THE RISE OF AGRIBUSINESSES AND ITS DISTRIBUTIONAL CONSEQUENCES

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Abstract. Crops are often modelled as homogeneous products exchanged in perfectly competitive markets. Yet smallholder farmers face high trade barriers in selling their crops. Agribusinesses with better access to world markets can enable farmers to overcome these barriers. But they may also raise buyer power in the thin crop markets faced by farmers. We document that farmers selling to agribusinesses receive higher incomes and higher trickle down from world crop price movements. Incorporating these facts and endogenous buyer power, we quantify the aggregate gains from trade and their distribution between farmers and their intermediaries for three low-income countries in the 2000s.

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

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1. Introduction

Agriculture continues to support a vast majority of people, particularly in low-income countries, where it is the main source of livelihood, employment and exports. Much of the literature in international trade treats crops as homogeneous products that are exchanged in perfectly competitive markets. While this may be a reasonable assumption to characterize world commodity markets, a vast literature finds that farmers face high trade barriers in selling their crops at home and abroad. About 80 per cent of the world's farmers are smallholders who sell through intermediaries, such as traders, parastatals and agribusinesses, which often constitute thin crop markets for farmers (Lowder, Skoet, and Singh (2014)).

Following a string of national reforms in the 1980s-1990s, governments across the world have moved away from directly controlling crop markets to encouraging participation by agribusinesses. There has been an accompanying increase in the production of export crops and entry of new intermediaries including supermarket chains, agro-industrial firms, and export-oriented companies offering outgrower schemes (United Nations Conference on Trade and Development (UNCTAD) (2009)).

The rise of agribusinesses offers opportunities for reducing the barriers that farmers face when accessing markets for their crops. However, there are growing concerns that agribusiness reforms may have also 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 high barriers to market access.[1] More recently, the introduction and rollback of contract farming laws in India present a stark example of these arguments. Farmer protests followed the introduction of laws aimed at boosting farm exports, among concerns in certain communities over income losses stemming from entry of agribusinesses and erosion of state protection in crop markets.

This paper embeds both these channels of increased productivity from agribusinesses and the potential for losses for small farmers from thin markets to examine the welfare consequences of intermediation in crop sales of farmers. It starts with the observation that farmers selling through agribusinesses tend to be larger and to get higher transmission from world price movements. Embedding these empirical regularities in a theoretical model of the microstructure of intermediation, it shows that heterogeneity across farmers and their endogenous sorting to different buyers is critical in determining the direction

[1]Surveys by Barrett and Mutambatsere (2008), Collier and Dercon (2014), Dillon and Dambro (2017), and Barrett et al. (2022) .

and the extent to which world prices and entry costs of intermediaries impact farm incomes. The reasoning behind this is that farmer sorting determines the farm supply elasticity to different intermediaries and hence the resulting endogenous market power of intermediaries.

Inequality and buyer power introduce a wedge between the aggregate gains from trade and the gains from trade that accrue to small farmers. Farmgate prices paid by intermediaries are higher when farm productivity is more equally distributed. In this case, the usual intuition for the welfare gains from trade goes through. As world prices rise or entry costs for intermediaries fall, intermediaries compete more fiercely and pay higher farmgate prices. The aggregate gains from trade and the producer gains from trade therefore move in the same direction.

However, the opposite can happen for small farmers who sell through traders when farm productivity is highly unequal. As relatively large and productive farmers switch to agribusinesses, farm supply to traders takes a hit because the remaining farmers are much smaller than the farmers who switch. Traders experience reduced profitability and exit, making the crop market less competitive for the smallest farmers who are left behind. Consequently, these small farmers who rely on surviving traders face thinner markets and are worse-off after a rise in world prices or a reduction in agribusiness entry costs.

We apply the model to trade data and microdata on farm earnings from three low-income countries in the 2000s to infer the division of the gains from trade between farmers and intermediaries. Trade data on exports of crops and farmer-buyer-crop income data provide estimates of the aggregate gains from trade and the farmer gains from trade across different intermediaries respectively. But broad-based intermediary data remain scarce. For example, studies typically focus on a single crop or a single type of intermediary, making it difficult to understand adjustments along the margins of cropping choices and intermediary choices. Consequently, the overall impacts of world prices on intermediation profits can rarely be directly estimated.

The model bridges the data gap by providing structural relationships that can be taken to trade and farm income data to infer the gains from trade retained by intermediaries, including agribusinesses. In our sample, the main finding is that two-thirds of the world price increases of a crop were received by the exporting country as their aggregate export gains, with about five percent arising from productivity gains. Intermediaries retained the majority of the gains from trade, and farmers gained about fifteen percent of the aggregate export gains. Both agribusinesses and traders obtained a larger share of the per unit world price rise, and hence farmers lost out in relative terms but gained in absolute terms. While the individual gains from trade to farmers who started to sell to agribusinesses after the world price rise were substantive, not enough farmers were able to take advantage of better intermediation to result in transformative productivity gains in the aggregate.

The main contribution of the paper is to propose an efficiency-equity trade-off in buyer markets. Welfare results are qualitatively different in the presence of buyer power and sorting to high productivity buyers. The theory helps conceptualize the various channels through which export gains are distributed across smallholder farmers in the presence of buyer power and a dualistic crop market. It shows how aggregate gains from trade and farmer-level gains can diverge when buyer power interacts with heterogeneous sorting. In doing so, the paper contributes to a large literature examining welfare in the presence of market power and rents, typically on the seller side (e.g. Dixit and Norman (1980), Helpman and Krugman (1987), Vives (1999)). Early work on monopsony shows that market power can overturn classic welfare results (Bishop (1966), Feenstra (1980); Markusen and Robson (1980); McCulloch and Yellen (1980); Bhagwati, Panagariya, and Srinivasan (1998), Devadoss and Song (2006)).

The paper contributes to a growing body of work that examines market power in factor markets (e.g. Manning (2011), Tenreyro, Abel, and Thwaites (2018), Syverson (2019), Burstein, Cravino, and Rojas (2024)). We focus on agricultural markets faced by smallholder farmers and highlight the role played by monopsony power in influencing both economic welfare and equity (Antras and Costinot (2011), Domínguez-Iino (2023)). Recent contributions have modelled the microfoundations of buyer power in crop markets, such as matching frictions and reputational rents (e.g. Bardhan, Mookherjee, and Tsumagari (2013), Chau, Goto, and Kanbur (2009), Krishna and Sheveleva (2017)).[2] We abstract away from the microfoundations, which are difficult to apply to large-scale data that are typically available for analysis in international trade. Instead, we draw on advances in monopolistic competition models of international trade (Helpman (2006), Melitz and Redding (2015)), generalise them to intermediation and oligopsonistic power, and provide a mapping from observable statistics to welfare impacts. The paper therefore provides a parsimonious model that reconciles empirical facts with theory and enables quantification. While the existence of exporter premia is well known in many settings, we show

[2]See Tomar (2016) and Chatterjee (2023) on behind the border barriers.

that farmer sorting and world price changes interact with each other to offer new insights into the gains from trade.

While various dimensions of heterogeneity and institutional context have been explored in the literature on smallholder farming, abstracting away from them enables us to have a model that clearly elucidates the key features on agribusiness sales of farmers that we observe in the data. We highlight the dual structure of crop markets faced by farmers, which is also related to a new body of work on co-existence of small and large firms (e.g.Parenti (2018), Helpman and Niswonger (2023)). We show that agribusinesses transmit world price movements more strongly to farm incomes and quantify the distribution of the gains from trade between farmers and intermediaries. On the measurement and empirical sides, our findings relate to work on the consumer gains from trade under intermediation (Atkin and Donaldson (2015), Startz (2018) and Grant and Startz (2022)), though our focus is on producer gains.

The paper is also related to a large body of work in development and agricultural economics, examining farmer-buyer interactions. Much of this analysis has focused on specific crops and experimental evidence, which usually precludes analysis of large firms, world price movements and national policies. Recent work has examined the role of trade in farming (e.g., Dippel, Greif, and Trefler (2020), Dragusanu, Montero, and Nunn (2022),Bustos et al. (2024), Macchiavello and Morjaria (2021), Fajgelbaum and Redding (2022); survey in Atkin and Khandelwal (2020)) and we contribute to this literature by examining agribusinesses. We also examine the extensive margin of participation in agribusiness supply chains and the lack of access of smallholders, that has been a key insight of the literature (Barrett and Mutambatsere (2008)).

The paper is organized as follows. Section 2 documents empirical regularities in crop intermediation. Section 3 embeds the regularities in a theoretical framework to determine sorting, pricing, and welfare comparative statics. Section 4 applies the theory to quantify the division of the gains from trade observed in Section 2. Section 5 concludes.

2. Agribusiness Facts

In this section, we highlight three facts related to the prevalence of intermediation and differences in farmgate incomes and trickle down rates across intermediaries. The facts systematize many of the observations on the rise of agribusinesses in crop markets. The emergence of modern marketing channels deploy more sophisticated methods than traditional traders to add value to raw commodities through transport, storage and/or processing, broadening the activity of intermediation beyond aggregation and spot distribution of farm produce. Farmers who have the comparative advantage to supply to modern agribusinesses are able to gain from supplying to more distant and profitable markets through access to their crop value chains (see Barrett et al. (2012) for a comparative overview).

We build on these observations to show systematic differences across farmers in intermediation access and its implications in the stylized facts below. The farming data are drawn from the World Bank's Living Standard and Measurement Surveys (LSMS) which provide consistent panels of households from Ethiopia (2004, 2006) and Malawi (2010, 2013, 2016) and from the Rural Household Survey of Kenya (2000, 2004, 2007, 2010) which offers comparable panels from the Tegemeo Agricultural Monitoring and Policy Analysis (TAMPA) project.[3]

2.1. **Empirical Regularities.** We consider a pooled sample of 6,725 households growing 90 distinct crops with over 22,000 distinct household-crop observations in Ethiopia (2,459 households), Malawi (2,770 households) and Kenya (1,496 households).

1. Small farmers often piggy-back on agribusinesses and other intermediaries to sell their produce in crop markets at home and abroad. About four-fifths of farm sales are made to intermediaries, including cooperatives (23.5%), traders (39.1%) and agribusinesses (16%), and the rest are directly to consumers (21.5%). For Kenya, we have a panel that spans over a decade, and we find that agribusinesses almost doubled their market share. The agribusiness share of crop purchases among all intermediaries rose from 19.8% to 37.8% for smallholder farmers (who farm less than fifty acres of land). The broad facts are supported by case study evidence, such as from potato farming for Pepsi Co in Punjab and tobacco production for BAT in Africa, which document a trend towards agro-industrial exporters.[4]

2. Farmers selling to agribusinesses have higher farm revenues and larger farms. A second fact is that farmers who sell to agribusinesses have higher farm incomes and larger farms, that we show formally for a broad set of crop markets though this observation features in studies of specific markets (see Barrett et al. (2012)). Consistent with two-sided selection

[3]All observations from Kenya are weighted by half to account for double the number of waves, while observations from Malawi for 2016 are excluded from panel results due to a change in sampling. The LSMS data is standard and a description of the Kenya data is in the Appendix. For an overview of the latter, see Suri (2011)

[4]Runsten (1994), Goodman and Watts (1997), Warning and Key (2002), Robbins (2003), Reardon and Timmer (2007), Minten, Randrianarison, and Swinnen (2009), Minot (2011).

into contract farming in this literature, in our data, larger farmers are disproportionately engaged with agribusinesses. The 1,068 households that sell to agribusinesses have an average farm income of USD 1,562 per year (in 2010 values), compared to USD 505 for households that do not sell to agribusinesses at all. Farmers who sell to agribusinesses have on average 7.3 acres of land, compared to 4.1 for households that sell to other buyers.

Following the vast literature on exporter premia (Melitz and Redding (2015)), the systematic patterns are examined in Panel A of Table 1 by regressing household outcomes on an indicator for whether the household sells crops to agribusinesses. Farmers who sell to agribusinesses have 136 per cent higher incomes and 45 per cent larger acreage than those for farmers who do not engage with agribusinesses. Panel B regresses household-crop income and household-crop prices on an indicator for whether the farmer sold that crop to an agribusiness. Even at the household-crop level, farmers who sold to agribusinesses have substantially higher incomes. They receive higher farmgate prices but these are not statistically significant. (Acreage is not always available at the household-crop level).[5]

Almost all sales to agribusinesses are of crops that are exported by the country, so we do not report them separately. Including an indicator for export crops and its interaction with the indicator for selling to agribusinesses, the income premia is estimated to be 133 per cent at the household level and 118 per cent at the household-crop level.[6]

3. Farmers selling to agribusinesses receive a higher trickle down of world price movements into farm earnings. While the elasticity of factor prices to world prices is an important line of research in international economics, systematic evidence on the transmission of world prices into farm incomes and farmgate prices is sparse.[7] Table 1C estimates a first-difference regression of the change in the farmgate price of a crop sold by a household with respect to the change in the world price of that crop.

[5]We exclude sales to cooperatives and state parastatals to focus on private sector buyers, but results barely change when the latter are included in other buyers as well.

[6]We note that our data captures direct sales and it may be that farmers sell indirectly to agribusinesses. This is a limitation of the data and one that arises in various settings in international trade and supply chains where indirect sales cannot be fully traced. As long as direct sales offer advantages that do not arise fully through indirect sales, we expect many of the findings on agribusiness premia in the paper to be qualitatively similar.

[7]In the dataset we use, each country exports crops to world markets, and world prices are measured as unit values (or the value of trade divided by the quantity in kilograms from UN COMTRADE data) for the year before the survey for all countries other than the three in our sample. Crop names/codes in the surveys are matched to HS six digit codes in the trade data and HS codes across years are harmonized to 1996. In some cases, multiple crop names in the surveys map to multiple HS codes, such as green maize and dry maize to multiple entries for maize. We take the main or the average based on the closest description.

TABLE 1. Agribusiness and Trickledown Premia for Farmers

A. Income and Size Premia of Farmers

	(1) $\ln Income_{ht}$	(2) $\ln Acreage_{ht}$
Farmer Household Sold to Agribusinesses A_{ht}	1.3335	0.4520
	(0.0538)	(0.0352)
Country-Year FE	Yes	Yes
N	11,604	11,579
R^2	0.139	0.021

B. Income and Price Premia of Farmer-Crops

	(1) $\ln Income_{cht}$	(2) $\ln Price_{cht}$
Farmer Household Sold Crop to Agribusinesses A_{cht}	0.9954	0.2311
	(0.1685)	(0.1219)
Crop-Country-Year FE	Yes	Yes
N	32,062	32,062
R^2	0.312	0.707

C. Trickledown Premia

	(1) $\Delta \ln Price_{ch}$	(2) $\Delta \ln Price_{ch}$
Change in Log of World Crop Price: $\Delta \ln p_c^w$	0.1279	0.1260
	(0.0564)	(0.0556)
ΔAgribusiness Share$_{ch} \cdot \Delta \ln p_c^w$		0.1886
		(0.0399)
Agribusiness Share$_{ch} \cdot \Delta \ln p_c^w$		0.0709
		(0.0736)
ΔAgribusiness Share$_{ch}$		0.3134
		(0.0998)
Agribusiness Share$_{ch}$		-0.0077
		(0.0795)
Country FE	Yes	Yes
N	5,993	5,993

The dependent variable in Panel A is the income from all crops of household h in year t in Column 1 and acreage of fields of household h in Column 2, in Panel B is the income and price from crop c in Columns 1 and 2, and in Panel C is the change in sales-weighted mean log price (in local currency) received for crop c by household h during survey year 1 relative to the previous survey year 0. The RHS in Panels A and B is an indicator for selling to agribusinesses which is A_{cht} for crop c in Panel B and $A_{ht} = \max_c A_{cht}$ for the household in Panel A. 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 for all waves. Agribusiness share is the share of crop income received from agribusinesses in survey year 0 and the change in agribusiness share is relative to the previous survey. Panel C has the change in the log trade-weighted world price for the crop (lagged by one year) between survey years, excluding source countries in the sample. Country-year fixed effects are included in A, crop-country-year fixed effects in B and country fixed effects in the first differences estimation in C. Standard errors are clustered by households in parentheses in A and also by crop-country in B and C. Panel C is weighted by crop income shares of households to ensure a summed weight of 1 for each household.

Column 1 of our baseline in Table 1 examines the trickle down rate from world price movements to farmgate prices. On average, a 1 percent higher increase in the world price of a crop raises the farmgate price received for that crop by 0.1279 percent more. Source country fixed effects are included to account for country-year differences such as through exchange rate movements or general inflation.

Column 2 contains the interactions of world price changes with the initial share of agribusinesses in the crop income of the household and the change in the agribusiness share in household-crop sales across waves. Farmers who increased their share of sales to agribusinesses experience a 0.1886 percent higher trickle down to farmgate prices. Farmers moving more towards agribusinesses also have higher prices, consistent with the agribusiness premia reported before. Farmers that continue to sell the same share to agribusinesses show negligible additional passthrough (0.0709).

Source countries in our sample have a tiny share in world exports of crops sold by them. On average, the source country has a market share of 0.62 of a percent (or 0.0062 in share terms) and their median market share across crop-countries is 0.012 of a percent in any year. It is therefore plausible that world price movements (in the rest of the world) can be considered exogenous to export revenues and farmgate prices in these source countries, though we examine robustness by excluding ten crop-countries that have a market share exceeding 5 percent in any of the relevant years in Table 6 in the Appendix. As might be expected, the trickle down rates are somewhat smaller in magnitude when crops with larger market share are excluded, but the qualitative results remain highly similar to the baseline.

To sum up, by the metric of world price transmission, agribusinesses therefore make farmers more connected to world markets for crops.[8] It is worth noting though that this also implies that agribusinesses pass on more of any reductions in world prices to farmers. The Appendix considers heterogeneity in trickle down rates by increases or decreases in world prices, which suggest that farmers selling to agribusinesses are not shielded from world price reductions.

3. From Facts to Theory

This section develops a theoretical framework to embed the empirical regularities into the microstructure of intermediation in crop markets.

[8]In contrast to 0.1279, recent work by Zavala (2022) finds a trickle down rate that is about double for Ecuador, though it is smaller for larger intermediaries.

3.1. **Model.** We consider a small open economy that takes the world price p of its export crop as given. For simplicity, farmers do not have direct access to the world crop market and rely on intermediaries to sell their produce. Intermediation is provided by Traders and Agribusinesses who compete oligopsonistically. In what follows, we characterize pricing decisions and welfare comparative statics with respect to world prices and entry costs. The Online Appendix and earlier working papers contain generalizations to multiple stages of agribusiness activity, subsistence crops, multiple crops, comparative advantage (differences in productivity across crops), government purchases and different formulations of fixed investments and economic rents for agribusinesses.[9]

3.1.1. *Farmers.* A continuum of farmers, each endowed with a unit of land, have linear utility for a numeraire consumption good and therefore maximize farm earnings. Farmers draw their productivity φ from a Pareto distribution $G(\varphi) = 1 - (\varphi_{\min}/\varphi)^k$ where $\varphi \geq \varphi_{\min} > 0$ and $k \geq 1$. Higher productivity is isomorphic in the model to greater farm output or farm size endowment. Higher values of $\varphi_{\min}$ reflect higher average farm productivity, while lower values of the shape parameter k summarize higher inequality in the productivity of land. The Gini index of land productivity/size is $1/(2k-1)$, and $k = 1$ corresponds to perfect inequality (Gini=1) while $k \to \infty$ to perfect equality (Gini=0).

