PIGGY-BACK EXPORTING, INTERMEDIATION, AND THE GAINS FROM TRADE TO SMALL FARMERS IN DEVELOPING ECONOMIES

SWATI DHINGRA[A] SILVANA TENREYRO[A,B]
[A]LONDON SCHOOL OF ECONOMICS, CEP, CEPR; [B]CFM

ABSTRACT. When the world price of a crop increases, how do the incomes of the crop's farmers in a developing country change? This paper investigates the distributional gains stemming from changes in agricultural world prices. Agricultural markets in developing countries are often characterized by the presence of a large number of small farmers who sell their produce to one or few big companies with significant monopsony or oligopsony power. We develop a flexible theoretical framework that captures this market structure and allows us to examine the impact of international trade on the incomes of farmers, agribusiness and traders in developing countries. The model highlights the conditions under which small farmers benefit (or lose) from increases in the world price of their crops. Using household-level panel data from Kenya, we empirically study the magnitude of the trickle-down effect of world price changes on the incomes of farmers. Farmers benefit from quality spillovers when selling through agribusinesses, but when global crop prices increase, on average, their income increases 30 percent less if they sell through agribusinesses rather than small traders. The model helps inform the debate over land and market reforms recently implemented or planned by several developing countries.

JEL Codes: F1, F6, Q1, O1.
Keywords: Agriculture, exporter, contract farming, middlemen, oligopsony.

Acknowledgments. We thank V Carvalho, F Caselli, E Helpman, E Ligon, J Morrow and T Sonno for helpful comments. Eui Jung (Jay) Lee and Yan Liang provided superb research assistance. We are grateful to Piero Fortino, Guzman Ourens and Alessandro Sforza for data assistance and to seminar participants at Aarhus, BI, CEMFI, Edinburgh, LSE, Kent, PODER, SED, UBC, UCLA and UC-Berkeley ARE for comments.
Contact: s.dhingra@lse.ac.uk; s.tenreyro@lse.ac.uk

Date: July 2017.

1. INTRODUCTION

Starting in the 1980s, several developing countries have moved to a more internationally open regime with reduced tariffs and non-tariff barriers, as part of a series of unilateral, multilateral, and regional trade liberalisations. Trade liberalisation was seen as a means to boost economic growth, raise living standards, and mitigate poverty. Inevitably, the gains from trade were not equally distributed, and winners and losers were likely to emerge from the wide wave of liberalization.

A large theoretical and empirical literature has examined the gains from international trade to producers and consumers. In this paper, we study the gains from trade accruing to farmers in developing countries, many of whom live close to subsistence levels. Agriculture continues to be the dominant sector in many developing countries in terms of employment and exports. Much of the early theoretical literature assumes, for simplicity, that agricultural markets are perfectly competitive. While this might be a good approximation for world commodity markets, there are important departures from perfect competition that need to be taken into account when assessing the gains from trade going to farmers in developing countries. In particular, four observations substantiate the need for a departure. First, several agricultural markets are characterized by the presence of a large number of small farmers together with few big agribusinesses that have monopsony power in the domestic market. Second, farmers often sell their produce through traders or piggy-back on agribusinesses to export their produce. Third, the share of agribusinesses has been growing in developing economies since the 1980s. Fourth, farmers gain technical knowledge from agribusinesses, but have low bargaining power in their relationship with agribusinesses. (We discuss these regularities in detail in the next section.) Our paper develops a flexible theoretical framework that captures this complex market structure and can be used to study the effects of globalization and changes in global commodity prices on farmers' incomes and welfare.

The modelling framework incorporates two key features. The first is the inability of farmers to supply directly to the world market. The second feature is their reliance on either imperfectly competitive traders or piggy-back exporting through agribusinesses to sell their produce to the world market. The lack of competition among intermediating exporters in developing economies is well-documented and arises due to factors such as

access to social networks and geographical remoteness, among others (Barrett and Mutambatsere, 2008; Bardhan, 1980). The presence of monopsonistic agribusinesses producing and buying from farmers for world export, though often glossed over in the literature, is a common feature in agricultural markets. Interestingly, policymakers in Africa are currently introducing new legislations for seeds, land, contract enforcement, and taxes to ease consolidation and operation of large commercial farms, which will pave the way for a bigger share for big agribusinesses (Unctad, 2009; Provost et al., 2014; Provost and Kabendera, 2014; Carr, 2013). The Ethiopian government has said it will encourage long-term land leases and strengthen the enforcement of commercial farm contracts. In Malawi, the government has promised to set aside 200,000 hectares of prime land for commercial investors by 2015, and in Ghana, 10,000 hectares will be made available for investment by the end of next year. Many of these investments are for non-food crops, including cotton, biofuels and rubber, or for projects explicitly targeting export markets.

