in the pre-policy period, and 0 otherwise. Columns 1, 3, 5 and 7 report the baseline and Columns 2, 4, 6 and 8 contain the full set of interactions. The sample of households is those who sell to agribusinesses in the pre-policy period $A_{ch} = 1$. Standard errors are clustered by crop in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE 15. Segmental Sales and Total Sales of Listed Firms by Specialisation in BTB Crops

	Segment Sales		Total Sales	
	(1)	(2) Pre	(3)	(4) Pre
$Post_t \cdot BTB_c$	-13.0548			
	(10.8939)			
$Pre_t \cdot BTB_c$		-0.5750		
		(0.4285)		
$Post_t \cdot BTB_{cv}$			-97.9302	
			(76.420)	
$Pre_t \cdot BTB_{cv}$				-6.6481
				(12.3432)
Company-Segment FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	3,588	1,794	156	78
R^2	0.235	0.990	0.894	0.992

The dependent variable in Columns 1 and 2 is the sales of the firm in a crop segment while in Columns 3 and 4 is the total sales of the firm across all crop segments (in Million KSh). The sample consists of the universe of agricultural companies listed on the Nairobi Stock Exchange between 1999 to 2010. $Post_t$ is an indicator for 2005 to 2010, Pre_t is an indicator for 2001 to 2004 and $Post_t = Pre_t = 0$ for 1999 to 2001. Crop-level BTB is $BTB_c \equiv \sum_s s \cdot BTB_{sc}$ and Firm-level BTB is $BTB_j \equiv \sum_c BTB_c \cdot S_{cj}$ where $s = 1$ for Marketing/Warehousing/Selling/Exporting, 2 for Milling/Processing and 3 for Buying, BTB_{sc} is the number of sections of legislations regarding agribusiness requirements that are repealed/deleted/amended at each stage for the crop between 2005-2006. S_{cj} is the mean share of crop c in sales across all crops of firm j between 1999 to 2004. Standard errors clustered by crop and company in Columns 1-2 and by crop in Columns 3-4 in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

TABLE 16. Household-Crop Summary Statistics

	Obs	Mean	S.D.	Min	Mdn	Max
Income_{chmt} ('000 KSh in 2000)	62072	3.33	31.1	0	0	3273
Potential Yield ($\bar{\varphi}_{cv}$)	62072	0.80	0.79	0	0.55	4.06
Hh-Crops Selling to Agribusiness in Pre period ($A_{ch} = 1$)	62072	0.04	0.20	0	0	1
Hh-Crops Selling to Agribusiness in Pre and Post periods	62072	0.02	0.12	0	0	1
Hh-Crops Selling to Agribusiness only in Post period	62072	0.07	0.25	0	0	1
Hh-Crops Selling to Agribusiness only in Pre period	62072	0.03	0.16	0	0	1
Hh-Crop BTB in Post period ($Post_t \cdot BTB_c \cdot \bar{\varphi}_{cv}$)	62072	2.41	7.02	0	0	45.74
Crop BTB $\left(BTB_c = \sum_s s \cdot BTB_{sc}\right)$	62072	7.49	14.31	0	1	96
Crop BTB $\left(\sum_s BTB_{sc}\right)$ for $s = 1$ across all stages	62072	5.30	11.15	0	1	48
Hh-Crop Election ($Election_c \cdot \bar{\varphi}_{cv}$)	2512	0.17	1.15	0	0	10.98
World Price_{ct}	2512	0.31	0.28	0.10	0.22	1.94
$\text{Fall in World Price}_{ct}$	2512	0.66	0.47	0	1	1
Crop-level Distortion in Pre-Period	2512	23.9	18.5	-3.30	36.5	46.2
Crop-level State Parastatal Indicator	2512	0.39	0.49	0	0	1
Crop-level Harvest Share Spoiled (%)	2512	0.76	2.47	0	0	11.64
Income_{chmt} for $A_{ch} = 1$	2512	19.94	100.30	0	0	2915
Grow Crop Indicator for $A_{ch} = 1$	2512	0.28	0.45	0	0	1
$\text{Log(Price}_{chmt})$ for $A_{ch} = 1$	577	1.40	1.24	-0.427	0.55	6.42
$\text{Log(Quantity}_{chmt})$ for $A_{ch} = 1$	577	8.96	2.21	0	9.57	12.86