Farmers choose whether to sell their produce to traders or to engage with agribusinesses. Agribusinesses pay more but farmers need to undertake investments to access agribusiness supply chains, denoted by $f > 0$ in terms of the consumption good. Barrett and Mutambatsere (2008) survey a number of studies and find that weak marketing infrastructure arising from both institutional weaknesses (such as contract law, police protection, uniform grades and standards) and physical deficiencies (such as, roads, electricity) imply that farmers need to undertake substantial fixed investments in technology and access to participate in agribusiness relationships. Farmer participation in agribusiness value chains is a key margin of study in this literature, and we show in Figure 7.1 of the Appendix that the distribution of sales to intermediaries is bimodal, with most farmers either choosing to sell or not sell to agribusinesses.

As is standard in the trade literature, fixed costs of participation generates stylized fact 2 of income premia for farmers selling to agribusinesses. Let p_t denote the price that farmers receive from selling to traders and p_a the price received from agribusinesses. Then

[9]Dhingra and Tenreyro (2017), Dhingra and Tenreyro (2020)

a farmer with productivity draw φ chooses to sell to agribusinesses if

$$\varphi \geq f / (p_a - p_t) \equiv \varphi_a. \tag{3.1}$$

Remark 1 below summarizes the farmer sorting pattern.

Remark 1. *As long as $p_a > p_t$, crop markets have a dual structure where higher productivity farmers ($\varphi \geq \varphi_a$) sell to agribusinesses and lower productivity farmers ($\varphi_a > \varphi \geq \varphi_{\min}$) sell to traders.*

3.1.2. *Intermediaries.* There are N identical traders who compete in a Cournot oligopsonistic fashion to procure farm produce. Each trader pays an entry cost of f_t units of the consumption good to commence trade. They have an intermediation productivity denoted by $0 \leq m_t \leq 1$, so that they receive pm_t net of intermediation costs. They pay farmers p_t and trader t purchases q_t units of the produce. Then the profit of a trader is $\pi_t = (pm_t - p_t)q_t$ and m_t acts like the inverse of an iceberg trade cost.

There are M identical agribusinesses who incur entry costs $f_a > 0$ to compete in a Cournot oligopsonistic way in agribusiness activities, such as marketing, processing and exporting, which increase the marketable surplus of farm produce. Realising quality or productivity gains in marketable farm surplus is often a key motivation for agribusiness-friendly policies across the world, and we assume $m_a \geq m_t$. Profit from providing agribusiness services to farmers is $\pi_a = (pm_a - p_a)q_a$ where q_a is the quantity sold to agribusiness a by all farmers.

When an intermediary receives pm_i net of intermediation costs per unit of crop sold, it earns a profit margin of $pm_i - p_i$. The markdown $\mathscr{M}_i \equiv (pm_i - p_i) / pm_i$ summarizes the share that the intermediary earns from each unit of crop sold and $1 - \mathscr{M}_i$ is the share that goes to the farmer growing that crop. Summing across all intermediaries and given all else equal, it is straightforward to see that the average export price earned in world markets by intermediaries is $p_x \equiv pm_t \frac{Nq_t}{Nq_t + Mq_a} + pm_a \frac{Mq_a}{Nq_t + Mq_a}$. It rises with world prices, intermediation productivity and the market share of agribusinesses (who provide better access to world markets).

3.1.3. *Prices.* Considering a symmetric Cournot equilibrium, the optimal farmgate price paid by an intermediary i equates the intermediated world price to the inverse of i's perceived derivative of supply from farmers with respect to the price is given by: $(pm_i - p_i) / p_i = 1 / (\partial \ln q_i / \partial \ln p_i)$, taking the usual form of Ramsey pricing. For agribusinesses, the perceived supply elasticity can be derived from the total quantity supplied by farmers to agribusiness a and all other agribusinesses (denoted by $-a$): $q_a + q_{-a} = \int_{\varphi_a}^{\infty} \varphi dG(\varphi) = \frac{k}{k-1}\varphi_{\min}^k f^{-k+1}(p_a - p_t)^{k-1}$. Given q_{-a} and trader prices, agribusiness a's perceived supply response to the price it offers is

$$\partial q_a/\partial p_a = k\varphi_{\min}^k f^{-k+1}(p_a - p_t)^{k-2} = (k-1)(q_a + q_{-a})/(p_a - p_t).$$

In a symmetric Cournot equilibrium, $q_a + q_{-a} = Mq_a$ and the price paid by agribusinesses to farmers is:

$$p_a = \frac{M(k-1)pm_a + p_t}{M(k-1)+1} \tag{3.2}$$

The perceived supply elasticity can be written out to compare with standard passthrough results in the literature (for example, Weyl and Fabinger (2013)). It expands out as $(1/(\partial \ln(q_a + q_{-a})/\partial \ln q_a)) \times (\partial \ln(q_a + q_{-a})/\partial \ln p_a)$ where $\partial \ln(q_a + q_{-a})/\partial \ln q_a$ is the elasticity of aggregate supply to own purchases of the agribusiness and $\partial \ln(q_a + q_{-a})/\partial \ln p_a$ is the aggregate supply elasticity of crops to agribusinesses. In a symmetric Cournot oligopsony, the supply elasticity of own purchases is $(q_a/(q_a + q_{-a}))/(\partial(q_a + q_{-a})/\partial q_a) = (1/M)/(1) = 1/M$. Under Pareto productivity and interlinked markets with traders, the aggregate supply elasticity to prices is $(k-1)p_a/(p_a - p_t)$. Combining these two elasticities gives the optimal price of equation 3.2.

The presence of p_t in the price offered by agribusinesses shows that the price paid by traders provides a floor for what agribusinesses must pay to induce farmers to undertake the investments needed to sell to agribusinesses. The feature of interlinked markets makes the optimal price paid by agribusinesses a weighted average of the world price (net of intermediation costs) and the price paid by traders. The weights depend on the entry of agribusinesses and the inequality in farm supply. As might be expected, perfect competition among agribusinesses ($M \to \infty$) results in complete passthrough of world prices into farmgate prices, net of intermediation costs ($p_a = pm_a$). A less apparent result is that a perfectly equal productivity distribution ($k \to \infty$) also results in complete passthrough because prices no longer determine the extent to which farmers alter their supply to intermediaries. As $k \to \infty$, farmers become homogeneous and the aggregate supply curve of farm produce becomes perfectly elastic. When intermediaries are oligopsonistic (finite M and k), farmers receive a smaller share of the price net of trade costs, $p_a < pm_a$ because $p_t < p_a$ and $0 < M(k-1)/(M(k-1)+1) < 1$ for finite values of entry and farm heterogeneity.

Proceeding similarly for traders, the total quantity supplied by farmers to trader t and all other traders $-t$ is $q_t + q_{-t} = \int_{\varphi_{\min}}^{\varphi_a} \varphi dG(\varphi) = \frac{k}{k-1}\varphi_{\min}^k \left(\varphi_{\min}^{-k+1} - f^{-k+1}(p_a - p_t)^{k-1}\right)$. Taking the decisions of agribusinesses and other traders as given, the optimal price paid by traders to farmers is

$$p_t = \frac{\mu N(k-1)}{\mu N(k-1)+1} pm_t, \tag{3.3}$$

where $\mu \equiv \frac{f^{-k+1}(p_a-p_t)^{k-2}p_t}{\varphi_{\min}^{-k+1} - f^{-k+1}(p_a-p_t)^{k-1}} = \frac{Mq_a}{Nq_t}\frac{p_t}{p_a-p_t}$ summarizes the direct competition that traders face from agribusinesses through shared farm supply. Under finite entry and farm inequality, the markdown paid by traders depends on the entry of traders, inequality and the relative quantities and prices of agribusinesses, as we summarize below.

Remark 2. *Prices received by farmers rise with the number of traders and agribusinesses in the crop market and with equality in the farm productivity distribution (holding all else constant). In the benchmark case of perfect competition among intermediaries or a perfectly equal farm productivity 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. Ignoring the integer constraint, free entry gives:

$$(pm_a - p_a) q_a - f_a = 0, \tag{3.4}$$

$$(pm_t - p_t) q_t - f_t = 0. \tag{3.5}$$

3.1.5. *General Equilibrium.* The general equilibrium of the economy is determined by the optimal cutoff equation 3.1, optimal price equations 3.2 and 3.3, and free entry conditions 3.4 and 3.5, given a set of world crop prices. Resource clearing is subsumed in these equilibrium conditions.

We substitute for the cutoff and for entry from the optimal price equation, into the free entry conditions. Then the two unknown prices p_a and p_t are determined by two equilibrium equations:

$$(pm_a - p_a)^2 (p_a - p_t)^{k-2} = f_a f^{k-1}/k\varphi_{\min}^k \tag{3.6}$$

$$(pm_t - p_t)^2 (p_a - p_t)^{k-2} = f_t f^{k-1}/k\varphi_{\min}^k \tag{3.7}$$

Solving for these unknown prices from equations 3.6 and 3.7, the price paid by agribusinesses is $p_a = pm_a - (f_a/f_t)^{1/2}(pm_t - p_t)$, which rises with world prices, reductions in agribusiness entry barriers and the price paid by traders (because of interlinked markets).

Substituting for the price of traders into the solved price paid by agribusinesses, the model solution for agribusiness prices is:

$$(pm_a - p_a)^2 \left((f_t/f_a)^{1/2} pm_a - pm_t + p_a\left(1 - (f_t/f_a)^{1/2}\right)\right)^{k-2} = f^{k-1} f_a / k\varphi_{\min}^k, \tag{3.8}$$

and a solution exists and is unique as long as the SOCs hold, which occurs for sufficiently productive agribusinesses as summarized below. When agribusinesses, have low productivity, they are unable to pay high enough farmgate prices to induce farmers to undertake the fixed costs of selling to them and the supply curve becomes completely flat for traders.[10]

Remark 3. *For sufficiently productive agribusinesses, an equilibrium exists and is unique.*

3.2. **The Gains from Trade and Entry.** We now examine comparative statics of farm incomes by totally differentiating equations 3.6 and 3.7 with respect to world prices and agribusiness entry costs and using the SOCs and the existence condition to arrive at Propositions 4 and 5 below, followed by an explanation for each (and with full details in the Appendix).

Proposition 4. World Prices. *Prices paid by agribusinesses p_a to farmers rise with world prices p. Prices paid by traders p_t to farmers rise with world prices p when farm productivity is more equal ($k > 2$) and fall otherwise ($k < 2$). Prices paid by agribusinesses respond more than prices paid by traders, $|d\ln p_a| - |d\ln p_t| > 0$.*

From the optimal prices in equations 3.2 and 3.3, the direct impact of world prices is clearly positive. The indirect impacts come from changes in competition among intermediaries (M and N) and their relative market shares through supply interlinkages across agribusinesses and traders (Mq_a/Nq_t).

When world prices rise, revenues from crop sales rise linearly from the direct impact of world prices. Agribusinesses have higher intermediation productivity and revenues

[10]The second-order conditions for profit maximisation are $(k-2)(pm_a - p_a) - \frac{M+1}{M}(p_a - p_t) < 0$ and $(k-2)(pm_t - p_t) + \frac{N+1}{N}(p_a - p_t) > 0$. A unique solution is guaranteed for $k < 2$ and for $k > 2$, a sufficient condition in terms of primitives is $m_a/m_t > \left((k/2-1)\left(1-(f_t/f_a)^{1/2}\right)-1\right)(f_t/f_a)^{1/2}$. This ensures a monotonically decreasing LHS for equation 3.8 that ranges over high enough values to guarantee sales to agribusinesses. It applies to any possible set of parameter values because it holds when traders are perfectly competitive, though the condition can be weakened outside of a competitive fringe of traders.

rise more for agribusinesses than traders. This induces more farmers to sell through agribusinesses to take advantage of the direct world price rise.

For a more equal distribution of farm productivity (larger values of k), the aggregate supply curve to agribusinesses is more convex and increased competition from more viable entry induces them to pass through more of the rise in world prices to farmers. Because of the interlinked crop markets across intermediaries, this puts competitive pressure on traders to also pay more to farmers to retain them. But they have less capacity to pay more and trading becomes less profitable, inducing traders to exit.

For low inequality ($k > 2$), the direct effect and the competition effect dominate the exit effect and traders pay higher farmgate prices. For high inequality ($k < 2$), crop volumes are heavily skewed towards farms with relatively higher productivity and the exit effect dominates for farmers selling through traders. Farmers who continue to rely on the surviving traders are left in thinner crop markets and are worse-off, consistent with empirical evidence on reduced farmgate prices from policy-induced exit of smaller buyers (Rubens (2023)). The critical point occurs at $k = 2$ because then the supply curves faced by agribusinesses and traders become linear, and the indirect effects exactly balance each other to become zero.

Markdowns $\mathscr{M}_i \equiv (pm_i - p_i)/pm_i$ summarize how the share of the pie is divided between farmers and intermediaries. Markdowns change through both the direct revenue channel and the indirect channels of entry and interlinked markets embodied in farmgate prices, $d\ln \mathscr{M}_i = (1/\mathscr{M}_i - 1)(d\ln p - d\ln p_i)$. Agribusinesses pass through world price increases to farmers, but not fully and hence their share $\mathscr{M}_a$ rises with world prices. In the Appendix, we show that $d\ln \mathscr{M}_a$ takes the same sign as changes in world prices $d\ln p$. In contrast, the indirect effect can dominate the direct effect of world price increases for traders and $d\ln \mathscr{M}_t$ need not take the same sign as changes in world prices $d\ln p$. The impact of world prices on the division of the pie between traders and farmers is therefore ambiguous.

Following reasoning similar to world price movements, we now examine comparative statics of farm incomes with respect to agribusiness entry costs in Proposition 5 below (see Appendix for details).

Proposition 5. Entry Costs. *Prices paid by agribusinesses p_a to farmers rise with reductions in agribusiness entry costs f_a. Prices paid by traders p_t to farmers rise with reductions in agribusiness entry costs when farm productivity is more equal ($k > 2$) and* *fall otherwise ($k < 2$). Prices paid by agribusinesses respond more than prices paid by traders, $|d\ln p_a| - |d\ln p_t| > 0$.*

As with a rise in world prices, a reduction in agribusiness entry costs has a positive direct impact on agribusiness profitability and this impact is larger in magnitude than that for trader profitability. Net profits of agribusinesses rise and this encourages entry, resulting in greater competition that induces them to pay higher farmgate prices as a result. Farmers switch from traders to agribusinesses to take advantage of this, and business stealing by agribusinesses puts competitive pressure on traders to also pay more to farmers. Trader profitability falls and incentivizes some traders to exit. For more convex supply to agribusinesses (larger values of k), the competition effect on farmgate prices dominates the exit effect and all farmers gain from the reduction in entry costs. But the opposite occurs when inequality is high ($k < 2$) and only the smallest farmers remain reliant on traders. The exit effect dominates and small farmers are left worse-off.

The share of the pie going to farmers moves in the same direction as the changes in prices paid to farmers. This is different from comparative statics for world price changes because there is no direct impact on markdowns and the change in the share of the pie going to intermediaries is

$$d\ln \mathscr{M}_i = -\left(1/\mathscr{M}_i - 1\right) d\ln p_i \tag{3.9}$$

We summarize the markdown comparative statics with respect to world prices and entry costs in Remark 6.

Remark 6. *When agribusiness entry barriers change, the share of the pie ($1 - \mathscr{M}_i \equiv p_i/pm_i$) going to farmers moves in the same direction as the changes in prices paid to farmers. But the direction of changes in farmer shares can differ from that of prices received by them when world prices change.*

To understand the welfare impacts, we now consider aggregate outcomes in the economy. Aggregate revenue of the economy from crop exports is $R \equiv pm_a M q_a + pm_t N q_t$. In equilibrium, aggregate revenues must equal aggregate incomes of factors $I + \Pi$ where $I \equiv I_a + I_t = p_a \int_{\varphi_a}^{\infty} \varphi dG + p_t \int_{\varphi_{\min}}^{\varphi_a} \varphi dG$ are farm incomes from agribusinesses and traders. Total profits of agribusinesses and traders are $\Pi \equiv \Pi_a + \Pi_t = (pm_a - p_a) \int_{\varphi_a}^{\infty} \varphi dG + (pm_t - p_t) \int_{\varphi_{\min}}^{\varphi_a} \varphi dG$. Writing the national income identities in terms of first differences of equilibrium outcomes ($\Delta X(p, f_a) = X\left(p', f_a'\right) - X(p, f_a)$ where $'$ denotes a new set of world prices and/or agribusiness entry costs), the aggregate comparative statics with respect to world prices and entry costs can be determined as follows:

$$\Delta R/R = \sum_{1=a,t} (\Delta \Pi_i + \Delta I_i \Big) /R = \sum_{i \in a,t} \Delta(\mathscr{M}_i R_i/R) + \sum_{i \in a,t} \Delta \left(1 - \mathscr{M}_i\right) R_i/R \tag{3.10}$$

where R_a and R_t are the export revenues of agribusinesses and traders respectively. $\Delta(\mathscr{M}_i R_i/R)$ can be further decomposed into the change in markdowns $\Delta \mathscr{M}_i$ and the change in the market share of each intermediary $\Delta \left(R_i/R\right)$ which arises because farmers switch between traders and agribusinesses, resulting in changes in real aggregate revenue from differences in intermediation technologies.

In many trade models, commonly made assumptions guarantee that trade values on the LHS of 3.10 co-move with factor incomes on the RHS. For example, when aggregate profits are a constant fraction of revenues or when there are choke prices (see Costinot and Rodríguez-Clare (2014)). In these models, information on trade values, the trade elasticity and factor shares summarises both the aggregate and individual gains from trade. In our setting, aggregate gains from trade need not co-move with incomes of small farmers because markdowns vary among the cross-section of intermediaries and they vary with model primitives (like world prices or entry costs). We therefore proceed to an empirical examination of the aggregate gains from trade and their division across farmers and intermediaries.

4. The Division of the Aggregate Gains from Trade

We can estimate the aggregate gains from trade and the farmer gains from trade with data on exports, farmgate prices and incomes, and world price movements. The usual constraint in quantifying the division of the gains from trade comes from a paucity of comprehensive information on intermediaries across all farmer-crops. We make progress through model-implied relationships that enable inference of intermediary profits from observable moments.

To start with, reduced form analysis determines how crop exports and farmgate prices vary with world price changes. This identifies relative effects of larger world price movements on export revenues and farmgate prices (relative to smaller world price movements). To quantify the absolute effects, the export revenue and farmgate price specifications are estimated structurally to determine underlying model parameters that enable quantification of the gains from trade.