In our model, farmers can grow a subsistence crop or an exportable crop. Farming requires land and inputs that are in limited supply, at least in the short run (e.g., packaging facilities, infrastructure). Traders have the capital inputs needed to ship to the world market, and they provide farmers with access to the markets for their export crop. There is a finite number of monopsonistic agribusinesses that own big farms and also have the ability to ship the export crop to the world market. Agribusinesses have technical knowledge of farming, and when a farmer invests resources to learn from her agribusiness, she benefits from quality spillovers in export crop production. For instance, a farmer invests in learning to grow her export crop to the higher quality standards of the export market to which the agribusiness supplies. The farmer earns a relationship-specific income from her agribusiness, who pays the farmer her reservation income. The income of the farmer depends on the price that she could get from the traders net of the cost of her investment in realizing the quality gains from the agribusiness. Within this setting, we determine the extent to which changes in world prices trickle down to small farmers.

We show that higher international prices for the export crop increase the gross revenue from exports but put pressure on the prices of inputs needed in farming and selling their produce. These two forces have competing effects on how much farmers share in the gains from higher international prices for their crops. If farmers can deflect some of their export crops to competing traders, they get a part of the higher export revenue through

increased competition among traders. Farmers, however, suffer declining returns on their subsistence and export crop production as prices of inputs rise due to increased investments into exporting. This weakens the ability of farmers to get better earnings for their export crops from agribusinesses. At one extreme, farmers receive the full benefit of higher world prices if they have access to traders that compete with each other by making bids for the farmer's export crop without the need to make any investments into quality gains. At the other extreme, farmers experience a decline in earnings when they must invest to produce higher quality produce or when they are locked into their relationships with agribusinesses (say, due to lack of timely access to other traders or exclusive contract farming). In the absence of other avenues to sell their export crop, farmers suffer a fall in their bargaining power and receive lower earnings from agribusinesses.

We model these two competing forces flexibly, and discuss the economic channels underlying the resulting relationship between farmers' earnings from export crops, the prices of capital inputs, the value of subsistence production, and the world prices for export crops. The trickle-down effect rises with a farmer's ability to divert sales from agribusinesses to traders outside the relationship. The share that farmers get from the traders in turn rises with greater competition among traders and with greater equality in land ownership. The trickle-down from world prices to farmer incomes is lower when farmers have greater reliance on inputs needed in farming and selling their crops. As export prices rise, the production and exports of agribusinesses expand and they step up their investments in quality. This raises the rental rate of capital which makes farming of the subsistence crop and entry of traders more costly. Farmers lose out to agribusinesses due to this pressure on resources, and subsistence farmers can even suffer an absolute decline in incomes. Therefore, farmers need not share in the gains from agricultural price increases when their domestic market for farm produce is imperfectly competitive.

We take the model predictions to data from Kenyan rural households. The Kenyan context fits with the focus of our study because it is a developing economy where agriculture is the primary sector of employment and which typifies the debate over whether to ease commercial farming to get productivity gains from agroindustrialization. Given the paucity of reliable panel data for farming communities in developing countries, Kenya is also unique in terms of the availability of a high quality panel database of farming households to trace the impact of world price changes on incomes. Testing the main predictions of

the model, we provide evidence for the results that farmers who sell their produce through large agribusiness firms have higher incomes but get less of the rise in world price, relative to farmers that sell through small traders. We show that this lower trickle down is unlikely to reflect insurance from agribusinesses. For one, the trickle down estimate is not driven by agribusinesses passing on less when the world price drops. Moreover, the variance in income or in consumption expenditure is not systematically lower for households that sell through agribusinesses. We find instead that the input costs faced by households rise with world prices, and this rise is greater in districts that are more exposed to large firms. A policymaker can therefore realize the productivity gains from agribusinesses without sacrificing equity by providing farmers with stable prices for scarce resources required in farming. Under such a policy, the potential gains from trade to Kenyan farmers would have been about six times higher than the actual gains from world price changes between 2000 to 2007.