TABLE 17. Household Summary Statistics

	Obs	Mean	S.D.	Min	Mdn	Max
Income_{ht} ('000 KSh in 2000)	1368	63.23	178.20	0	23.15	3911
Income from Selling to Agribusiness_{ht} ('000 KSh in 2000)	1368	32.51	126.52	0	0	2915
Income from Wage/Salary ('000 KSh in 2000)	1368	26.77	58.48	0	1.17	554
Income from Enterprise Activity ('000 KSh in 2000)	1368	26.89	130.59	0	0	2829
Income Net of Cash Input Costs ('000 KSh in 2000)	1368	62.50	177.08	-43.69	22.96	3904
Consumption of Crops ('000 KSh in 2000)	1368	1.53	5.12	0	0	81
Consumption of Fruit and Vegetables ('000 KSh in 2000)	1026	1.83	3.91	0	0.62	84
Credit Needs for Education/Medical/Household Purposes	1368	0.19	0.39	0	0	1
Value of Assets Owned ('000 KSh in 2000)	1368	194.82	1086.22	0	44.10	31378
Value of Agricultural Assets Owned ('000 KSh in 2000)	1368	94.26	929.08	0	7.2	27958
Non-Maize Income ('000 KSh in 2000)	1368	48.99	128.52	0	16.68	2928
Potential Yield ($\bar{\varphi}_{cv}$)	1368	12.20	8.02	0	10.88	38.52
Household-level BTB in Post period $\left(Post_t \cdot \sum_c \cdot BTB_c \cdot \bar{\varphi}_{cv}\right)$	1368	31.13	43.37	0	0	268.58
$\sum_c \text{World Price}_{ct} \cdot \bar{\varphi}_{cv}$	1368	3.64	2.36	0	3.33	11.17
$\sum_c \text{Fall}_{ct} \cdot \bar{\varphi}_{cv}$	1368	3.64	2.36	0	3.33	11.17
$\sum_c \text{Fall}_{ct} \cdot \text{World Price}_{ct} \cdot \bar{\varphi}_{cv}$	1368	2.17	1.66	0	1.90	10.45
$Post_t \sum_c \text{Distortion}_c \cdot \bar{\varphi}_{cv}$	1368	101.33	82.41	-4.83	119.76	333.06
$Post_t \sum_c \text{Spoiled}_{ct} \cdot \bar{\varphi}_{cv}$	1368	0.03	0.05	0	0.005	0.38
$Post_t \sum_c \text{Election}_c \cdot \bar{\varphi}_{cv}$	1368	0.25	0.69	0	0	4.39
Hh BTB with $I_a = 1$ in Post period $\left(Post_t \cdot \sum_c BTB_c \cdot \bar{\varphi}_{cv}\right)$	1368	17.40	23.99	0	0	140.90
$Post_t \cdot \text{Violence}_h$	1368	0.05	0.21	0	0	1
Farmers Selling to Agribusiness ($A_{ch} = 1$ for some c in Pre-period)	5688	0.24	0.43	0	0	1

TABLE 18. Agribusiness Summary Statistics

	Obs	Mean	S.D.	Min	Mdn	Max
Sales (Million KSh)	156	6240.73	10932.11	0	1253.2	64718.6
Margin (Profit Before Tax/ Sales)	156	0.074	0.195	-0.56	0.065	1.06
Company-level BTB in Post period	156	3.23	9.40	0	0	48

TABLE 19. BTBs from National Legislations by Crops

Act	**Crops**
National Cereals and Produce Board Act	Wheat Maize Rice Cashewnut
NCPB Exportation of Maize Act	Maize
Investment Promotion Act	Pyrethrum Sisal Maize
	Wheat Tea Sugarcane Coffee
Licensing Laws (Repeals and Amendment) Act	
Canning Crops Act	Pineapple Passionfruit
Coconut Industry Act	Coconut
Coffee License Fees Rules/Coffee Act	Coffee
Sugar Levy	Sugarcane
Cotton Act	Cotton
Pyrethrum Act	Pyrethrum
Sisal Industry Act	Sisal
Sale of Sisal and Collection of Cess	Sisal
Subisidiary Legislation	
Finance Act	Coffee
General Amendment Rules	Coffee
Agriculture Act	
Horticultural Crops Development Authority Act	Mangoes Onion
	Fruit Vegetable Flowers
Pyrethrum Act	Pyrethrum
Tea Elections Regulations Act	Tea
Seed and Ware Potato Regulations Act	Potato
Castor Seed Rules	Castor
Tea Forms Regulations	Tea
Wheat Rules	Wheat