4.1. **Reduced Form Estimation.** To examine the aggregate gains from trade, the log change in export value $\Delta \ln Exports_{cs}$ of crop c from source country s (from UN COMTRADE data) over the same period as the household survey waves of that country is specified as

$$\Delta \ln Exports_{cs} = \alpha_s + \nu \cdot \Delta \ln p_c^w + \epsilon_{cs}.$$

where $\Delta \ln p_c^w$ is the change in the log of the trade-weighted world price of crop c over the same period (lagged one year and excluding the source countries, as explained earlier) and ν is the export price passthrough of world price movements. Source country fixed effects α_s are included to account for time-varying country characteristics and ϵ_{cs} is the error term. Column 1 of Table 2 shows that on average, exports of a crop rise by $\hat{\nu} = 0.6525\%$ more when the world price of that crop rises by 1% more.

Stylized fact 3 shows the transmission of world price movements to farmgate prices across different intermediaries. We now re-estimate the trickledown rates for farmgate prices, taking into account the endogeneity of intermediary choice of farmers. A key difference from stylized fact 3 is that we focus on farmers who stay with the same buyer over time to remove initial differences in prices across agribusinesses and traders.

For clarity, let x denote an outcome in period 0 and x' denote the same outcome in period 1 when world prices have changed between period 0 to period 1. Staying farmers have $A'_{ch} = A_{ch} = 1$ for sales to agribusinesses or $A'_{ch} = A_{ch} = 0$ for sales to traders. The first-difference regression for the change in farmgate price is re-written as:

$$\Delta \ln Price_{ch} = \alpha_s + \eta_t \Delta \ln p_c^w + \eta_1 A_{ch} \Delta \ln p_c^w + \eta_2 A_{ch} + \epsilon_{ch}$$

where $\Delta \ln Price_{ch}$ is the change in log price received for crop c by farming household h over its two survey waves, A_{ch} is an indicator for selling to agribusinesses (as before) that is also interacted with the log world price change to allow for differences in trickle down, and α_s is included to account for country-specific inflation (or movements in the numeraire consumption goods in the model). In order to match the structural estimation later, we will now focus on crops that are exported by each country and measure farmgate prices in local currency units, in line with the theory. Additionally, we refine the sample to focus on prices where the unit of quantities recorded in the data is the same over time to reduce measurement problems when examining price levels later.

The estimated transmission of world prices to farmgate prices for farmers selling to traders is $\hat{\eta}_t$ while that for farmers selling to agribusinesses is $\hat{\eta}_a = \hat{\eta}_t + \hat{\eta}_1$. And therefore the farm price trickle down is appropriately measured within buyer types and summarized in the slopes of farmgate prices with respect to world prices. Column 2 of Table 2 shows that, on average, farmers selling to traders get $\hat{\eta}_t = 0.1165\%$ for a 1% greater rise in world prices of their crop. Farmers selling to agribusinesses receive a higher trickle down, $\hat{\eta}_a = \hat{\eta}_t + \hat{\eta}_1 = 0.2211\%$ (with an associated standard error of 0.0572). This is in line with stylized fact 3 in terms of the trickledown rate for farmers selling to traders, and the magnitude for the trickledown from agribusinesses is in between the range for farmers who maintained their initial sales to agribusinesses and those who started selling more to agribusinesses in Panel C of Table 1.

TABLE 2. World Price Transmission to Crop Exports and Crop Incomes of Incumbent and Switching Farmers

	Trade	Incumbent Farmers
	$\Delta \ln Exports_{cs}$	$\Delta \ln Price_{ch}$
	(1)	(2)
Change in Log of World Crop Price: $\Delta \ln p_c^w$	0.6525	0.1165
	(0.2086)	(0.0212)
Agribusiness Share$_{ch} \cdot \Delta \ln p_c^w$		0.1056
		(0.0594)
Agribusiness Share$_{ch}$		0.0398
		(0.0574)
Country FE	Yes	Yes
N	127	4,865

In Column 1, the dependent variable is the first difference in log export sales of crop c for each source country s. The specification is weighted by the trade share of the crop in the country for the estimation sample. The dependent variable in Column 2 is the first difference in log farmgate price of crop c for household h, and corresponds to Table 1 Panel C. The specification in Column 2 now only includes incumbent households that either have the indicator for sales to agribusinesses as $A_{ch1} = A_{ch0} = 1$ or $A_{ch1} = A_{ch} = 0$. Standard errors are clustered by crop-country in Column 1 and by households in Column 2.

For completeness, we also examine responses of quantities sold by farmers to world price movements, replacing the dependent variable in Column 2 of Table 2 with $\Delta \ln Quantity_{ch}$ and the corresponding estimates (with standard errors in parentheses) for $\eta_t^q, \eta_1^q, \eta_2^q$ are 0.0003 (0.0270), -0.0090 (0.2349), -0.2652 (0.0967), suggesting negligible changes from world price movements. Further, we examine responses in cropping choices to world price movements. Let $Grow_{cht} = 1$ when household h has positive sales of crop c in year t and 0 otherwise (where zeros are added to balance on household-crops for each country and year). When the dependent variable is $\Delta Grow_{ch}$, the corresponding estimates (with standard errors in parentheses) for $\eta_t^g, \eta_1^g, \eta_2^g$ are 0.0002 (0.0002), 0.0007 (0.0013), 0.0021 (0.0018), suggesting that there are also negligible changes on cropping choices from world price movements. Given the negligible responses of these margins, extensions of the model to selling choices is discussed in the context of subsistence crops and selling to parastatals in the Appendix. These extensions activate the margin of market participation and the interaction with agribusinesses because there is a tradeoff between the effective outside option and farmers' exposure to intermediary pricing.

4.2. **Structural Relationships.** Tables 1 and 2 suggest that farmers who change their buyer choice have somewhat different outcomes for trickle down and hence prices received. In line with the theory, we turn to structural estimation that will account for this in both the exports and farmgate price estimation. There are three reasons for undertaking a structural estimation. First, it moves beyond relative effects of the reduced form analysis to determine the absolute effects of world price movements on exports and farmgate prices. The model provides the structural relationships to determine the absolute effects in revenues and prices from world price movements. A key insight of the model is that absolute effects can be identified from variation in revenues and prices arising from farmers who switch buyers, and we account for this in the structural estimation. Second, the structural estimation identifies underlying model parameters that enable inference of the unobservable model-consistent intermediary productivity and profits. We will estimate the markdown ratio across intermediaries from the structural relationships and combine it with calibrated values of agribusiness markdowns to arrive at the productivity difference between agribusinesses and traders (m_a/m_t) and to infer the impact of world prices on profits. Finally, the system of structural equations jointly estimates the revenue and farmgate prices and in doing so, accounts for buyer choice that is implicit in the reduced form analysis that conditions on buyer choice over time.

We start with setting out model-implied relationships that form moment conditions to link the theoretical sufficient statistics and parameters (farm price premia, pass-through elasticities, intermediary markups) to observable outcomes in the data. Next, the moments are estimated jointly to obtain key parameters — including the ratio of markdowns consistent with differences in trickle down and the model-implied absolute trickle down (that goes beyond the relative difference-in-difference effects). These parameters enable quantification of the impacts of world price movements on the aggregate gains from trade and the division of the gains from trade across farmers, traders and agribusinesses.

For crop revenues $R = pm_aMq_a + pm_tNq_t$, the change between period 0 and 1 is $\Delta R \equiv R' - R$. Let e and e' denote the buyer choices of farmers in period 0 and period 1 respectively. Dividing by initial revenues, the percentage change in revenues is $\Delta R/R = \Delta p/p + \sum_{e=a,t} 1_{e' \neq e} \left(m_{e'}/m_e - 1\right)\left(1 + \Delta p/p\right) pm_eQ_e/R$ for sales receipts pm_eQ_e of intermediary e. The first term on the RHS, $\Delta p/p$, is the direct export revenue effect of the world price change and the second term on the RHS is the additional productivity gain arising from differences in intermediation productivity across buyer types.

Intermediation productivity m_e is unobservable and we therefore re-write the change in revenues in terms of farmgate prices and a farmer share ratio that can be estimated. The underlying farmer share ratio θ is defined as:

$$\theta \equiv \left(1 - \mathscr{M}_t\right) / \left(1 - \mathscr{M}_a\right) \tag{4.1}$$

From the definition of markdowns, export prices pm_e can be re-written in terms of farmgate prices and markdowns as $pm_e = p_e / \left(1 - \mathscr{M}_e\right)$. Expanding out to both types of switching farmers ($e'e = at, ta$), the change in revenue is therefore:

$$\begin{aligned} \Delta R/R = {} & \nu \Delta \ln p \\ & + \sum_{e=a,t} \int \left(1_{e' \neq e} \frac{p_e \varphi / I_e}{1 + \left(I_{e'}/I_e\right)\theta} \, dG \right) \left(1 + \nu \Delta \ln p\right)\left(\left(p_{e'}/p_e\right)\theta - 1\right) \end{aligned} \tag{4.2}$$

where ν denotes the trickle down from world prices to exports prices (as in the reduced form equation for exports) and for brevity, I_t and I_a are the incomes of farmers selling to traders and agribusinesses in the initial period respectively, and p_t and p_a are the prices paid by traders and agribusinesses in the initial period. Equation 4.2 shows that revenues are affected by both the direct world price impact $\nu \Delta \ln p$ and the indirect productivity impact arising from farmers switching across buyers.

The structural relationship provides the model-implied intercept that is missing from the reduced form analysis. This is the second line of equation 4.2 and we will estimate it with variation in income and price ratios across intermediaries. The farmer share ratio θ can be combined with observable farmgate prices p_t and p_a to arrive at the productivity difference between agribusinesses and traders:

$$m_a/m_t = \left(p_a/p_t\right)\left(1 - \mathscr{M}_t\right) / \left(1 - \mathscr{M}_a\right) = \theta p_a/p_t. \tag{4.3}$$

Calibrating the model to a value for $\mathscr{M}_a$ would then allow us to solve for markdowns of traders and the changes in them because

$$\Delta\mathscr{M}_i = (\Delta p/p - \Delta p_i/p_i)(1-\mathscr{M}_i)\,. \tag{4.4}$$

Having determined revenues, we now turn to the structural relationships for farmgate prices and buyer choice. Income of a farmer selling to intermediary $e = a, t$ in period 0 and to intermediary e' in period 1 changes by $\Delta I_{e'e} = I'_{e'} - I_e \equiv \left(p'_{e'} - p_e\right) Q_e$. Dividing by initial income, the percentage change in farmer income is $\Delta I_{e'e}/I_e = \Delta p_{e'e}/p_e = \left(p'_{e'}/p_e\right) - 1$. When a farmer stays with the same buyer ($e' = e$), the change in income is $\Delta p_{e'e}/p_e = \left(p'_e/p_e\right) - 1 = \Delta p_e/p_e$. When farmers switch buyers ($e' \neq e$), the change in farmgate prices is $\Delta p_{e'e}/p_e = \left(p'_{e'}/p_e\right) - 1 = \Delta p_{e'}/p_{e'} + (p_{e'}/p_e - 1)(\Delta p_{e'}/p_{e'} + 1)$ because the price ratio $p_{e'}/p_e$ across buyers is no longer equal to one. To sum up, for $e'e = tt, aa, at, ta$, the percentage change in farmgate price is

$$\Delta p_{e'e}/p_e = \eta_{e'}\Delta p/p + \sum_{e'\neq e}\sum_{e=a,t}(p_{e'}/p_e - 1)(\eta_{e'}\Delta p/p - 1) \tag{4.5}$$

To model endogenous intermediary choice, we first note that the share of farmers selling to agribusinesses is $1 - G(\varphi_a)$, and it rises with world price increases because agribusinesses gain more through their higher intermediation productivity and are able to pay more to farmers selling through them. The change in agribusiness market share is $\Delta(1 - G(\varphi_a)) = -k(1 - G(\varphi_a))(\Delta\varphi_a/\varphi_a)$ where as shown earlier in Remark 1, $\varphi_a = f/(p_a - p_t)$. Substituting for the change in the price premium,

$$\Delta(1 - G(\varphi_a)) = k(1 - G(\varphi_a))(\Delta p_a - \Delta p_t)/(p_a - p_t) \tag{4.6}$$

and the share of farmers selling to agribusinesses rises more for higher initial agribusiness share $1 - G(\varphi_a)$, but the rate of increase falls when agribusinesses were already paying a higher price premium.

The market share of agribusinesses in the model comes from aggregation of the individual buyer choices of farmers (Remark 1). Buyer choice of a farmer φ is a function of the initial price premium paid by agribusinesses $p_a - p_t$ that determines whether undertaking the fixed costs of participation in agribusiness value chains is viable for the farmer. Across time periods, farmers can switch from traders to agribusinesses ($1_{e'e=at}$) and from agribusinesses to traders ($1_{e'e=ta}$). Farmers start to sell to agribusinesses (choose at) if $(p'_a - p'_t)\varphi \geq f > (p_a - p_t)\varphi$ and they choose to stop selling to agribusinesses ta for $(p_a - p_t)\varphi > f \geq (p'_a - p'_t)\varphi$. From this structural relationship, the change in buyer choice ΔA is positively correlated with the price premium, initial scale of the individual farmer and with the evolution of the price premium with world price movements $\Delta p/p$ (because the price premium rises with world price movements as shown in Proposition 4):

$$\Delta A = \mathscr{A}\left(p_a - p_t, p_t\varphi, \Delta p/p\right). \tag{4.7}$$

Summing up, equations 4.2 for revenues and 4.5 for farm prices, along with equation 4.6 for agribusiness market share and equation 4.7 provide the system of structural relationships that we take to the estimation in the next sub-section.

4.3. **Structural Estimation.** To operationalise estimation of the structural relationships, let A_{ch} denote the share of income of household h from selling crop c to agribusinesses (as earlier) and let T_{ch} denote incumbent farmers (who do not switch between buyer types). This is in line with reduced form analysis though it can easily be extended to an indicator for selling to agribusinesses, that we summarize in Table 8 of the Appendix. It will also be convenient to denote the price ratio $P_{e'e,cs} = p_{e',cs}/p_{e,cs}$, which deviates from one when $e' \neq e$, and the initial income of household h selling crop c to buyer e is $I_{e,ch}$.

We estimate the system of equations with generalized method of moments:

$$\mathbb{E}[\, w^p_{ch}\, Z^p_{ch}\, u^p_{ch}(\beta)\,] = 0$$
$$\mathbb{E}\left[\, w^R_{ch}\, Z^R_{ch}\, u^R_{ch}(\beta)\,\right] = 0$$

where equations 4.2 and 4.5 give

$$\begin{aligned} u^p_{ch}(\beta) =& \Delta \ln p_{e'e,ch} - \alpha^p_s - \eta_t \Delta \ln p^w_c - T_{ch} A_{ch} \eta_1 \Delta \ln p^w_c \\ & - \zeta_{at}\left(1 - T_{ch}\right) \Delta A_{ch} - \zeta_1 A_{ch} \end{aligned} \tag{4.8}$$

$$\begin{aligned} u^R_{ch}(\beta) =& \Delta \ln R_{cs} - \alpha^R_s - \nu \Delta \ln p^w_c \\ & - \theta\gamma_p\left(1 + \nu\Delta \ln p^w_c\right)\left(1 - T_{ch}\right) A_{ch}\left(I_{a,ch}/I_{t,cs}\right) \\ & - \gamma_p\left(1 + \nu\Delta \ln p^w_c\right)\left(1 - T_{ch}\right)\left(1 - A_{ch}\right)\left(I_{t,ch}/I_{t,cs}\right) \\ & + \theta\gamma_p\left(1 + \nu\Delta \ln p^w_c\right)\left(1 - T_{ch}\right)\left(1 - A_{ch}\right)\left(I_{t,ch}/I_{t,cs}\right) P_{at,cs} \\ & + \gamma_p\left(1 + \nu\Delta \ln p^w_c\right)\left(1 - T_{ch}\right) A_{ch}\left(I_{a,ch}/I_{t,cs}\right) P_{ta,cs} \\ & + \gamma_1\left(1 - T_{ch}\right)\left(I_{e,ch}/I_{t,cs}\right) + \gamma_2\left(1 - T_{ch}\right)\left(I_{e,ch}/I_{t,cs}\right) P_{e'e,cs} \end{aligned} \tag{4.9}$$

for incomes from intermediaries $e = t, a$ denoted by $I_{e,ch}$ and the vector Z and weights w are defined below.

Let A_{cs} denote the sample analog of the share of agribusinesses $1-G(\varphi_a)$ in crop c in source country s. Then the Z^p vector can be specified as:

$$\begin{aligned} Z_{ch}^{p} = & 1_s, \Delta \ln p_c^w, A_{ch}, T_{ch} A_{ch} \Delta \ln p_c^w, \\ & p_{a,cs}, p_{t,cs}, I_{e,ch}, A_{cs} \end{aligned}$$

that consists of exogenous variables in the first moment u_{ch}^p of equation 4.8 (country fixed effects, world price changes and an indicator for selling to agribusinesses initially) and variables from the structural determinants of individual buyer choice in equation 4.7 (initial prices paid by agribusinesses and traders, initial income of the household from the crop, and the share of farmers selling to agribusinesses to account for $p_{a,cs}$ being well-defined). Similarly,

$$\begin{aligned} Z_{ch}^{R} = & 1_s, \Delta \ln p_c^w, A_{ch}, A_{ch} \Delta \ln p_c^w, I_{e,ch}, I_{e,ch} \Delta \ln p_c^w, \\ & A_{cs}, p_{a,cs}, p_{t,cs}, A_{cs} \Delta \ln p_c^w, A_{cs} p_{a,cs} \Delta \ln p_c^w, A_{cs} p_{t,cs} \Delta \ln p_c^w \end{aligned}$$

consists of the exogenous variables in the second moment u_{ch}^R of equation 4.9 (country fixed effects, world price changes, agribusiness sales share and initial income and their interactions with world price changes) and variables from the structural relationship for the share of farmers selling to agribusinesses in equation 4.6 (the initial agribusiness share, prices paid by agribusinesses and traders and their interactions with world price changes). The weights w_{ch}^p for farmgate prices are the shares of crop c in income of household h to ensure that each household has a weight of one, and the weights w_{ch}^R for export revenues are the average export shares of each crop in the country.[11]

The first line of each u equation comes from farmers who stay with traders or with agribusinesses, while the second line in each equation comes from farmers switching across buyers. As earlier, η_t is the trickle down from traders and $\eta_a = \eta_t + \eta_1$ from agribusinesses. Switchers may experience further price shifts as discussed in equation 4.5, and these are estimated as ζ_{at} and $\zeta_{ta} = \zeta_{at} + \zeta_1$.