The paper connects to a growing literature that has focused on the gains from trade in settings with imperfect competition. On the theoretical side, early work has examined how the Stolper Samuelson theorem is altered in the presence of a monopsony (Feenstra, 1980; Markusen and Robson, 1980; McCulloch and Yellen, 1980; Bhagwati et al., 1998). Recent contributions have focused on some of the microfoundations for market power. In particular, Antràs and Costinot (2011) and Chau et al. (2009) focus on search and matching frictions that confer market power to intermediaries while Bardhan et al. (2013) stress reputational rents in the intermediation. A related theoretical literature has examined oligopsony power in intermediates and final goods markets (Devadoss and Song, 2006; Raff and Schmitt, 2005; Eckel, 2009; Bernard and Dhingra, 2015). Our main theoretical contribution is to embed key structural characteristics of smallholder farming. Rogers and Sexton (1994) explain that the structural characteristics of agricultural markets give rise to unique modeling issues relative to the analysis of seller market power in industry studies. On the empirical side, most of the extant work has focused on imperfections in the product markets and the gains from trade for consumers rather than producers. For example, Atkin and Donaldson (2012) examine the gains from trade to Ethiopian and Nigerian consumers in the presence of intermediaries, and Macchiavello and Morjaria (2015b) estimate the value of the relationship between domestic exporters and foreign buyers of Kenyan roses. In an informative study on producers, Balat et al. (2009) find that access to local markets makes

it more likely for farmers to plant export crops and this helps in reducing poverty at the household level. Sheveleva and Krishna (2016) theoretically examine how these cropping choices are affected by the contracting environment in developing economies. Our paper seeks to systematically study how small producers of export crops might be affected by globalization and changes in world export prices, when they face monopsony power in the domestic market. While the focus of our paper is small producers in developing countries, possibly among the poorest in the world, some of the issues we analyze are also present in other markets and in more developed economies. They can speak to a broader theme on the distribution of gains from trade that has taken centre stage in the aftermath of the financial crisis.

The rest of the paper is organized as follows. Section II discusses the motivating evidence and the related literature. Section III presents the model and discusses its implications. Section IV presents concluding remarks.

2. Empirical Motivation

In this section, we discuss the main empirical observations motivating the model.

1. Several agricultural markets have a large number of small farmers together with few big agribusinesses with monopsony power in the domestic market.

Our framework will build on the observation that a large number of small farmers with limited bargaining power coexist with a few agribusinesses and traders with monopsony power. This market structure appears to be common in developing countries. Lowder et al. (2014) demonstrate that out of a sample covering about 80 percent of the world's farms as well as about 80 percent of the world's population, 72 percent of the farms are smaller than one hectare in size; 12 percent are 1 to 2 hectares in size and 10 percent are between 2 and 5 hectares. Only 6 percent of the world's farms are larger than 5 hectares. Assuming this average is representative of the land distribution worldwide, they estimate that there are more than 410 million farms less than 1 hectare in size and more than 475 million small farms that are less than 2 hectares in size.

Specific case studies confirm these estimates. Whitfield (2012) documents that at its peak, the Ghanian pineapple export industry consisted of 12 large farms (of 300-700 hectares), 40 medium farms (of 20-150 hectares) and 10,000 smallholders with acreage

less than 10 hectares. Smallholders transacted with large agribusinesses with almost non-existent bargaining power (Fold and Gough, 2008). Based on interviews of the Kenyan horticulture producers, Jaffee and Masakure (2005) finds that smallholders accounted for 27 percent of fresh vegetable exports, medium and large-scale growers accounted for 29 percent, and farms leased or owned by export companies accounted for the remaining 44 percent of vegetable exports. The distribution of farm acreage and sales is characterized by the coexistence of a large number of small farmers together with a small number of large producers.

2. Small farmers typically sell through traders or piggy-back on agribusiness firms.

Small producers often carry out either piggy back exporting - sell their produce through big agribusinesses - or sell part of their produce through small traders. Allen (2014) documents that farmers in the Phillip pines typically consume a portion of their produce after harvest and sell the rest to traders quickly afterwards to avoid possible losses from a decline in the quality of their unprocessed produce. The inability of farmers to ship directly is caused by a number of potential obstacles that increase the fixed cost of exporting, including, among others, lack of marketing knowledge, credit market imperfections, and information barriers (Allen, 2014; Ashraf et al., 2009; Burke, 2014). The reliance on traders and agribusinesses is a way of circumventing these high transaction costs of exporting. A vast literature in agricultural economics, surveyed in Barrett (2008), finds that smallholders face high transaction costs in selling their crops to export markets. They lack the productive assets, access to technologies, and infrastructure needed to produce a marketable surplus, and must rely on intermediaries or agribusinesses to access markets. For instance, Fafchamps and Hill (2008) find that only 15 per cent of Ugandan coffee growers travel to nearby markets to sell their produce and the others sell through traders due to high costs of transportation.