The second line of the u_R equation for revenues has the export price passthrough of world price movements ν in the first line as before, and the productivity gains in

[11]To implement this weighting, export revenues R_{cs} (which are constant across households within crop-sources) are weighted by the average export share of the crop-source divided by the number of households selling the crop in each source country to ensure that the crop-household level specification aggregates to the crop-source level specification. Further, we focus on the parsimonious relationship implied by the model in our main quantification, but results remain similar when other two-way interactions - $A_{cs}p_{a,cs}$ and $A_{cs}p_{t,cs}$ along with $A_{ch}A_{cs}p_{a,cs}$ and $A_{ch}A_{cs}p_{a,cs}$ - are included.

intermediation in the remainder lines of equation 4.9. From the structural relationship in equation 4.2, the estimate for the farmer share ratio θ will enable us to quantify the underlying difference in intermediation productivity across agribusinesses and traders from equation 4.3. The last line allows for a full set of interactions so that θ estimation is identified from the interaction with world price movements.

With estimates for $\theta, \eta_a, \eta_t, \gamma_p, \gamma_1, \gamma_2$ in hand, we can also determine the change in the share of revenues going to traders and agribusinesses once we have a measure of markdowns for agribusinesses. The change in profits for $i = a, t$ is $\Delta\Pi_i/\Pi_i = \Delta R_i/R_i + \Delta\mathscr{M}_i/\mathscr{M}_i$ and we have already shown that $\Delta\mathscr{M}_i = (\Delta p/p - \Delta p_i/p_i)(1 - \mathscr{M}_i)$ in equation 4.4.[12] We therefore need to determine $\mathscr{M}_a$ to quantify the markdown changes in the next subsection, and to also be able to arrive at $\mathscr{M}_t$ from the definition of θ subsequently.

4.4. **Agribusiness Profit Margins.** As is well-known, data on intermediaries is scarce, particularly in developing economies. We discuss two approaches to calibrate agribusiness markdowns.

4.4.1. *Company Accounts.* To get the initial agribusiness markdown $\mathscr{M}_a$, we put together primary data on profit margins of agribusinesses listed on the Nairobi stock exchange. (There were no agribusiness firms listed in Malawi or Ethiopia, and agribusinesses could serve these markets from Kenya, which had a capital market). Listed companies are mandated to declare their annual company accounts by law, and we manually compile profits and sales for listed agricultural companies from accounts available from the Capital Markets Authority of Kenya for each year from 1999 to 2010 (more in Online Appendix). There are 13 agribusiness companies that have operated in almost all years since the start of the exchange, with an average annual revenue of over 6 billion Kenyan Shillings 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.

The first approach takes the mean profit margin of agribusinesses to calibrate $\mathscr{M}_a =$ 12.36%. This naturally comes with a caveat that accounting profits need not correspond to the underlying economic profit margins in the theory, and we discuss this in the next sub-section. However, it gives a well-understood and consistent measure of company surpluses and we use it as a first summary statistic to solve for equation 4.4.

[12]This follows from the definitions of markdowns that give $\Delta\Pi_i/\Pi_i - \Delta R_i/R_i = (\Delta I_i/I_i + \Delta\mathscr{M}_i/\mathscr{M}_i(1 - \mathscr{M}_i)) - (\Delta I_i/I_i + \Delta\mathscr{M}_i/(1 - \mathscr{M}_i))$.

4.4.2. *Entry Cost Variation.* The second approach determines $\mathscr{M}_a$ from variation in markdowns arising from policy-induced changes in agribusiness entry barriers, following Proposition 5 (and its extensions to purchases by state parastatals in the Appendix). Following the literature on misallocation and rents (Baqaee and Farhi (2020), Restuccia and Rogerson (2017)), we model entry barriers in a reduced form way as wedges and focus on the welfare consequences of removal of entry barriers that generate rents and distortions.[13] The wedges are introduced by generalizing the free entry condition to explicitly separate out rents of each agent from entry costs: $\pi_a = f_a + B_a - B_g - b\left(\varphi_{\min}/\varphi_a\right)^k \equiv B$ where entry barriers impose costs on agribusinesses, denoted by B_a. It is noteworthy that reductions in B_a operate in a way similar to the usual entry costs f_a for firms, and our previous results for how prices vary with entry barriers remain consistent with the derivation in this generalization, while also showing how rents change with entry barriers. Among the barrier costs, B_g is the rent accruing to the government and b is the rent accruing to each farmer who engages with agribusinesses. Reductions in B_g reflect a lowering of entry fees paid to the government by agribusinesses and are a shift in surplus from the government to agribusinesses. Reductions in b reflect rent erosion for farmers who sell to agribusinesses. It directly shifts surplus away from farmers to agribusinesses but can also affect the surplus of governments indirectly. In this sub-section, we focus on the implications of entry barriers B for arriving at the initial level of markdowns from policy-induced variation in entry barriers and the gains from world price movements. In the Online Appendix, we further examine the evolution of rents and welfare impacts from the national policy through farmer survey data.

Changes in entry barriers only affect markdowns indirectly through prices paid to farmers (as opposed to world price changes that also directly change markdowns through revenues), and gives us another source of variation to identify agribusiness markdowns that can be estimated at the firm level.[14] We focus on Kenya's national policy that included reductions in entry barriers for agribusiness operations in many crops. A new government came to power in 2002 on the platform to "do something about agriculture." On March

[13]A growing line of work quantifies misallocation from microdata and examines welfare gains in the presence of distortions (e.g. Bau and Matray (2023), Grant and Startz (2022), Kroft et al. (2024), Peters (2020), Burstein, Carvalho, and Grassi (2025)).

[14]This empirical strategy in this sub-section would not be feasible in the same way for world price movements because they affect markdowns both directly through revenues and indirectly through optimal farmgate prices paid by agribusinesses.

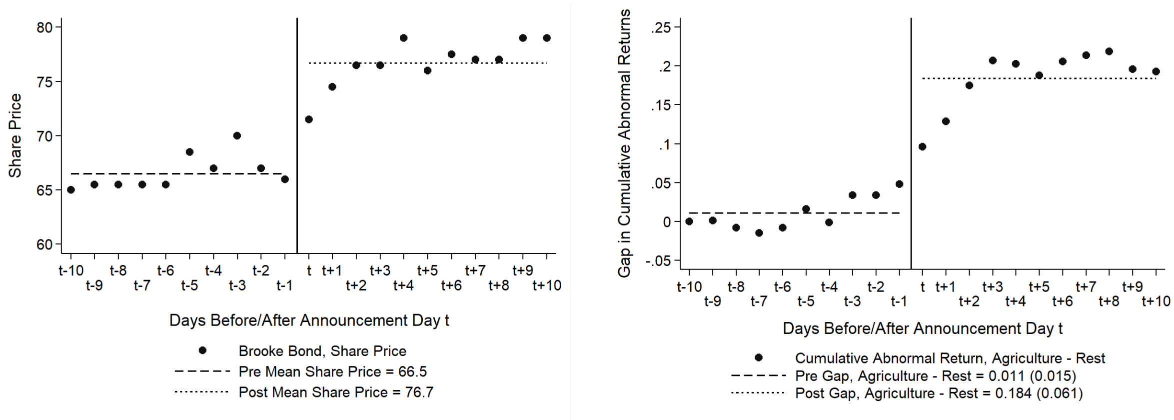
4, 2004 after uncertainty surrounding the president's health and a political party meeting, the East African Standard (retrieved from LexisNexis) reported imminent changes in agricultural policy which later that year became national legislation. There were some slight but uncertain murmurings in the press a few days before the meeting too, but the meeting solidified support for the large policy reform in agriculture. We start with an event study of the immediate changes in agribusiness share prices within days of the news reports to show that the national policy affected agribusinesses.

Figure 4.1 (a) plots the share price of the well-known agribusiness Brooke Bond (or PG Tips or Lipton) which is listed on the Nairobi Stock Exchange (NSE). Its share price jumped relative to the share price of all other listed companies within days of the leak of the policy announcement. Panel (b) compares the evolution of share prices for agricultural companies compared to the 39 other companies listed on the NSE. Cumulative Abnormal Returns (CAR) refer to the change in share prices of agricultural companies over the previous day relative to the change in the NSE-20 share index over the previous day. CAR for the Rest refers to the change in share prices, relative to the previous day and relative to the change in the daily NSE-20 share index for the 39 other companies. The horizontal lines show the mean CAR gap between agricultural companies and the Rest in the ten days before and after the policy announcement. The stock returns of agribusinesses in Kenya shows a substantial uptick just after the policy was announced, suggesting a rise in profitability of agribusiness firms from the policy.

The new policy relaxed licensing and investment restrictions for agribusiness activities across the majority of crops grown by smallholder farmers. 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 a count measure of the number of sections of legislation that were deleted/repealed/amended. A typical example, a full list of Crops and Acts for the policy measure construction is provided in the Appendix in Table 11. The policy is matched to the cropping segment in which the company operates, which is available from company sales reports and sales descriptions.[15] The crop-level policy measure is the count of sections repealed for each crop segment (denoted by ΔB_c) and the company-level policy measure is its sales share-weighted policy measure across all segments (denoted by $\Delta B_j \equiv \sum_c (r_{cj}/r_j)\,\Delta B_c$), where the sales shares

[15]Segments include for example, Beer and Beverages, Coffee, Horticulture, Sisal, Sugar made from cane, Tea and Tobacco and there are 29 distinct company-segments.

FIGURE 4.1. Relative Stock Returns of Agribusiness Companies Before and After the Announcement of Kenya's Agribusiness Entry Policy



(A) Brooke Bond (B) Agricultural Companies

The announcement date is March 4, 2004. The share price is the average daily price, available from the Nairobi Stock Exchange.

r_{cj}/r_j refer to sales in the pre period (1999-2004). Table 10 in the Appendix contains the list of companies, their main segments and policy measure values.

The agribusiness markdown can be obtained from changes in sales and profit margins with respect to the policy-induced reductions in entry costs for agribusinesses ΔB. From free entry of agribusinesses, $\mathscr{M}_a r_a = B$ for firm revenue $r_a \equiv p m_a q_a$ is the individual revenue of an agribusiness firm. The change in agribusiness markdown is $r_a \Delta \mathscr{M}_a + \mathscr{M}_a \Delta r_a = \Delta B$ and the initial markdown can be solved for as

$$\mathscr{M}_a = \left(1 - r_a \Delta \mathscr{M}_a / \Delta B\right) / \left(\Delta r_a / \Delta B\right). \tag{4.10}$$

We estimate the change in segment level sales of firms (Δr_a) and the change in profit margins with respect to changes in agribusiness entry costs ($\Delta \mathscr{M}_a$) through the following specifications:

$$r_{a,cjt} = \beta_r \cdot Post_t \cdot \Delta B_c + \alpha_{cj} + \alpha_t + \varepsilon_{cjt}$$

$$\mathscr{M}_{a,jt} = \beta_m \cdot Post_t \cdot \Delta B_j + \alpha_j + \alpha_t + \varepsilon_{jt}$$

for each firm j selling in crop segment c at time t where $Post_t$ is an indicator for the period after the national reforms and α_{cj}, α_j are respectively crop-firm and firm fixed effects. The level specifications allow for quantities and markdowns to be zero if a firm does not sell in a specific segment or a year.

Table 3 shows the results of lower firm sales and higher profit margins for agribusinesses. Repealing one section of the Agriculture Acts for each crop segment of a firm ($\Delta B_j = 1$) reduces average agribusiness revenues by 11.59% and raises the average profit margin by 1.09 percentage points. From the estimates for Δr and $\Delta \mathscr{M}_a$, equation 4.10 gives the markdown $\mathscr{M}_a = 11.66\%$ at the sample means.[16]

Table 3. Entry Cost Reductions, Segmental Revenues and Profit Margins of Agribusinesses

	(1) Segment Revenue $r_{a,cjt}$	(2) Profit Margin $\mathscr{M}_{a,jt}$
$Post_t \cdot \Delta B$	-0.0756	0.0109
	(0.0413)	(0.0046)
Fixed effects	Segment-Company	Company
	Year	Year
N	321	133

The dependent variable in Column 1 is firm sales (in constant KSh) in crop segment c of firm j in year t . $Post_t$ is an indicator for years 2005 to 2010, after the national reform of 2004. ΔB is the number of sections of legislations regarding agribusiness requirements that are repealed/deleted/amended at each stage for crop c between 2005-2006 (ΔB_c) in Column 1 and in Column 2 is $\Delta B_j = \sum_c \left(r_{a,cj} / \sum_c r_{a,cj} \right) B_c$. The dependent variable in Column 2 is the Profit Margin (Profit Before Tax/Sales) $\mathscr{M}_{a,jt}$ of firm j in year t. The sample consists of the universe of agricultural companies listed on the Nairobi Stock Exchange between 1999 to 2010. Regressions are weighted by agribusiness sales shares. Standard errors are clustered by company.

The markdowns from the previous sub-section and this sub-section are summarized in Table 4, and we proceed to quantifying the gains from trade and their division.

4.5. **Quantification of the Gains from Trade.** Table 4 contains results from the structural estimation, including passthrough rates $\nu, \eta_t, \eta_1, \zeta_{at}, \zeta_1$ for equations 4.8 and 4.9. The passthrough rate is slightly smaller for exports, 0.6270 compared to 0.6525 in the reduced form analysis of Table 2. The trickle down rate for traders is somewhat lower (7.78% compared to 11.65% earlier) while for agribusinesses is slightly higher. (25.15% compared to 22.21%).

The implied farmer share ratio θ from equation 4.1 is 1.0826. With $\theta > 1$, we find that $\mathscr{M}_a > \mathscr{M}_t$. From the two different methods, the markdowns $\mathscr{M}_a$ are somewhat similar - 12.36% and 11.66% from the first and second approaches respectively. Combining

[16]Because the specification for agribusiness segmental sales in levels is hard to interpret, the semi-elasticity ($\Delta r_a / \bar{r}_a$ at the mean $\bar{r}_a$ across all firms) is reported in Column 1 of Table 3 and for completeness, we note here that the estimated $\Delta r_a = -3.17$ with a standard error of 1.73.

with $\theta \equiv (1 - \mathscr{M}_t) / (1 - \mathscr{M}_a)$, the markdown rate for traders is 5.12% and 4.36% respectively. This shows that on a comparable metric of markdowns offered on farmgate prices, agribusinesses have higher buyer power.

TABLE 4. Structural Estimation Results: Key Parameters

Directly Estimated Parameters			Indirectly Estimated or Calibrated Parameters		
Parameter	Value	Equation	Parameter	Value	Equation
η_t	0.0778	4.8	$\eta_a = \eta_t + \eta_1$	0.2515	4.8
	(0.0198)			(0.0557)	
η_1	0.1737	4.8			
	(0.0565)				
ζ_{at}	0.2820	4.8	$\zeta_{ta} = \zeta_{at} + \zeta_1$	0.4098	4.8
	(0.1226)			(0.1629)	
ζ_1	0.1278	4.8			
	(0.0198)				
ν	0.6270	4.9			
	(0.0417)				
θ	1.0826	4.9	$\mathscr{M}_t$	5.12%	4.1, Mean $\mathscr{M}_a$ =12.36%
	(0.0999)		$\mathscr{M}_t$	4.36%	4.1, Entry $\mathscr{M}_a$ =11.66%

For brevity, we denote the sample mean of any variable x_{ch} as x, suppressing the subscript for the crop-household of each source country. The revenue gains from world price movements are

$$\begin{aligned} \Delta \ln R =& \nu \Delta \ln p^w \\ & - \theta\gamma_p \left(1 + \nu\Delta \ln p^w\right) \left(1_{ta} I_a / I_t\right) \\ & - \gamma_p \left(1 + \nu\Delta \ln p^w\right) \left(1_{at} I_t / I_t\right) \\ & + \theta\gamma_p \left(1 + \nu\Delta \ln p^w\right) \left(1_{at} I_t / I_t\right) P_{at} \\ & + \gamma_p \left(1 + \nu\Delta \ln p^w\right) \left(1_{ta} I_a / I_t\right) P_{ta} \\ & + \gamma_1 1_{e' \neq e} \left(I_e / I_t\right) + \gamma_2 1_{e' \neq e} \left(I_e / I_t\right) P_{e'e} \end{aligned} \tag{4.11}$$

If there were no productivity gains from higher agribusiness purchases, then the gains from trade would just be ν =0.6270 for every 1% rise in world prices (or the first line of equation 4.11). But with farmers switching to agribusinesses, there are additional productivity gains (second line onwards in equation 4.11) and the gains from trade are 0.6812, as summarized in the trickle down rates from world price movements in Table

5. The estimated gains are evaluated at the means of the variables, and are modest 0.0542.[17] The implied productivity difference in intermediation from equation 4.3 shows agribusinesses are 26.29% more productive than traders (with a standard error of 11.66%).

TABLE 5. Results: Gains from Trade

Trickle Down	Rate	Equation	Parameter
$\Delta \ln R$	0.6812	4.11	
$\Delta \ln R$ with no switchers	0.6270	4.9	ν from Table 4
$\Delta \ln I$	0.0927	4.12	
$\Delta \ln I$ with no switchers	0.0866	4.8	$\eta_t + 1_a\eta_a$ from Table 4

Gains from Trade	Value at Mean $\Delta \ln p^w$	Equation	Parameter
Mean $\Delta \ln p^w$	0.2617		
$\Delta \ln R$	0.1783	4.11	
$\Delta \ln I_t$	0.0165	4.8	
$\Delta \ln I_a$	0.1901	4.8	
$\Delta \ln I$	0.0243	4.8	
$\Delta I/R$	0.0228	4.13	Mean $\mathscr{M}_a$ from Table 4
	0.0230	4.12	$\mathscr{M}_a$ from Table 4
$\Delta \mathscr{M}_a$	0.0861	4.14	Mean $\mathscr{M}_a$ from Table 4
	0.0868	4.14, 4.10	$\mathscr{M}_a$ from Table 4
$\Delta \mathscr{M}_t$	0.1364	4.15	Mean $\mathscr{M}_a$, θ from Table 4
	0.1374	4.15, 4.10	$\mathscr{M}_a$, θ from Table 4

Table 5 also shows the trickle down to farmgate incomes:

$$\Delta \ln I \equiv \eta_t \Delta \ln p^w - 1_{aa} A \eta_1 \Delta \ln p^w - \zeta_{at} \Delta A - \zeta_1 A \tag{4.12}$$

World price movements trickle down to incomes at a rate of 9.27% which is slightly higher than the average trickle down of 8.66% from the slopes for world price changes. The productivity increase from more sales to agribusinesses therefore raises income gains, but the overall contribution is modest because fixed costs reduce the net surplus from switching.

[17]Along with θ, the relevant estimated coefficients and their standard errors are $\gamma_p, \gamma_1, \gamma_2$ = -34.0120 (35.0502), -52.0572 (45.4651), 48.1267 (44.3055). While these coefficients cannot be interpreted individually, their sum is the estimated productivity gain that is reported here.

Income and profit changes sum to the revenue gains, $\Delta R/R = \Delta I/R + \Delta\Pi/R$ and the income gains as a share of revenue are

(4.13)
$$\Delta I/R = ((\eta_t - 1_{aa}A\eta_1)\,\Delta\ln p^w - \zeta_{at}\Delta A - \zeta_1 A)\,(1-\mathscr{M}_a)\,\theta\,(1+I_a/I_t)\,/\,(1+\theta I_a/I_t)$$

The average change in world price is an increase of 26.17% and this raises revenues by 17.83%. Of this revenue gain, the income gain for a farmer selling through a trader is 1.65% (including the losses accruing from having switched away from agribusinesses). Farmers selling through agribusiness get a larger income gain of 19.01% of their initial income, of which most accrues to some farmers who start to sell more to agribusinesses for some farmers (because the trickle down rate to incumbent farmers is much smaller at 25.15% from $\eta_a \times$ 26.17% of world price change). Total incomes for farmers is 2.28% to 2.30% under the two approaches to calibrate $\mathscr{M}_a$ in equation 4.13.

Profits change by $\Delta\Pi_i/R_i = \mathscr{M}_i\Delta R_i/R_i + \Delta\mathscr{M}_i$ where the first component is the change in profits from a rise in revenues $\mathscr{M}_i\Delta R_i/R_i$ (given constant markdowns) and the second component is the change from markdowns being altered by firms. Substituting for the estimated passthrough rates in $\Delta\mathscr{M}_i = (\Delta p/p - \Delta p_i/p_i)\,(1-\mathscr{M}_i)$, markdown changes are given by

$$\Delta\mathscr{M}_a = (1-\mathscr{M}_a)\,(\nu - \eta_t - \eta_1) \quad (4.14)$$

$$\Delta\mathscr{M}_t = \theta\,(1-\mathscr{M}_a)\,(\nu - \eta_t) \quad (4.15)$$

Table 5 shows world price movements increase the markdown rates by about 8.6pps for agribusinesses and about 13.6pps for traders, implying that the bulk of the aggregate gains from trade accrue to intermediaries.

To sum up, the aggregate gains from trade are over two-thirds of the rise in world prices for crops, which rose by over a quarter. Of the aggregate gains from trade, about 5.4 percentage points were due to productivity gains from more intermediation by higher productivity agribusinesses compared to traders. Farmers gained 9.25% more in incomes on average, with farmers selling to agribusinesses experiencing 17% higher trickle down of world price increases. Almost all of these gains to farmers were experienced by a small group of farmers who started to sell to agribusinesses. The share of revenues going towards profits rose for both agribusinesses and traders.

5. Conclusion

The presence of agribusinesses as buyers of farm produce has grown in recent decades. Yet, there is limited systematic analysis of their contribution to the aggregate gains from trade and the division of the gains among agribusinesses, traders and smallholder farmers from whom they buy.

This paper starts from the observation that farmers selling through agribusinesses tend to be larger and to get higher transmission from world price movements. We embed these empirical regularities in a theoretical model that features heterogeneous farmers. Agribusiness intermediation requires material fixed-investment outlays from farmers, while offering higher prices. Thus, agribusiness intermediation tends to "select" higher income farmers, creating a dual structure in crop markets.

The model features endogenous oligopsony power in intermediation that responds to world price movements and other market conditions such as entry barriers. This provides the potential for differences in the aggregate gains from trade and the individual gains from trade to farmers and intermediaries. World price trickledown in the model, along with profit margins inferred from agribusiness company accounts, enable quantification of the individual gains from trade, including intermediary profit gains that are rarely directly observable.

The model is applied to quantify the welfare gains from world price movements for three low-income countries, for which household panels and buyer types are available. We find that two-thirds of the increases in world price over a decade were passed through to these exporting countries. Farmers got less than 15 percent of the export gains. Intermediaries retained the bulk of the gains, with profit margins of traders and agribusinesses rising by over 8.5 and 13.5 percentage points respectively.

The findings show that trade and farm data can help in opening up the black box of gains from trade in crop markets. We infer that agribusinesses are about a quarter more productive than traders. But most farmers remain too small to be able to access world markets through them. The findings echo the insights of Barrett and Mutambatsere (2008) that improving smallholder access to modern crop value chains remains challenging and trade policy tools on their own appear less effective in inducing market participation by smallholders. Removing entry barriers to agribusiness operation also do not have the standard effects of reducing average profit margins and shifting surplus towards farmers.

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Appendix

6. Theory Results

6.1. **Farmgate Price Comparative Statics.** Totally differentiating the equilibrium equations with respect to world prices and agribusiness entry costs, changes in prices are

$$\frac{(k-2)(pm_a-p_a)-2(p_a-p_t)}{(pm_a-p_a)(p_a-p_t)}p_a d\ln p_a = d\ln f_a - \frac{2pm_a}{pm_a-p_a}d\ln p + \frac{k-2}{p_a-p_t}p_t d\ln p_t$$

$$-\frac{(k-2)(pm_t-p_t)+2(p_a-p_t)}{(pm_t-p_t)(p_a-p_t)}p_t d\ln p_t = -\frac{2pm_t}{pm_t-p_t}d\ln p - \frac{k-2}{p_a-p_t}p_a d\ln p_a$$

Substituting for the change in trader price, the change in agribusiness price is

$$p_a d\ln p_a = -\frac{(pm_a-p_a)((k-2)(pm_t-p_t)+2(p_a-p_t))/2}{(k-2)(pm_t-p_t)+2(p_a-p_t)-(k-2)(pm_a-p_a)}d\ln f_a + \frac{(k-2)(pm_t-p_t)+2(p_a-p_t)-(k-2)(pm_a-p_a)(m_t/m_a)}{(k-2)(pm_t-p_t)+2(p_a-p_t)-(k-2)(pm_a-p_a)}pm_a d\ln p$$

The RHS in the first line has a positive numerator and denominator from the second-order conditions (SOCs) for profit maximisation. For $k>2$, the RHS in the second line also has a positive numerator and denominator from the existence condition and the SOCs respectively. For $k<2$, the numerator is always positive from the SOC and so is the denominator. Consequently, the sign of $d\ln p_a$ is negative with respect to changes in entry costs $d\ln f_a$ and positive with respect to changes in world prices $d\ln p$.

Substituting back into the trader price change, it can be solved as

$$\begin{aligned}
p_t d\ln p_t &= \frac{2pm_t(p_a-p_t)}{(k-2)(pm_t-p_t)+2(p_a-p_t)}d\ln p + \frac{(k-2)(pm_t-p_t)}{(k-2)(pm_t-p_t)+2(p_a-p_t)}p_a d\ln p_a \\
&= -\frac{(k-2)(pm_t-p_t)}{(k-2)(pm_t-p_t)+2(p_a-p_t)}\frac{(pm_a-p_a)((k-2)(pm_t-p_t)+2(p_a-p_t))/2}{(k-2)(pm_t-p_t)+2(p_a-p_t)-(k-2)(pm_a-p_a)}d\ln f_a \\
&+ \frac{(k-2)(pm_t-p_t)pm_a}{(k-2)(pm_t-p_t)+2(p_a-p_t)}\frac{(k-2)(pm_t-p_t)+2(p_a-p_t)-(k-2)(pm_a-p_a)(m_t/m_a)}{(k-2)(pm_t-p_t)+2(p_a-p_t)-(k-2)(pm_a-p_a)}d\ln p
\end{aligned}$$

Therefore, changes in trader prices take the same sign as the changes in agribusiness prices for $k \geq 2$ and vice-versa otherwise.

6.2. **Buyer Choice Comparative Statics.** Taking the difference in price changes, world price increases and entry cost reductions induce larger increases in the farmgate prices paid by agribusinesses relative to traders because:

$$\begin{aligned} & p_a d\ln p_a - p_t d\ln p_t \\ & = \frac{2\left(p_a - p_t\right) pm_a}{\left(k-2\right)\left(pm_t - p_t\right) + 2\left(p_a - p_t\right)} \frac{\left(k-2\right)\left(pm_t - p_t\right) + 2\left(p_a - p_t\right) - \left(k-2\right)\left(pm_a - p_a\right)\left(m_t/m_a\right)}{\left(k-2\right)\left(pm_t - p_t\right) + 2\left(p_a - p_t\right) - \left(k-2\right)\left(pm_a - p_a\right)} d\ln p \\ & - \frac{\left(p_a - p_t\right)\left(pm_a - p_a\right)}{\left(k-2\right)\left(pm_t - p_t\right) + 2\left(p_a - p_t\right) - \left(k-2\right)\left(pm_a - p_a\right)} d\ln f_a \end{aligned}$$

6.3. **Markdowns Comparative Statics.** By definition, $\frac{\mathscr{M}_i}{1-\mathscr{M}_i} d\ln \mathscr{M}_i = d\ln p - d\ln p_i$. Therefore, the change in markdowns with respect to entry barriers is

$$\frac{\mathscr{M}_i}{1-\mathscr{M}_i} d\ln \mathscr{M}_i / d\ln f_a = -\, d\ln p_i / d\ln f_a.$$

For comparative statics with respect to world prices, the change in markdowns from agribusinesses to farmgate prices is

$$\begin{aligned} \frac{\mathscr{M}_a}{1-\mathscr{M}_a} d\ln \mathscr{M}_a = & d\ln p \\ & - \frac{\left(k-2\right)\left(pm_t - p_t\right) + 2\left(p_a - p_t\right) - \left(k-2\right)\left(pm_a - p_a\right)\left(m_t/m_a\right)}{\left(k-2\right)\left(pm_t - p_t\right) + 2\left(p_a - p_t\right) - \left(k-2\right)\left(pm_a - p_a\right)} \frac{pm_a}{p_a} d\ln p \end{aligned}$$

The second term in parenthesis on the RHS is positive as shown earlier for $d\ln p_a$. It can be smaller or greater than one, depending on the magnitude of m_t/m_a. For $k > 2$, the second term is greater than one because $m_t < m_a$ and then the product with the third term (which is weakly greater than one because $p_a \leq pm_a$) would make it greater than one. At $k = 2$, the product is also exactly one. For $k < 2$, the second term is less than one and we will show that its product with pm_a/p_a is weakly greater than one. If $\left(k-2\right)\left(pm_t - p_t\right) + 2\left(p_a - p_t\right) < 0$, then the second term is increasing in $\left(pm_a - p_a\right)$ and its minimum value is at $p_a = pm_a$ where it turns out to be 1. If $\left(k-2\right)\left(pm_t - p_t\right) + 2\left(p_a - p_t\right) > 0$, then the second term is decreasing in $\left(pm_a - p_a\right)$ and its minimum value is at the minimum value of p_a. For $\left(k-2\right)\left(pm_t - p_t\right) + 2\left(p_a - p_t\right) > 0$, the implied lower bound for p_a is $p_a > \left(k/2\right) p_t + \left(1 - k/2\right) pm_t$ (which is also greater than p_t for a well-defined solution). At this lower bound, the second term is m_t/m_a and its product with the third term is pm_t/p_a. If this were to be less than one, then $pm_t < p_a = \left(k/2\right) p_t + \left(1 - k/2\right) pm_t$ and p_t would accordingly be greater than pm_t which is a contradiction. Consequently, $d\ln \mathscr{M}_a$ has the same sign as $d\ln p$ and markdowns rise with world prices.

Trader markdowns change with world prices as follows:

$$\frac{\mathscr{M}_t}{1-\mathscr{M}_t}\, d\ln\mathscr{M}_t = d\ln p - \frac{(k-2)\,(pm_t-p_t)}{(k-2)\,(pm_t-p_t)+2\,(p_a-p_t)}\times$$
$$\frac{(k-2)\,(pm_t-p_t)+2\,(p_a-p_t)-(k-2)\,(pm_a-p_a)\,(m_t/m_a)}{(k-2)\,(pm_t-p_t)+2\,(p_a-p_t)-(k-2)\,(pm_a-p_a)}\,\frac{pm_a}{p_t}\, d\ln p$$

For $d\ln\mathscr{M}_t/d\ln p$, the denominators of the second and third terms in parenthesis on the RHS are always positive from the SOCs. For $k=2$, the second term is zero and $d\ln\mathscr{M}_t$ has the same sign as $d\ln p$. For $k<2$, when m_t approaches m_a and p_t approaches p_a, the second and third terms go to one and the sign of $d\ln\mathscr{M}_t$ moves in the opposite direction as $d\ln p$. Therefore, the sign of $d\ln\mathscr{M}_t$ with respect to world price changes is ambiguous.

7. Extensions of The Theory

This section generalises the model to incorporate real world features - barriers to entry of agribusinesses, state parastatals, subsistence farming and multiple stages of agribusiness activity. As mentioned in the introduction, encouraging agribusiness-led development of crop markets is high on the agenda of policymakers. We therefore introduce entry barriers and state purchases of crops into the model to conceptualise rent shifting and subsidisation. We also examine the choice between subsistence and export crop production and generalise agribusinesses to providing multiple stages of value addition to farmers.

7.1. **Barriers to Agribusiness Entry.** We have already discussed comparative statics with respect to entry costs of agribusinesses, but have not accounted for rents that are generated by entry barriers. Crop markets in many developing economies feature high barriers to entry of agribusinesses which could generate economic rents for agents due to rationing of agribusiness services. To account for this, we follow the classic reasoning on import quota rents in international economics and the recent advances in macroeconomic modelling of distortions as wedges to provide a flexible and tractable way of modelling entry barriers. As is well-known from the import quota literature, the assignment of property rights to the proceeds of entry barriers determines the distribution of the gains from trade. In standard textbook analysis, when governments auction off quotas to firms, they earn the rents but when they distribute them lumpsum, they show up with the agents who receive them. Similarly, in our setting, removal of entry barriers shifts rents across agents and we can exploit the general equilibrium relationships to quantify unobserved welfare changes through rent shifting (in addition to the channel of interlinked intermediary markets specified before).

Entry barriers can be introduced in the benchmark model through the free entry condition for agribusinesses. The wedges are introduced by generalising the free entry condition to explicitly separate out rents of each agent from entry costs: $\Pi_a = MB_a - MB_g - Mbn$ where B_a is the cost of barriers per entrant, MB_a is the total cost of entry barriers, MB_g is the rent accruing to the government from agribusiness entry barriers and Mbn is the rent accruing to each of n farmers who engage with agribusinesses (where $n = (\varphi_{\min}/\varphi_a)^k$ for brevity). The model can be easily generalised to entry barriers discussed above. The pricing relationships remain the same as before but sorting of farmers and the free entry conditions now contain the rescue costs on entry barriers and rents from it. The productivity cutoff condition for farmers selling to agribusinesses now contains the rent to farmers: $\varphi_a = (f - b) / (\bar{p}_a - \bar{p}_t)$. The free entry conditions for agribusinesses and traders respectively:

$$(pm_a - p_a)^2 (f - b)^{-k+1} (p_a - p_t)^{k-2} k\varphi_{\min}^k = f_a + B_a - B_g - bn$$
$$(pm_t - p_t)^2 (f - b)^{-k+1} (p_a - p_t)^{k-2} k\varphi_{\min}^k = f_t$$

As some of the rents from barriers to entry go to the government, the national income identify (and resource clearing subsumed in it) is also modified to $R = \Pi_t + \Pi_a + (I_t + I_a) + (C_g - MB_g)$ where C_g denotes own consumption of the government. In the Appendix, we also show that the model generates sufficient statistics for the gains from trade and their division which can be estimated with trade, farm and agribusiness data for a real-world example of a national-level policy to reduce barriers to agribusiness entry.

7.2. **State Parastatals.** We introduce a channel of direct participation in crop markets by the state. This is specified as the government offering a price p_g for the crop and targeting a share κ of farmgate output to purchase. Most farmers engage in some form of sales to governmental agencies, so there is a subsidisation element to crop purchases by the government: $p_g > p_t, p_a$. We assume farmers are randomly matched to government agencies and expect to sell κ share of their produce to them. Then the cutoff for farmers who sell to agribusinesses is $\varphi_a = (f - b) / (\bar{p}_a - \bar{p}_t)$ where $b \leq f$. The expected price of farmers who sell to traders is $\bar{p}_t = (1 - \kappa) p_t + \kappa p_g$ and $\bar{p}_a = (1 - \kappa) p_a + \kappa p_g$ is the expected price of those who sell to agribusinesses. The term κp_g summarises the higher prices (or farm subsidies) paid by government agencies and the size of the government sector in the crop market, $I_g = \kappa p_g \frac{k}{k-1} \varphi_{\min}$.

The presence of a higher-paying government sector affects the optimal prices paid by traders and agribusinesses: $p_t = \frac{\mu N(k-1)pm_t - \kappa p_g/(1-\kappa)}{\mu N(k-1)+1}$ and $p_a = \frac{M(k-1)pm_a + \bar{p}_t/(1-\kappa) - \kappa p_g/(1-\kappa)}{M(k-1)+1}$ where $\mu/\bar{p}_t \equiv \frac{(f-b)^{-k+1}(\bar{p}_a-\bar{p}_t)^{k-2}}{\varphi_{\min}^{k-1}-(f-b)^{-k+1}(\bar{p}_a-\bar{p}_t)^{k-1}}$. The main insight is that the government makes the crop market for intermediaries smaller and lowers the farmgate prices that private intermediaries pay to farmers. However, expected farmgate prices are higher on account of the subsidisation element of government purchases.

Incorporating both features of rents from barriers to agribusiness entry and the presence of state parastatals, the free entry equations are now given by

$$(pm_a - p_a)^2 (f-b)^{-k+1} (\bar{p}_a - \bar{p}_t)^{k-2} (1-\kappa)^2 k\varphi_{\min}^k = f_a + B_a - B_g - bn$$
$$(pm_t - p_t)^2 (f-b)^{-k+1} (\bar{p}_a - \bar{p}_t)^{k-2} (1-\kappa)^2 k\varphi_{\min}^k = f_t$$

Let R_g denote the governmental crop revenues from selling the crops that they buy directly from farmers. Then the government's consumption must equal the rents and governmental crop revenues: $C_g = MB_g + R_g - I_g$. The national income identity is now given by $R = R_t + R_a + R_g = \Pi_t + \Pi_a + (I_t + I_a + I_g) + (C_g - MB_g)$ and subsumes resource clearing within it.

7.3. **Subsistence.** We now consider a subsistence crop that gives c units of consumption when the unit of land can be sown with the subsistence crop or the market crop. The cutoff productivity for sales to traders (and hence growing the market crop) and for sales to agribusinesses are: $\varphi_t = \max\{c/\bar{p}_t, \varphi_{\min}\}$ and $\varphi_a \equiv (f-b)/(\bar{p}_a - \bar{p}_t)$. Introduction of a subsistence crop therefore provides another channel of adjustment to world price movements through the extensive margin of farmers selling to traders relative to opting for subsistence farming.