3. The share of agribusiness firms in buying agricultural produce in developing countries has been growing.

Since market reforms in many developing countries in the 1980s and 1990s, the rise of supermarket chains, agro-industrialization, and export oriented outgrower schemes, there

has been a substantial increase in production of export crops in developing countries (Barrett and Mutambatsere, 2008). This has increased contract farming and outgrower schemes between agro-industrial firms and farmers in developing countries.

Examples of these new relationships include small farmers that engage in contract farming of tea in Kenya, tobacco production for the British American Tobacco company (Minot, 2011), contract farming in Senegalese groundnut production (Warning and Key, 2002), vegetable farming for European supermarkets by farmers in Madagascar (Minten et al., 2009), production for supermarket supply chains in Latin America, Asia and Africa (Reardon and Timmer, 2007), commercial farming of export crops in Kenya and commercial farming of cash crops like sugar, cotton and tea in Europe and Central Asia (Robbins and Ferris, 2003). These studies show that agro-industrial firms and large commercial farms typically provide inputs to small farmers in the form of expertise, seeds, credit, etc. As they sell to export markets with higher quality standards, they also provide small farmers with technical assistance to meet these higher quality standards and to comply with sanitary requirements involved in export sales. Increased industrialization of agricultural markets has integrated markets which were fragmented, encouraged product diversification through differentiation, and provided opportunities for value addition and technology transfer (Barrett and Mutambatsere, 2008).

The rise of agribusiness is viewed as part of a broader trend towards globalization in agriculture (Simmons, 2002). Runsten (1994) documents that since 1989, there has been a range of contracts between Mexican farmers and agribusinesses for the production of high-value crops (such as strawberries, melons and frozen vegetables) that are exported to the United States. Goodman and Watts (1997) find a similar trend in contract farming and multinational agribusiness activity in pineapple and banana farming in Central America for exports to the United States and Europe.

4. Small farmers receive technological transfers from agribusinesses but have low bargaining power in the relationship.

In their survey, Barrett and Mutambatsere (2008) document that while industrialization of agricultural markets provides small farmers with access to export markets and technical assistance, it reduces their bargaining power in negotiating contract conditions. Agroindustrial firms provide the credit, inputs, information, and services smallholders need to

cultivate and market lucrative nontraditional crops (Reardon and Timmer, 2007). For example, Germany's Metro supermarket chain provided Croatian strawberry suppliers with contracts that served as a substitute for the bank collateral required from the farms to make needed greenhouse investments. There is growing concern however that the skewed distribution of farm production and the complex arrangements with agribusinesses might lead to a dual structure in farming, with small farmers that have limited bargaining power and few large firms that have the scale and capital to market their produce.

Increasingly, contracts are being negotiated bilaterally between an individual farmer and an agribusiness firm, rather than through collective bargaining by farmer associations with government parastatals. In fact, Dries et al. (2007) find that the vast majority of dairy farmers in Ukraine have no written or formal contracts with their agribusiness buyers, and they do not enjoy guarantees regarding what price would be paid and how much would be purchased. Simmons (2002) argues that as farmers divert resources towards contract production, they narrow the markets that are available to them outside the contract. The barriers to exiting the contracts are even higher when small farmers experience higher prices of local farm inputs and relationship-specific investments, and these problems compound when they are over-reliant on cash crops during food shortages (Key and Runsten, 1999).

Case studies provide evidence for some of these concerns. Warning and Key (2002) look at melon cultivation in Senegal. They document that small farmers had negotiated a fixed price for their produce. But when there was a glut in supply, the contracting firm did not return to purchase the melons and farmers lost out as spot market prices fell dramatically. Likulunga (2005) looks at cotton farming in Zambia where agribusiness firms paid farmers a lower price (in local currency) than that agreed at the time of making the contract as, in the firm's view, the price was tied to the dollar. The study argues that improving the flow of market information and market trends could improve the negotiating position of farmers. Mitra et al. (2013) conduct an experimental study of West Bengal potato farmers to study this phenomenon, and examine the prices received by potato farmers in randomly selected villages that were provided daily price information from neighboring wholesale markets. In villages located in market areas with low wholesale prices in 2008, traded quantities as well as farm-gate prices fell significantly as a result of the information interventions. The opposite happened in villages with high wholesale prices. They take this as evidence of

ex post bargaining in which the trader makes a take-it-or-leave-it price offer to the farmer after observing the wholesale price, and the farmer responds with a quantity that he wishes to sell. The only outside option farmers have is to thereafter take their produce to a local market and sell to a different trader who will also resell it in the wholesale market.