The optimal prices take the same forms as those under state purchases, though now $\mu/\bar{p}_t \equiv \frac{c^{-k+1}\bar{p}_t^{k-2}+(f-b)^{-k+1}(\bar{p}_a-\bar{p}_t)^{k-2}}{c^{-k+1}\bar{p}_t^{k-1}-(f-b)^{-k+1}(\bar{p}_a-\bar{p}_t)^{k-1}}$ to account for the extensive margin of subsistence farming.[18] The free entry condition for agribusinesses is the same as before but the trader free entry reflects the extensive margin of subsistence farming:

$$(pm_t - p_t)^2 \left(c^{-k+1}\bar{p}_t^{k-2} + (f-b)^{-k+1} (\bar{p}_a - \bar{p}_t)^{k-2}\right) (1-\kappa)^2 k\varphi_{\min}^k = f_t$$

[18]The sufficient conditions for profit maximisation are $(k-2)(pm_t - p_t) + \frac{N+1}{N(1-\kappa)}(\bar{p}_a - \bar{p}_t) > 0$ and $(k-2)(pm_a - p_a) - \frac{M+1}{M(1-\kappa)}(\bar{p}_a - \bar{p}_t) < 0$ and an additional condition is needed when $\varphi_t = c/\bar{p}_t$ which is $(k-2)(pm_t - p_t) - \frac{N+1}{N(1-\kappa)}\bar{p}_t > 0$.

The government budget constraint is slightly modified to show that state purchases are from farmers growing the export crops: $C_g = MB_g + R_g - I_g$ where $I_g = \kappa p_g \frac{k}{k-1} \varphi_{\min}^k c^{-k+1} \bar{p}_t^{k-1}$.

7.4. **Stages of Agribusiness Activity.** To enable a flexible formulation of agribusiness stages of operation (e.g. buying or marketing), 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 formalize 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 (and suppressing the crop subscript), when agribusinesses are allowed to operate up to stage s, the price premium paid to farmers by agribusinesses is

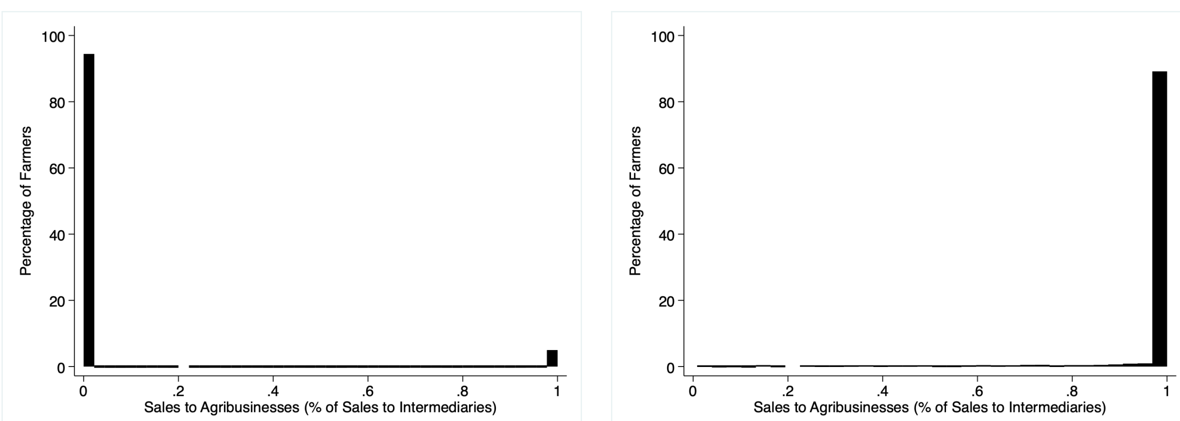
$$p_a = \frac{M(k-1)\,p\sum_{s'=1}^{s}\delta_{s'}m_{s'a} - \kappa p_g/(1-\kappa)}{M(k-1)+1}$$

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 and crops, this formulation 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 Antràs and Chor (2013) and Domínguez-Iino (2023) for environmental application to farming supply chain). The earlier equilibrium relationships continue to hold but now the free entry condition for agribusinesses in each crop market is generalised to $(1-\kappa)\frac{k}{k-1}\varphi_{\min}^k\left(\sum_{s'=1}^{s}\delta_{s'}pm_{s'a} - p_a\right)\varphi_a^{-k+1}/M = f_a + \delta_s f_s$. As explained earlier, $\delta_{s'}$ indicates the ability to operate in stage s' of agribusiness activities (with $1 \leq s' \leq s$) and δ_s refers to the ability to operate at stage s closest to the farmgate. Each stage entails investment costs f_s 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. 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.

7.5. **Empirics.** This sub-section contains empirics related to the distribution of farm sales across intermediaries, robustness checks for crops with "large" market share in world exports and asymmetric estimates of trickle down rates from Section 2, an explanation of the Kenya farm data, summary statistics for the main estimation and an explanation of the agribusiness data compilation.

Figure 7.1. Distribution of Share of Sales to Agribusinesses



(A) All Household-Crops

(B) Household-Crops with Positive Sales Share to Agribusinesses

Histogram of sales share $I_{a,cht} / \sum_{i=a,t} I_{i,cht}$ for crop c by household h in year t.

7.5.1. *Distribution of Sales Across Intermediaries.* Figure 7.1 (a) shows a bimodal distribution for the share of sales of a crop by a household going to agribusinesses as a percentage of all sales by that household-crop in that year. For clarity, Figure 7.1 (b) plots only the positive values to show the variation in positive sales shares across household-crops.

7.5.2. *Robustness of World Price Transmission.* Robustness of world price transmission is examined with respect to commodities where the source countries have larger market share that could make the world price movements endogenous to export revenues and farmgate prices. The magnitudes are smaller but results remain qualitatively similar when large crop-countries are excluded (where the source country's exports of a crop in a given year exceeds 5 percent of world exports of that crop in that year).

Table 6. Trickledown Premia for Farmers: Robustness

A. Export Revenues $\Delta \ln Exports_{cs}$		
	(1) All Crops	(2) No Large Crops
Change in Log of World Crop Price: $\Delta \ln p_c^w$	0.6525	0.5543
	(0.2089)	(0.1946)
Country FE	Yes	Yes
N	130	120

B. Trickledown Premia for Farmgate Prices $\Delta \ln Price_{ch}$		
Change in Log of World Crop Price: $\Delta \ln p_c^w$	0.0971	0.0957
	(0.0394)	(0.0391)
ΔAgribusiness Share$_{ch} \cdot \Delta \ln p_c^w$		0.1664
		(0.0400)
Agribusiness Share$_{ch} \cdot \Delta \ln p_c^w$		0.0837
		(0.0654)
ΔAgribusiness Share$_{ch}$		0.2991
		(0.0997)
Agribusiness Share$_{ch}$		-0.0028
		(0.0836)
Country FE	Yes	Yes
N	5,209	5,209

The dependent variable in Panel A is the export revenue of crop c sold by source country s in world markets. Column 1 contains all crops and Column 2 excludes any crop for which the country has a large market share in worldwide exports of that crop in that year. Large is defined as exceeding 5 percent in any given year corresponding to the survey years. Panel A is weighted by trade values and standard errors are clustered by crop-country in Panel A, as in Column 1 of Table 2. Panel B is the same as Panel C of Table 1 but with Large crops excluded from the analysis.

The relevant years to compute market shares are 2001-2005 for Ethiopia, 1999-2010 for Kenya and 2008-2012 for Malawi. Any commodity in related HS six digit codes is also categorised as large if it does not directly feature with a market share of more than 5 but belongs to the same crop type as a six digit category that in one or more of these years has a market share exceeding 5 percent.

In addition, when we only consider the sample of non-switching households as in Column 2 of Table 2, the corresponding estimates for $\Delta \ln Price_{ch}$ and associated standard errors are 0.0797 (0.0207) for $\Delta \ln p_c^w$, 0.1348 (0.0540) for $A_{ch}\Delta \ln p_c^w$ and 0.0777 (0.0444) for ΔA_{ch}.

Results with asymmetric responses to world price increases and decreases corresponding to world price transmission results in Section 2 are reported in Table 7 below. While these results suggest that agribusinesses do not shield farmers during negative price shocks, there is naturally a tradeoff in terms of higher earnings during positive shocks and building in risk aversion to study the appropriate tradeoff remains a growing line of inquiry (Allen and Atkin (2022)).

TABLE 7. Fact 3': Trickle Down from World Price Rise and Fall for Farmers Selling to Agribusinesses and Other Buyers

	$\Delta \ln Price_{ch}$	$\Delta \ln Income_{ch}$
	(1)	(2)
Δ ln World Crop Price$_c$	0.2287	0.2410
	(0.0508)	(0.0339)
ΔAgribusiness Share$_{ch}$$\cdot\Delta$ ln World Crop Price$_c$	0.1964	0.0858
	(0.0579)	(0.0679)
Agribusiness Share$_{ch}$$\cdot\Delta$ ln World Crop Price$_c$	-0.0044	0.1118
	(0.0676)	(0.0965)
ΔAgribusiness Share$_{ch}$	0.3836	0.3981
	(0.1202)	(0.1563)
Agribusiness Share$_{ch}$	-0.0171	-0.2174
	(0.0970)	(0.1788)
Rise$_c$$\cdot\Delta$ ln World Crop Price$_c$	-0.2174	-0.2845
	(0.0596)	(0.0434)
Rise$_c$$\cdot\Delta$Agribusiness Share$_{ch}$$\cdot\Delta$ ln World Crop Price$_c$	-0.3113	-0.2121
	(0.1865)	(0.3187)
Rise$_c$$\cdot$Agribusiness Share$_{ch}$$\cdot\Delta$ ln World Crop Price$_c$	-0.0923	-0.1953
	(0.1855)	(0.3652)
Country FE	Yes	Yes
N	5,993	5,993

Same as Panel C of Table 1 but with coefficients allowed to vary by rise in world prices. Rise is an indicator for an increase in the world price of the crop from survey year 0 to 1.

7.5.3. *Robustness of Structural Parameters.* Here we re-estimate the system of equations but now with A_{ch} defined as an indicator instead of the share of sales to agribusinesses. Unsurprisingly, the bimodal distribution of sales shares implies that the results are highly similar across Tables 4 and 8.

Table 8. Structural Estimation: Robustness with Agribusiness Indicator

Parameter	Value	Equation
(1)	(2)	(3)
η_t	0.0781	4.8
	(0.0198)	
η_1	0.1816	4.8
	(0.0558)	
ζ_{at}	0.2900	4.8
	(0.1154)	
ζ_1	0.1291	4.8
	(0.0556)	
ν	0.6293	4.9
	(0.0421)	
θ	1.0797	4.9
	(0.0962)	

Same as Table 4 but with A_{ch} defined as an indicator instead of sales share, $A_{ch} = 1\left(I_{a,ch} > 0\right)$.

7.5.4. *Kenya Farm Data.* Information on cropping patterns and incomes per buyer before and after the policy was implemented is obtained from surveys 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 each year that represent eight different agricultural-ecological zones in Kenya and follow them over time (see Chamberlin and Jayne (2013) for sampling details and Suri (2011) for application of the data). 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 seasons 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 many World Bank LSMS datasets).

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. Agribusinesses in the survey refer to large companies, exporters, miller, processors or supermarkets.[19] The overwhelming majority

[19]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.

of households sell a particular 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 non-farm channels through which the BTB policy may have impacted households, such as wages and business enterprises, incomes for which are reported for the household annually.

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 made up less than 1 per cent of world exports. Maize is the most important crop every year and the ranking of the other main crops changes slightly across years. 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.

7.5.5. *Summary Statistics.* For completeness, unweighted summary statistics, including for world prices of all household-crop observations are reported in Table 9.

TABLE 9. Summary Statistics

	Observations	Mean	Std. Dev.	Min	Max
$\Delta \ln Exports_{cs}$	130	0.2634	2.9539	-7.3045	7.9340
$\Delta \ln Price_{ch}^{farmgate}$ of Incumbent Farmers	5,539	-0.0307	0.9528	-7.4526	8.8331
ΔAgribusiness Share$_{ch}$	5,993	0.0197	0.2598	-1	1
Agribusiness Share$_{ch}$	5,993	0.0497	0.2140	0	1
$\Delta Income_{ch}^{farmgate}$ of Switching Farmers	455	93.9228	1348.496	-21655	4039
Δ ln World Crop Price$_c$	5,993	0.3686	1.3986	-4.3921	6.9383

7.5.6. *Agribusiness Data.* We first looked up the 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 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.[20]

There is no entry and one company is de-listed for a couple of years. Although firms report their accounts in different ways, sales and profits are available consistently over time and across firms. These two variables give the profit margin of the firm (profit before tax reported by the company divided by its revenue). The mean sales-weighted profit margin is 12.36 per cent, which is the value we use to calibrate the markdown rate of agribusinesses. The median profit margin of companies is 5.7%.

TABLE 10. Policy Exposure of Agribusinesses: Sales Shares in Policy-Affected Segments

Agribusiness Name	Main Crop Segments	ΔB_a
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	1
Limuru Tea Company Limited	Tea	1
Williamson Tea Kenya Plc	Tea	1
Mumias Sugar Company Limited	Sugar	1
Rea Vipingo Plantations Limited	Sisal	2
Sasini Plc	Coffee and Tea	7.99
Kakuzi Plc	Coffee, Horticulture and Tea	8.57
Eaagads Limited	Coffee	41

7.5.7. *Agribusiness Policy Measures.* To construct the policy measure for agribusiness entry costs, we read every law (and its antecedents) to categorise and count the number of sections changed in the legal texts. A section largely corresponds to a specific requirement, typically a license or permission or registration, that needs to be fulfilled for the crop(s) to which the Act applies. The full list of legislations (and their antecedents) are 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 applicable

[20]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.

between 2004 to 2006. 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. Table 10 contains the list of companies, their main segments and policy measure values for agribusiness entry cost reductions.[21]

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 7.2 and further detailed in Figure 7.3. A full list of Crops and Acts for the policy measure construction is provided in Table 11.

In particular, these sections referred to (19) Registration and licensing of millers, (20) Licenses, (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, NCPB crops for milling activity are coded as 5 for the number of sections 19-23 that are removed from registration and licensing requirements. (Other changes for these crops are also added in from various legislations.)

[21]Uchumi operates in multiple segments because it is a supermarket, so we assign it the most appropriate segment of vegetables and fruits, and we examine robustness of key results to this assignment in the Online Appendix.

Figure 7.2. 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.*

FIGURE 7.3. Example of Codification

No. 7 *National Cereals and Produce Board* **1985**

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.

Licences.

20. A miller's licence shall—

(*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;

(*b*) be in the prescribed form;

(*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.

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;

Cap. 242.

(*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.

167

1985 *National Cereals and Produce Board* **No. 7**

(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 11. 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
Subsidiary 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

Online Appendix: Not for Publication

8. Application to Removal of Barriers to Agribusiness Entry

This Appendix contains an extension of the model discussed in sub-section 5.1 to incorporate barriers to agribusiness entry. It also contains an application to a real-world national policy to remove barriers to agribusiness entry using microdata on household-crop-buyer incomes to infer the distribution of the gains from trade arising from removal of agribusiness entry barriers, referred to as Behind-The-Border Trade Barriers (BTBs).

8.1. **Context of Application to BTBs.** This section starts with a description of the data on households and agribusinesses and then discusses the context and policy application.

8.1.1. *Context and Policy.* 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 with a mean consumption of USD 1,176 for rural households in 2005 (World Income Inequality Database/Kenya Integrated Household Budget Survey consumption data). A vast majority of people continue to be employed in agriculture which makes up 25% of GDP and 75% of the labor force.

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 relatively open to private sector operations, had experienced high growth rates (see Macchiavello 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 government launched its Strategy for Revitalising Agriculture (SRA) proposing a "radical reform" of Kenyan agricultural policy

8.1.2. *Context and Farm Data.* The mean share of farmer incomes from crops by their changes in behind-the-border barriers to entry of agribusinesses is summarised in Table 12. 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 (74 such crops) to over dozens being removed for crops such as cotton. Crops with BTBs larger than one make up the majority of household farm incomes in the pre-policy period (2000 and 2004). A detailed analysis of the BTBs and their correlation with key variables is in the Online Appendix. Here we emphasize that the policy had its desired impact of raising farmer engagement with agribusinesses as reflected in the mean shares sold to agribusinesses for crops that were affected by the BTB policy in Table 12.

TABLE 12. Mean Share of Agribusinesses in Farmer Incomes by Crops %

	All crops		Grown crops		Balanced crops	
	Pre	Post	Pre	Post	Pre	Post
$\Delta B_c = 0$ crops (26)	6.62	8.03	9.57	9.08	4.81	3.45
$\Delta B_c = 1$ crops (74)	3.72	10.30	4.67	11.54	4.75	8.46
$\Delta B_c > 1$ crops (28)	5.01	14.37	7.02	16.09	4.76	14.27

All crops refer to the full set of crops, Grown crops refer to crops that have positive sales and Balanced crops refer to the crops that have positive sales in pre and post periods.

8.2. **Aggregate and Distributional Gains from Trade.** We are interested in examining the aggregate gains from trade $\hat{R}$ and their division between farmers and intermediaries. The aggregate gains are estimated through a standard gravity regression where the trade elasticity is estimated with respect to the policy measure. The change in farmer incomes and agribusiness profits is estimated from data on household-crop-buyer incomes and profit margins reported in company accounts of agribusinesses. The unobservables are changes in trader profits and changes in government rents, which are rarely available in standard data sources. The change in profit margins of traders are inferred using equilibrium conditions that rely on farmer sorting and profit maximisation, but are not constrained by the structure of the benchmark model. Finally, changes in government rents (or rent of other intermediaries such as state parastatals) are inferred from the national income identity after accounting for the estimated changes in trade, farm incomes, agribusiness profits and (inferred) trader profits.

To account for multiple crops, we first assume that a farmer has L parcels of land. Each farmer has a vector of productivity draws $\varphi_c \sim G_c(\varphi)$ where c is the crop with the highest productivity for that parcel. Then the aggregate equilibrium outcomes are a sum of the outcomes across all crops: $X \equiv \sum_c X_c$. Let $\hat{X} \equiv \Delta X/X$ denote the usual percentage change in outcomes.[22] The aggregate comparative static is

(8.1)
$$\hat{R} = \left(1 - S_a^R - S_t^R - S_g^R\right)\left(S_a^I \hat{I}_a + S_t^I \hat{I}_t + \left(1 - S_a^I - S_t^I\right)\hat{I}_g\right) + \left(S_a^R \hat{\Pi}_a + S_t^R \hat{\Pi}_t + S_g^R \hat{\Pi}_g\right)$$

where S_a^R, S_t^R and S_g^R are the profits received by agribusinesses, traders and the government respectively as a share of aggregate revenues while S_a^I and S_t^I are the shares of agribusinesses and traders in aggregate farm incomes respectively.