The model we present next will be consistent with these facts, and will attempt to shed light on how these features of agricultural markets determine the trickle-down effects of world price changes on farmer incomes.

3. A Model of Agricultural Production and Trade

In this section, we develop a model to capture what appear to be widespread features of agriculture in less developed countries. The first feature is the inability of small farmers to supply directly to the world market. The second feature is their reliance on either imperfectly competitive traders or piggy-back exporting through agribusinesses in order to sell their produce to the world market. In an open economy setting, the model will seek to understand how changes in global commodity prices affect the income received by farmers.

We consider a small open economy that takes world prices for its exports as given. The model economy consists of Farmers who are unable to export directly, Agribusinesses, which farm and have access to export markets, and Traders, who do not farm but have access to the world market for the export crop. The environment is characterized as follows. There is a continuum of farmers, each endowed with a unit of land on which they can grow a subsistence crop or an export crop. If farmers grow the export crop, they can sell it through traders or through agribusinesses to the world market. There is a finite number of traders, who have the capital inputs needed to ship the export crop to the world market. Traders are oligopsonistic in their purchases from farmers, but take world prices p_w (net of export costs) as given. There is a finite number of agribusinesses that own big farms and also have the ability to ship the export crop to the world market. Traders and agribusinesses draw on a fixed stock $\bar{K}$ of capital for marketing the export crops. We will first describe the operation of farmers, then traders, and finally, agribusinesses. Next, we will determine the equilibrium prices and earnings. Details on parametric conditions for the existence of a market equilibrium are in the Appendix.

3.1. **Description of the Economy.** We start with a description of the production and distribution operations of farmers, traders and agribusinesses.

3.1.1. *Farmers.* There is a continuum of farmers who have linear utility for a numeraire good and maximize farm earnings. Each farmer can grow s units of a subsistence crop on her land, the price of which we take as one for brevity. Alternatively, the farmer can grow a units of the export crop, where a is drawn from a productivity distribution $G(a)$.

If the farmer chooses to grow the export crop, she cannot sell it directly to the world market and must ship through traders or agribusinesses. A trader pays price p for the export crop and the farmer earns pa by selling through traders. If the farmer chooses to sell through an agribusinesses, she must engage in relationship-specific investments to grow crops of a desired level of quality for the world market. The farmer's earnings from the agribusiness will depend on the options available outside the relationship. Our focus is on understanding the role of agribusinesses in trickle down of world prices to small farmers, so we will assume that the export crop and its sale through agribusinesses is viable for some farmers and determine the earnings of farmers across its different options.

3.1.2. *Traders.* There is a finite number N of identical traders who compete for the export crops produced by small farmers as Cournot oligopsonists. Traders have intermediation productivity of $m \in (0,1)$. When the world price is p_w, the trader receives $p_w m$ and pays the farmer p. The inverse of the intermediation productivity $1/m$ acts like an iceberg trade cost for the exporter to ship to the world market.

Trader t's profit from exporting x_t units of the export crop is $\pi_t = (p_w m - p)x_t$. Traders can export as long as they pay an entry cost of f units of capital. Let r denote the rental rate of capital. Then free entry into trading implies that the expected profits of a trader are driven down to his entry costrf.

3.1.3. *Agribusinesses.* There is a fixed number M of identical agribusiness firms who produce b units of the export crop and have the ability to access world markets. Each agribusiness has an intermediation productivity m_b with $1 > m_b > 0$. Agribusinesses invest to increase the quality of their produce. By investing q units of capital, agribusiness b increases its effective units of export crops from b to $bq^{\beta} > b$ for $\beta \in (0,1)$.