8.2.1. *Trader Profits.* To solve for the unobserved changes in trader profits in the presence of entry barriers, we map the trader profit changes to observable changes. The trader profit change is based on sorting of farmers across intermediaries and free entry of traders. The aggregate supply to traders is $Nq_t = (1-\kappa)\left(\int_{\varphi_{\min}}^{\varphi_a} q(\varphi)\, dG\right)$ where $q(\varphi)$ is the quantity of a farmer with productivity φ. From free entry of traders, $(pm_t - p_t)\, q_t = f_t$ and the envelope theorem gives the total (indirect) change in trader quantity as $\hat{q}_t(p_t, B_a - B_g - bn) = 0$ where the price effect from p_t drops out because of profit maximisation. Then the change in aggregate trader profits can be written as

$$\begin{aligned}\hat{\Pi}_t = & -\frac{\kappa}{1-\kappa}\hat{\kappa} + \frac{1-\kappa}{Nq_t} q(\varphi_a)\, g(\varphi_a)\, \varphi_a \hat{\varphi}_a(p_t, B_a - B_g - bn) \\ & + \frac{1-\kappa}{Nq_t}\int_{\varphi_t}^{\varphi_a} q(\varphi)\, \hat{q}_t(p_t, B_a - B_g - bn)\, dG\end{aligned}$$

where $\hat{q}_t$ in the second line is zero when supply does not directly depend on entry barriers (although it is indirectly affected through free entry). The productivity cutoff condition for farmers selling to agribusinesses is $\varphi_a = (f - b)/(\bar{p}_a - \bar{p}_t)$. Therefore, the indirect change in the cutoff is the observed change in the cutoff net of the change arising in it from the direct impact of changes in prices paid by traders: $\hat{\varphi}_a(p_t, B_a - B_g - bn) = \hat{\varphi}_a - \frac{\bar{p}_t}{\bar{p}_a - \bar{p}_t}\hat{\bar{p}}_t$. This gives the change in trader profits as

[22]Later we will also examine within-household across-crop spillovers.

(8.2)

$$\hat{\Pi}_t = -\frac{\kappa\hat{\kappa}}{1-\kappa} + (1-\kappa)\frac{I(\varphi_a)}{I_t}\left(\hat{\varphi}_a(p_t, B_a - B_g - bn) - \frac{\bar{p}_t\varphi_a}{(\bar{p}_a - \bar{p}_t)\varphi_a}\hat{\bar{p}}_t(p_t, B_a - B_g - bn)\right)$$

In economic terms, the first term on the RHS is the change in market size of traders from changes in governmental purchases. The second term is the change in market size of traders from farmers switching to agribusinesses, net of the price changes from traders.

The LHS $\hat{\Pi}_t$ is unobserved and the RHS is observed or can be estimated from data on household-crop-buyer incomes over time. The share of government purchases κ is directly observed and the change in sales to government $\hat{\kappa}$ is estimated using data on household-crop-buyer incomes with respect to the policy measure. The incomes of marginal sellers to agribusinesses $I(\varphi_a)$, the income sold to traders I_t and the relative incomes from traders and agribusinesses for marginal sellers is $\frac{\bar{p}_t\varphi_a}{(\bar{p}_a-\bar{p}_t)\varphi_a}$, whose components are directly observed in the income data too. The change in the share of farmers selling to agribusinesses $\hat{\varphi}_a$ and the change in trader prices is estimated with respect to the policy measure.

8.3. **Results of Application to BTBs.** Having discussed the theoretical gains from trade and their mapping to observables, this sub-section contains estimation results for the elasticities of gains from trade with respect to the policy. Detailed regression tables follow the main summary of baseline results in the subsequent sub-section.

Our empirical strategy exploits variation in licensing and investment requirements for agribusinesses across different crops to gauge the aggregate and individual gains from the removal of entry barriers. These policy changes were implemented in a majority of crop markets in an economy (Kenya) that is largely reliant on agriculture. Despite the importance of intermediation policies in alleviating poverty, severe measurement challenges have led to limited work on agribusinesses and behind-the-border barriers to trade for farmers. The national policy we examine lends itself well to codification because it directly repealed sections of legislation related to licensing and investment requirements for agribusinesses, and provides a count measure of the number of sections repealed. The sections are comprehensively documented in legal texts which were changed quickly within a couple of years to introduce new parliamentary acts. This enables us to use trade data, farmer-buyer-crop income data and company accounts to quantify the aggregate and distributional gains from legislative changes under assumptions on farmer sorting, profit maximisation and resource clearing. It also provides insights into the modelling of barriers to entry in crop markets

The main finding is that the policy raised exports of policy-affected crops. But it shifted surplus away from farmers to agribusinesses and the state. Smallholder farmers were left worse-off, consistent with the channel highlighted in the benchmark model when inequality in farm productivity is high, as was the case in Kenya. Interestingly, our empirical findings point to an additional effect from the new policy: a shift in surplus away from all farmers (not just smallholders) to both agribusinesses and the state. This can be accounted for by our generalised model, which realistically incorporates state purchases and rents from entry barriers. The reduction in government purchases hurt all farmers because of the effective subsidy provided by the state. Large farmers who sold to agribusinesses before the policy was implemented suffered further income losses from rent erosion.

8.3.1. *Trade, Crop Incomes and Agribusiness Profits.* We start with estimating a gravity regression of log trade values on the BTB policy changes to obtain an estimate for the aggregate gains from trade $\hat{R}$. For source country s exporting crop c to world markets in year t, the log of the COMTRADE reported trade value is

$$\ln R_{cst} = \beta_R \cdot Post_t \cdot \Delta B_c \cdot Kenya_s + \alpha_{cs} + \alpha_{st} + \alpha_{ct} + \varepsilon_{cst}$$

where $Post_t = 1$ after 2004, ΔB_c is the number of sections of legislation that are repealed for crop c, $Kenya_s$ is an indicator for Kenya and ε is an error term. The coefficient of interest is β_R which is the trade elasticity of behind the border barriers to agribusiness operations. The fixed effects include crop-source country α_{cs}, source country-year α_{st} and crop-year α_{ct} terms, which respectively account for time-invariant crop-country characteristics, source country macroeconomic changes and world crop demand and supply shocks. There are 66 crops and 175 countries from 1997 to 2010. The estimated increase in Kenya's exports of crops with one section of legislation repealed is 1.91 % on average in Column 1 of Table 13. Therefore, there is a substantive rise in Kenya's exports of policy-affected crops.

Column 2 estimates the household-crop elasticity of farm incomes, $\hat{I}_{hcm}$, to the BTB policy . For household h selling crop c in season m (main or short) of year t, the log of income in (1000 Kenyan shillings) is

TABLE 13. BTB Reductions and Source Country-Crop Exports, Household-Crop Incomes and Profit Margins of Agribusinesses

	(1) Exports $\ln R_{sct}$		(2) Incomes $\ln I_{hcmt}$	(3) Profits $\mathscr{M}_{a,jt}$
$Post_t \cdot \Delta B_c \cdot Kenya_s$	0.0191	$Post_t \cdot \Delta B_c$	-0.0177	0.0091
	(0.0053)		(0.0089)	(0.0045)
Fixed effects	Crop-Country	Fixed effects	Hh-Crop-Season	Company
	Crop-Year		Year	Year
	Country-Year		Crop-Season-Pre Years	
N	83759	N	17130	156

The dependent variable is log of Crop Exports $\ln R_{sct}$ (in '000 USD) from selling agricultural commodity (crop group) c by source country s in year t for a panel of crop-source country-year observations for all crops and for all countries in years 1997 to 2010. $Post_t$ is an indicator for years 2005-2010. Crop-level BTB change is ΔB_c, which is the number of sections of legislations regarding agribusiness requirements that were repealed/deleted/amended at each stage for the crop between 2005-2006 in all Columns. The dependent variable in Column 2 is the Log of Crop Income $\ln I_{hcmt}$ (in '000 KSh) from selling crop c for household h in season m of year t for a panel of household-crop-season-year observations for all crops and for all households. The dependent variable in Column 3 is the Profit Margin (Profit Before Tax/Sales) of the agribusiness firm j during year t. The sample consists of the universe of agricultural companies listed on the Nairobi Stock Exchange between 1999 to 2010. Regressions are weighted by the share of the crop in the initial farm income of Kenyan households in Column 1, unweighted in Column 2 (weighted versions are in the Online Appendix) and by the agribusiness sales share in Column 3. Standard errors are clustered by crop and source country in parentheses in Column 1, by crop and household in Column 2 and by company and crop segments, correcting for small clusters in Column 3.

$$\ln I_{hcmt} = \beta_I \cdot Post_t \cdot \Delta B_c + \alpha_t + \alpha_{hcm} + \alpha_{cmt'} + \varepsilon_{hcmt}$$

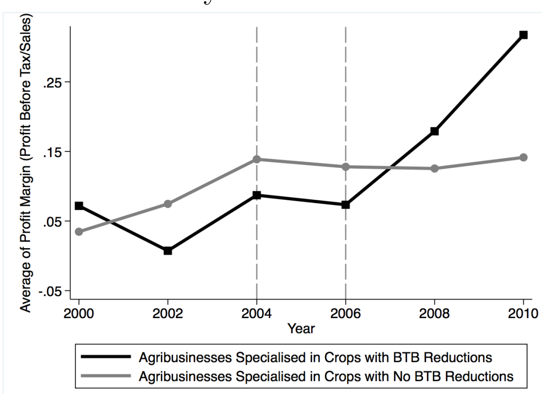
where β_I is the coefficient of interest and α_t are year fixed effects. Household-crop-season fixed effects α_{hcm} ensure that the variation is from within household-crop changes in incomes and $\alpha_{cmt'}$ are crop-season-pre 2004 fixed effects that allow for differences in crop pre-trends. There are 76 crops and 1,284 households during four survey years (1999/2000, 2003/2004, 2006/2007, 2009/2010). The estimated elasticity of household-crop incomes to repealing one section of the BTB policy is a reduction of 1.77 %. Farmers received lower prices and rents after the policy change, and we discuss these income changes across different farmers in detail later.

Column 3 estimates the elasticity of agribusiness profit margins, $\mathscr{M}_{a,jt}$, to the BTB policy.[23] The profit margin of firm a specialising in crop segment c is specified as:

$$\mathscr{M}_{a,jt} = \beta_a \cdot Post_t \cdot \Delta B_j + \alpha_a + \alpha_t + \varepsilon_{at}$$

where $\Delta B_j = \sum_c (S_{cj}/S_j)\, \Delta B_c$ for sales S_{cj} of crop c by agribusiness j between 1999 and 2004. Column 3 shows that on average the elasticity of agribusiness profits to repealing of one section of BTB is 9.1 percent. This confirms the evolution of profits depicted in Figure 8.1 below. Mean profit margins tripled for agribusinesses specialising in policy-affected crops but the increase was much more muted for agribusinesses that specialised in other crops.

FIGURE 8.1. Fact 4a: Agribusiness Profit Margins by Crop Specialisation, Before and After the BTB Policy



Mean Profit Margins %	(1) Pre	(2) Post
Companies Specialised in Crops with BTB Reductions	5.54	18.90
Companies Specialised in Crops with No BTB Reductions	8.27	13.16

Average Profit Margin is the average of profit margins (defined as Profit Before Tax/Turnover) 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 policy change between 2005-2006 after the announcement in 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.

While the gravity specification is standard, robustness of agribusiness profits and crop-level incomes of households is explored in greater detail in the Online Appendix. Table

[23]The sample differs from that in Table 3 only on account of weighting by concurrent sales, that is more appropriate in estimating the markdown to revenue elasticity there compared to the full sample here (including zero sales).

18 shows the profit margin results are robust to different variations of weighting and samples. Tables 19 and 20 further show that the income results are not driven by world price changes, spoilage of harvest, initial crop-level distortions or elections to crop boards, different weighting for buying stage of agribusiness operations (also see theory appendix for stages), incomes from maize (which is the main food crop) and incomes from tea (which is the main export crop).

8.3.2. *Intensive and Extensive Margins of Crop Sales to Buyers.* Having estimated the key elasticities, we examine the heterogeneity in farm income impacts by buyer type suggested by the theory. The estimated elasticities of household-crop incomes from each buyer to the BTB policy is shown in Table 14. For farmers who continue to sell to agribusinesses, Column 1 shows an estimated elasticity of incomes from agribusinesses of -9.38 percent for a repeal of one section of legislation. The policy is therefore associated with a sharp reduction in rents (b in the theory) for farmers selling to agribusinesses before and after the policy change. The corresponding income elasticity for government purchases is estimated to be -2.41 percent in Column 2 (although imprecisely). This confirms the subsidisation feature of government purchases, $\hat{\kappa} < 0$ in the theory, which reduces farmer incomes as state purchases give way to higher agribusiness sales.

Farmers switch across buyers and the estimated elasticities of the extensive margins are provided in Columns 4 and 5. The share of farmers switching to agribusinesses from traders/consumers is estimated to rise by 1.67 percent with a repeal of one BTB section. The policy therefore had the desired consequence of increased engagement with agribusinesses. Further, the share of farmers switching to governmental agencies from market sales is estimated to be -0.32 percent, showing the general decline in government purchases. This decline had corresponding negative changes in the household-crop incomes of the switchers. Farmers who switch to agribusinesses from other private sales are estimated to see a reduction in household-crop incomes of -0.025 (0.016) for a single BTB repeal from 1815 household-crop-year observations. It also had negative consequences for incomes of the small number of 123 household-crops that switch out of governmental agencies to market sales. Their income elasticity is estimated as -0.048 (0.005), which shows an expected farm income contraction from the rollback of government purchases.

8.3.3. *Other Income Margins.* Before we turn to quantifying the welfare changes with the agricultural income elasticity estimates in hand, we examine whether the policy had spillovers on to other income sources (see Table 23). The first is across-crop spillovers

TABLE 14. BTB Policy and Household-Crop-Buyer Incomes: Intensive and Extensive Margins of Farm Sales to Buyers

	Log of Crop-Level Incomes from Buyer b: $\ln I_{bchmt}$			Sell Crop to Buyer b: $1_{I_{bhcmt}>0}$	
	(1) $\ln I_{ahcmt}$	(2) $\ln I_{ghcmt}$	(3) $\ln I_{ohcmt}$	(4) $I_{ahcmt} > 0$	(5) $I_{ghcmt} > 0$
$Post_t \cdot \Delta B_c$	-0.0938	-0.0241	-0.0138	0.0167	-0.0032
	(0.0339)	(0.0089)	(0.0084)	(0.0061)	(0.0016)
Hh-Crop-Season FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Crop-Season-Pre FE	Yes	Yes	Yes	Yes	Yes
N	473	1903	13629	14938	15371

The dependent variable is the Log of Crop Income $\ln I_{bhcmt}$ from selling crop c in Columns 1, 2 and 3 for household h in season m of year t to buyer $b \in \{a, g, o\}$, where $a =$ Agribusiness, $g =$ Board/Coop and $o =$Other (Trader or Consumer). The dependent variable is an Indicator for Positive Sales of crop c for household h in season m of year t to agribusinesses (among the group that makes a switch between agribusinesses and traders/consumers) in Column 4 and for positive sales to government agencies (among the group that makes a switch between government and agribusinesses/traders/consumers). $Post_t$ is an indicator for 2007 and 2010. Crop-level BTB change is ΔB_c which 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. Hh refers to households and Pre refers to survey years 2002-03 before the BTB policy.

within the household, for which we construct a share-weighted BTB policy variable for crops other than the one under consideration, $\sum_{c' \neq c} S_{hc'm0} \Delta B_c$, where $S_{hc'm0}$ is the income share of crop c' in the household's income. When the initial share-weighted BTB policy change for other crops in the household-crop income specification is included, the cross-crop policy spillovers into incomes are almost zero. There is also no systematic change in crops grown by the household and the BTB policy change for the crop, so the extensive margin of entry into crops is negligible.

Farming input expenditures also show almost zero changes with respect to the policy measure. If interlinked input transactions were driving the income losses of farmers, costs would be expected to respond to the policy change. As a number of the reported cash costs are zeros, the estimation is done in levels rather than logs. Finally, the log of other income sources – wages, livestock and enterprise incomes – show a fall with respect to the initial share-weighted BTB measure for the household, $\sum_c S_{hcm0} \Delta B_c$. But the estimated elasticity is small (-0.32 of a percent) and an order of magnitude lower than the estimated household-crop income elasticity. We therefore focus on agricultural income elasticities, though changes in total incomes are also summarised later.

8.3.4. *Distribution of the Gains from Trade.* Having estimated the income elasticity and with data on initial household-crop-buyer incomes, the aggregate change in incomes of farmer who do not switch buyers can be predicted as $\sum_h \sum_b \sum_c \beta_b I_{bhcmt}$ from the estimated log income regressions for each household-crop-buyer and evaluated at the mean change in crop BTBs for the sample (Columns 1, 2, 3 of Table 14). For farmers who switch buyers, the income change is predicted as the estimated β_b in Columns 4 and 5 multiplied by the mean BTB policy change for the sample. This is further multiplied by the estimated elasticity of household-crop incomes for switchers mentioned earlier (-2.5 percent and -4.8 percent). Aggregating the income impacts for the farmers who continue with their buyers and those who switch gives the aggregate farm income loss of $\hat{I} = 6.84$ percent. When divided by total initial income (and not just farm income), the estimated total income loss is 3.25 percent. Dividing the households by quintiles of total initial income, the bottom to top quintiles lose on average 6.2, 6.2, 6.4, 8.2 and 7.1 percent of their farm income or 2.1, 3.5, 3.1, 4.7 and 2.9 percent of their total income.

The estimated revenue elasticity from the export gravity regression is $\hat{R} = 1.91$ percent (Column 1 of Table 13). Evaluated at the mean policy value of 5, the estimated trade impact is 9.6 percent of initial trade value. The estimated agribusiness profit margin increase (in levels) is $\Delta \mathscr{M}_a = 9.1$ percent, which is multiplied with the mean policy measure of 3.7 and divided by the mean sales-weighted markup of 0.156.

The initial aggregate revenue shares of agents in the economy are computed from various sources. From the ILO and the World Bank, 39 percent of the Kenyan population was in agricultural employment and the bottom two quintiles received 14.1 percent of national income in 2004-2005. Agribusiness profits were 15.6 percent of their total sales and they made up 21.5 percent of farm sales in 2004. Consequently, $\Pi_a / R_a = 0.156$. As $R_a = \Pi_a + I_a$, this gives $R_a = I_a / (1 - 0.156)$. For $I_a / I = .215$, we can therefore write aggregate revenues as $R = I_a / (1 - 0.156) + (0.785/0.215) I_a + \Pi_t + \Pi_g$. An upper bound on agribusinesses profit share in aggregate revenues is obtained by setting trader profits and government rents to their lowest values, $\Pi_t = 0$ and $\Pi_g = 0$.

To infer the changes in trader profits, we exploit the equilibrium condition of the model in Equation 8.2. The share of sales to governmental agencies κ is observed from household-crop-buyer income data for each crop. It is multiplied with the estimated elasticity of the extensive margin of sales to government agencies and evaluated at the mean policy measure for this sample to get $\hat{\kappa}$ (Column 5 of Table 14). The total income of farmers selling to traders I_t is observed from household-crop-buyer income data and the income of less productive farmers who sell to agribusinesses is proxied with the median farm sales to agribusinesses $I(\varphi_a)$. The elasticity of the extensive margin of sales to agribusinesses $\hat{\varphi}_a$ is from Column 4 of Table 14 and evaluated at the mean policy measure for the sample. The relative incomes from traders and agribusinesses is evaluated at the median farm sales to agribusinesses and traders $\frac{\bar{p}_t \varphi_a}{(\bar{p}_a - \bar{p}_t)\varphi_a}$. The change in trader prices $\hat{\bar{p}}_t$ is the estimated elasticity of crop incomes from traders to the policy measure, and evaluated at the mean of the policy measure for farmers who continue to sell to traders/consumers. The inferred impact on trader incomes $\hat{\Pi}_t$ turns out to be negligible at 0.0016 percent. This suggests that entry of traders barely responded to the policy, and it should be noted that free entry has not been imposed to arrive at this computation.

With each of the components in hand, we now infer the rents accruing to the government. These are given by

$$
\begin{aligned}
S_g^R \hat{\Pi}_g =& \hat{R} - S_a^R \hat{\Pi}_a - \left(1 - S_a^R - S_g^R - S_t^R\right) \hat{I} - S_t^R \hat{\Pi}_t \\
\leq& 9.6 - 0.245 \times 21.4 - 0.141 \times (-3.25) - 0 \\
=& 9.6 - 5.2 + 0.5 = 4.9
\end{aligned}
$$

Agribusinesses saw large increases in profits but as they make up less than a quarter of all revenues, the residual government sector is inferred to have experienced gains in rents of a comparable but slightly lower magnitude. While it is plausible that many of these gains may be transferred back to farmers or intermediaries, they nonetheless had substantial impacts on earnings and rents (as opposed to transfers).

Summing up, household-crop incomes fell for farmers who were selling the BTB-affected crops, especially for farmers who were selling these crops to agribusinesses before. Evaluated at the mean BTB policy value, farmers experienced a 6.8 percent drop in farm incomes (or 3.25 percent drop in total income). It resulted in an aggregate gain of 9.6 percent in aggregate exports of affected crops and this surplus went largely to agribusinesses and government agencies. Traders saw negligible changes in profitability and the smallholders who continued to sell to them were worse-off, as expected in an economy with high inequality.

8.4. **Additional Results.** Notably, the variation in BTBs is not systematically correlated with various crop characteristics in the pre-policy period. Table 15c 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.

TABLE 15. Correlation of Crop BTBs with Crop Characteristics

Crop Characteristic in Pre-Period	p-value of F-stat
Farmers Selling to Agribusiness	0.98
Market Share of Agribusiness	0.46
Mean Price of Crop across Farmers	0.55
World Prices	0.75
World Price Changes (1, 2 years)	0.82, 0.28
Total Income Share of Crop for Farmers	0.24
Mean Acreage of Crop across Farmers	0.56

Crop-level BTB is the number of sections of legislations regarding agribusiness requirements that are repealed/deleted/amended at each stage for the crop between 2005-2006. Crop characteristics refer to the pre-period values for the share of farmers selling to agribusinesses, the market share of agribusinesses in crop income, the mean frontage price of the crop before, the world price of the crop in the year and the year before, the total income share of the crop and the mean 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.

8.4.1. *Empirical Results.*

TABLE 16. BTB Policy and Crop Exports of Source Countries

	Log of Crop Exports $\ln R_{sct}$		
	(1)	(2)	(3)
$Post_t \cdot \Delta B_c \cdot Kenya_s$	0.0108***	0.0191***	0.0181***
	(0.0013)	(0.0053)	(0.0067)
Crop-Country FE	Yes	Yes	Crop-Country-Pre Years
Crop-Pre 2004 FE	Yes	Crop-Year	Crop-Year
Country-Year FE	Yes	Yes	Yes
N	83,759	83,759	82,469
Adjusted R^2	0.884	0.885	0.890

The dependent variable is log of Crop Exports $\ln R_{sct}$ (in '000 USD) from selling agricultural commodity (crop group) c by source country s in year t for a panel of crop-source country-year observations for all crops and for all countries in years 1997 to 2010. $Post_t$ is an indicator for years 2005-2010. Crop-level BTB change is ΔB_c which 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. Pre refers to 2000-2004 before the BTB policy. Regressions are weighted by the share of the crop in the initial farm income of Kenyan households. Mean of $\ln R_{sct}$ is 12.89 and mean of ΔB_c is 5. Standard errors are clustered by crop and source country in parentheses. $^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

Table 17. BTB Policy and Household-Crop Incomes of Farmers

	Log of Crop-Level Incomes of Households $\ln I_{hcmt}$						
	(1)	(2)	(3)	(4)	(5)	(6) Balanced	(7) Weighted
$Post_t \cdot \Delta B_c$	-0.0054	-0.0177**	-0.0178**	-0.0192***	-0.0172***	-0.0175*	-0.0173***
	(0.0085)	(0.0089)	(0.0089)	(0.0077)	(0.0092)	(0.0091)	(0.0026)
Hh FE, Crop-Season FE	Yes						
Hh-Crop-Season FE		Yes				Yes	Yes
Year FE	Yes	Yes	Yes	Hh-Year	Yes	Yes	Yes
Crop-Season-Pre FE		Yes	Yes	Yes		Yes	Yes
Hh-Crop-Season-Pre FE					Yes		
Hh-Pre FE			Yes	Yes			
N	27235	17130	16759	15899	10374	16114	17130
Adjusted R^2	0.552	0.672	0.632	0.658	0.670	0.669	0.802

The dependent variable is Log of Crop Income $\ln I_{hcmt}$ (in '000 KSh) from selling crop c for household h in season m of year t for a panel of household-crop season-year observations for all crops and for all households. $Post_t$ is an indicator for 2007 and 2010. Crop-level BTB change is ΔB_c which 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. Hh refers to households and Pre refers to survey years 2002-03 before the BTB policy. Balanced refers to household-crop observations for households that are surveyed in each of the four years. Weighted refers to income share weighted regressions. Standard errors are clustered by crop and household in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Exports, Profits and Household-Crop Incomes. The full set of profit margins results are in Table 18. Column 2 winsorizes the profit margins (to lie between -0.4 to 0.4) to account for outlier values and results remain robust. Column 3 weights the regression by the initial sales shares of firms. Column 4 uses the stagewise policy measure. Column 5 drops Uchumi supermarkets from the sample to ensure that its assignment to the fruit and vegetable segments is not driving the result. Column 6 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 not alter the main results.

Robustness of Household-Crop Income Elasticities. Tables 19 and 20 contain a number of checks of robustness of household-crop income elasticities to other changes. 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 average changes are: log farm

TABLE 18. BTB Policy and Profit Margins of Listed Agricultural Firms

	Dependent Variable: Agribusiness Profit Margin $\mathscr{M}_{a,jt}$					
	(1)	(2) Winsorize	(3) Initial	(4) Stages	(5) No Uchumi	(6) No KOrchards
$Post_t \cdot \Delta B_j$	0.0091*	0.0098**	0.0055*	0.0083**	0.0110***	0.0091*
	(0.0045)	(0.0045)	(0.0025)	(0.0036)	(0.0025)	(0.0045)
Company FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	156	156	144	156	144	144
R^2	0.377	0.655	0.540	0.573	0.569	0.570

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 $\sum_c S_{cj} \Delta B_c$ and Crop-level 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 a between 1999 to 2004. Winsorize refers to profit margins between -0.4 and 0.4. $BTB_c = \sum_s s \cdot BTB_{sc}$ in Column 4 is the Stagewise BTB where $s = 1$ for Marketing/Warehousing/Selling/Exporting/Milling/Processing and 2 for Buying. Regressions are weighted by firm sales shares in each period, except in Column 3 where the weight refers to firm sales shares in the initial period. No Uchumi and KOrchards in Columns 5 and 6 refer to regressions dropping Uchumi Supermarket (which sells all food and is given the modal value of all fruits and vegetables) and Kenya Orchards (which gets delisted during a couple of years). Standard errors in parentheses are clustered by company and crop segments and corrected for small clusters. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

price -0.182, log income -0.109, log world price -0.868 and rise 0.508. About half of the farmers who sell to agribusinesses experience a fall in world prices. The latter accounts for the potential role of intermediaries in reducing negative world price shocks to farmers (Allen and Atkin (2022)). Note that these results for world price trickle down are not directly comparable to the stylised facts earlier because they are relative to previous crop-year changes due to the presence of crop-season-pre 2004 fixed effects.

Negative *productivity shocks* to crops, for example, through bad weather, could lower income from policy-affected crops. Column 1 of Table 20 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)). The policy variation in BTBs is much finer and not confounded by these other changes which included regulations and elections to crop boards, as shown in Column 3 which adds an indicator for 20 crops that received regulatory or election changes. Column 4 adds an indicator for households that were affected by the violence that followed a subsequent election in 2009.

To examine the *stages of agribusiness activity* affected by the policy, we examine an alternative policy variable where the buying stage is given a larger weight to account for the ability to do more downstream stages of agribusiness value addition (once procurement is done). 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 6 restricts the sample to non-maize crop incomes and results remain qualitatively similar. Column 7 does the same for tea which is a major export crop of Kenya and Column 8 removes observations where there have been observed to be greater noise in the data in 2004 (Suri (2011)).

TABLE 19. Robustness of BTB Policy and Household-Crop Incomes of Farmers to World Prices

	Log of Crop Income of Farmers	
	(1) All	(2) Post
$Post_t \cdot \Delta B_c$	-0.0211**	-0.0200**
	(0.0088)	(0.0088)
$\ln p^w_{ct}$	-0.0367	
	(0.1269)	
$Fall_{ct}$	-0.1034*	
	(0.0557)	
$\ln p^w_{ct} \cdot Fall_{ct}$	-0.0621	
	(0.0540)	
$Post_t \cdot \ln p^w_{ct}$		0.0622
		(0.0714)
$Post_t \cdot Fall_{ct}$		-0.1036
		(0.0930)
$Post_t \cdot \ln p^w_{ct} \cdot Fall_{ct}$		-0.0715
		(0.0585)
Hh-Crop-Season FE	Yes	Yes
Crop-Season-Pre FE	Yes	Yes
Year FE	Yes	Yes
N	17130	17130

The dependent variable is Log of Crop Income I_{hcmt} 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 crops and for all households. $Post_t$ is an indicator for 2007 and 2010. Crop-level BTB change is ΔB_c which 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. $\ln p^w_{ct}$ is the log of 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. Hh refers to households and Pre refers to survey years 2002-03 before the BTB policy. Standard errors are clustered by crop and household in parentheses. $^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

Table 20. Robustness of BTB Policy and Household-Crop Incomes to Other Channels

	Log of Crop Income of Farmers			
	(1)	(2)	(3)	(4)
Panel A. Controls				
$Post_t \cdot \Delta B_c$	-0.0196**	-0.0183**	-0.0240***	-0.0177**
	(0.0091)	(0.0089)	(0.0091)	(0.0089)
$Post_t \cdot Spoiled_{ct}$	-0.0290***			
	(0.0108)			
$Post_t \cdot Distortion_c$		-0.0048***		
		(0.0014)		
$Post_t \cdot Regulations_c$			0.0679***	
			(0.0141)	
$Post_t \cdot Violence_h$				0.0221
				(0.0670)
N	17130	17130	17130	17130
Panel B. Samples	Stages	No Maize	No Tea	No Coast
	(5)	(6)	(7)	(8)
$Post_t \cdot \Delta B_c$	-0.0145**	-0.0179**	-0.0171*	-0.0176**
	(0.0074)	(0.0091)	(0.0089)	(0.0089)
N	17130	15072	16373	16970
Hh-Crop-Season FE	Yes	Yes	Yes	Yes
Crop-Season-Pre FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

The dependent variable is Log of Crop Income $\ln I_{hcmt}$ 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 crops and for all households. $Post_t$ is an indicator for 2007 and 2010. Crop-level BTB change is ΔB_c which 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. $Spoiled_{cmt}$ is the log of the harvest that was spoiled for each crop and season-year. $Distortion_c$ is the distortion index for Kenyan crops from the World Bank for 1999-2004. $Regulations_c$ is an indicator for crops that saw changes in crop regulations or election requirements for boards of the crops, which applies to 20 crops. $Violence_h$ is an indicator for whether the household suffered directly or indirectly from the post-election violence in 2009. Column 5 recodes the BTB variables as $\Delta B_c \equiv \sum_s s \cdot BTB_{sc}$ where $s = 1$ for Marketing/Warehousing/Selling/Exporting/Milling/Processing stage and 2 for the Buying stage. Columns 6, 7 and 8 remove maize, tea and coastal provinces respectively transactions from the sample. Standard errors are clustered by crop and household in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 21. BTB Policy and Household-Crop Income Intensive Margins of Farmers by Buyer Types

	Log of Crop-Level Incomes of Households from Buyer b: $\ln I_{bhcmt}$					
	From Agribusiness $\ln I_{ahcmt}$		From State $\ln I_{ghcmt}$		From Traders $\ln I_{ohcmt}$	
	(1)	(2)	(3)	(4)	(5)	(6)
$Post_t \cdot \Delta B_c$	-0.0938**	-0.0966**	-0.0241	-0.0241	-0.0138**	-0.0187**
	(0.0339)	(0.0397)	(0.0089)	(0.0093)	(0.0084)	(0.0091)
Hh-Crop-Season FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Crop-Season-Pre FE	Yes	Yes	Yes	Yes	Yes	Yes
Hh-Pre FE		Yes		Yes		Yes
N	473	333	1903	1662	13629	13165

The dependent variable is Log of Crop Income $\ln I_{bhcmt}$ (in '000 KSh) from selling crop c for household h in season m of year t to buyer $b \in \{a, g, o\}$, where a = Agribusiness, g = Board/Coop and o =Other (Trader or Consumer). $Post_t$ is an indicator for 2007 and 2010. Crop-level BTB change is ΔB_c which 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. Hh refers to households and Pre refers to survey years 2002-03 before the BTB policy. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 22. BTB Policy and Household-Crop Income Extensive Margins of Farmers by Buyer Types

	Household Sells the Crop to Buyer b: $1_{I_{bhcmt}>0}$			
	To Agribusinesses		To State	
	(1)	(2)	(3)	(4)
$Post_t \cdot \Delta B_c$	0.0167***	0.0170***	-0.0032**	-0.0034**
	(0.0061)	(0.0061)	(0.0016)	(0.0017)
Hh-Crop-Season FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Crop-Season-Pre FE	Yes	Yes	Yes	Yes
Hh-Pre FE		Yes		Yes
N	14938	14504	15371	14952

The dependent variable is an Indicator for Positive Sales of crop c for household h in season m of year t to buyer $b \in \{a, g, o\}$, where a = Agribusiness, g = Board/Coop. $Post_t$ is an indicator for 2007 and 2010. Crop-level BTB change is ΔB_c which 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. Hh refers to households and Pre refers to survey years 2002-03 before the BTB policy. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 23. BTB Policy and Other Income/Expenditures of Farmers

	Log Crop Income$_{hcmt}$		Grow$_{hcmt}$	Log Other Income$_{ht}$	Cost$_{ht}$
	(1)	(2) Balanced	(3)	(4)	(5)
$Post_t \cdot \Delta B_c$	-0.0181*	-0.0179*	-0.0009		
	(0.0093)	(0.0095)	(0.0009)		
$Post_t \cdot \sum_{c' \neq c} S_{hc'm0} \Delta B_{c'}$	0.0033	0.0033			
	(0.0036)	(0.0037)			
$Post_t \cdot \sum_c S_{hcm0} \Delta B_c$				-0.0032*	-0.0001
				(0.0017)	(0.0019)
Hh-Crop-Season FE	Yes	Yes	Yes		
Crop-Season-Pre FE	Yes	Yes	Yes		
Hh-Pre FE				Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
N	17130	16114	107528	3238	3522

The dependent variable is the Log of Crop Income I_{hcmt} from selling crop c for household h in season m of year t in Columns 1 and 2. Balanced refers to household-crop observations for households that are surveyed in each of the four years. $Post_t$ is an indicator for 2007 and 2010. Crop-level BTB change is ΔB_c which 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. Grow$_{hcmt}$ in Column 3 is an indicator for growing crop c for sale where zeros are added for crops that are not sold. The dependent variables are Log of Other Income (Wages+Livestock+Enterprise incomes) of the household in Column 4 and Costs paid for fertilisers and land preparation in cash (in '000 KSh) in Column 5. Standard errors are clustered by crop and household in parentheses in 1-3, and are estimated according to Adao, Kolesár, and Morales (2019) in Columns 4 and 5. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 24. Summary Statistics: Household-Crops

Variable	Obs	Mean	S.D.	Min	Mdn	Max
Income ('000 KSh in 2000 values) I_{hcmt}	17130	11.75	57.62	0.00	1.49	3273.05
Change in BTBs ΔB_c	17130	5.23	10.69	0	1	48
$\ln p^w_{ct}$	17130	-0.85	0.84	-2.96	-0.98	1.26
$Fall_{ct}$	17130	0.56	0.50	0	1	1
$\ln p^w_{ct} \cdot Fall_{ct}$	17130	-0.53	0.82	-2.96	0	1.26
Spoiled_{cmt}	17130	1.96	2.49	-2.08	0	8.76
Distortion_{c0}	17130	1.71	8.57	-3.30	0	46.20
$\Delta\text{Regulations}_c$	17130	0.70	1.33	0	0	4
$Violence_h$	17130	0.09	0.29	0	0	1
Change in Stagewise BTBs $\sum_s s\Delta B_{sc}$	17130	6.00	13.07	0	1	60
Change in Other BTBs $\sum_{c'\neq c} S_{c'm0}\Delta B_{c'}$	17130	5.96	7.67	0	3.04	41.00
Grow Indicator $Grow_{chmt}$	107528	0.25	0.43	0	0	1
Log Income from Agribusiness $\ln I_{ahcmt}$	473	3.41	1.41	-2.23	3.55	7.98
Log Income from Board/Coop $\ln I_{ghcmt}$	1903	1.93	2.12	-4.76	2.12	8.09
Log Income from Others (Trader/Consumer) $\ln I_{ohcmt}$	13629	0.21	1.58	-9.72	0.10	6.68
Sell to Agribusiness S_{ahcmt}	14938	0.07	0.26	0	0	1
Sell to Board/Coop S_{ghcmt}	15371	0.02	0.14	0	0	1

Table 25. Summary Statistics: Households and Exports

Variable	Obs	Mean	S.D.	Min	Mdn	Max
Log of Farm Income_{it} ('000 KSh in 2000)	3522	2.60	1.78	-4.45	2.76	8.27
Log of Other Non-Farm Income ('000 KSh in 2000)	3238	3.47	1.80	-4.25	3.48	9.64
Cash Input Costs on Fertilisers/Land Preparation ('000 KSh in 2000)	3522	0.35	4.62	0	0	176.24
Log of Commodity Exports of Source Country	83759	11.72	3.95	0	11.83	23.65
Change in BTBs ΔB_c for All Source Exports	83759	2.68	7.00	0	1	48
Log of Commodity Exports of Kenya	882	11.39	3.83	1.39	11.20	20.87
Change in BTBs ΔB_c for Kenya Exports	882	2.41	6.19	0	1	48