The agribusiness also invests in its relationship with farmers and shares its technical knowledge with them. This increases the quality of the farmer's produce from a to $\delta a >$

a. But growing and selling higher quality export crops requires the farmers to invest θ units of capital. For instance, higher quality produce may require specialized transport facilities which the farmer must pay for if her relationship with the agribusiness breaks down. Or, farmers may need regular irrigation to grow higher quality crops which requires investing in water pumps. To model this as flexibly as possible, the farmer's outside option therefore gives her $\delta pa - \theta r$. The parameter δ reflects the quality gains from the technical knowledge or inputs provided by the agribusiness. It increases the revenue that the farmer would earn if she sold her produce to traders in the event of a breakdown of the relationship with her agribusiness. The parameter θ captures the extent to which marketing higher quality crops entails capital investments such as own local transport to get to the market, specialized refrigerated trucks to carry the higher quality produce or increased credit costs when outside of a relationship with the agribusiness. For clarity, we start in this Section with the assumption of capital inputs only in quality and later we extend the model to capital inputs in farming.

Let $T(a,b)$ denote the payment to farmer a from agribusiness b. Then agribusiness b earns a profit of :

$$\pi_b = p_w m_b b q^{\beta} - rq + \int 1_{a \text{ meets } b}(p_w m_b \delta a - T(a,b))dG(a).$$

The agribusiness pays each farmer her reservation value to ensure farmers do not divert the crops outside of the relationship. The farmer receives $T(a,b) = \delta pa - \theta r$, and the next subsection discusses how this determines the choices that farmers make to grow and sell crops.

3.2. **Market Equilibrium.** Having described the three types of agents in the economy, we determine the cropping choices of farmers, and then discuss how much they earn from traders and agribusinesses.

3.2.1. *Farmer Decisions of Crops and Sales.* A farmer has three choices: grow the subsistence crop and earn s, grow the export crop and sell through a trader to earn pa, or grow the export crop and sell through an agribusiness to earn $\delta pa - \theta r$. Farmers choose the option that gives them the highest farm earnings. Farmers with the lowest levels of export crop productivity ($a < s/p \equiv a_s$) grow the subsistence crop. Farmers with the highest levels of export productivity ($a > \theta r/(\delta - 1)\, p \equiv a_l$) grow the export crop and

sell through an agribusiness, as documented in sever la studies of farming in developing economies (Key and Runsten, 1999). These farmers have the scale of production to take advantage of the quality spillovers from the agribusiness. They can make the investments needed to realize the quality gains and sell higher effective units of the export crop in the event of a disagreement with the agribusiness. Farmers with medium productivity levels of $s/p \leq a \leq \theta r/(\delta - 1)p$ choose to grow the export crop and sell through traders. Having determined the supply of crops from farmers, we summarize this result in Proposition 1 below 1 and proceed to determining the payments made for the export crops.

Proposition 1. *High productivity farmers sell to large agribusinesses, intermediate productivity farmers sell to small traders and the lowest productivity farmers grow the subsistence crop.*

This sorting of high productivity farmers with agribusinesses is consistent with Dragusanu et al. (2014) which finds that skilled coffee producers who sell to coffee mills get the income gains from Fair Trade certification in Costa Rica.

3.2.2. *Prices paid by Traders.* The total supply of the export crop to traders is $X_T = \int_{a_s}^{a_l} a dG(a)$. For simplicity, we assume a Pareto productivity distribution, $G(a) = 1 - (a_{\min}/a)^k$ with $a \geq a_{\min} > 0$ and $k \geq 1$. A fall in the Pareto shape parameter k captures an increase in inequality (as measured by the Gini index for land productivity). Using the Pareto distribution, traders procure $X_T = \sum_t x_t = \frac{k}{k-1} a_{\min}^k \left[a_s^{-k+1} - a_l^{-k+1} \right]$ units of the export crop.

Trader t chooses his quantity x_t of export crops to maximize $\pi_t = (p_w m - p)x_t$. Traders are Cournot oligopsonists and take into account how their quantity choices impact the price of the export crop. The own price impact of purchases by a trader is $dp/dx_t = p/X_T(k-1)$, holding fixed the purchases of other intermediaries. From the FOC for profit maximization, the optimal purchase of a trader is $x_t = (p_w m - p)(k-1)X_T/p$. In a symmetric equilibrium, traders have identical sales, with $x_t = X_T/N$ and the optimal price paid by the trader is

$$p = \frac{N(k-1)}{N(k-1)+1} p_w m. \tag{3.1}$$

Under perfect competition prices equal costs, $p = p_w m$, and the full world price (net of trade costs) is transmitted to the farmers. When traders are oligopsonistic (i.e.N is finite),

farmers receive a smaller share of the world price:

$$\text{Farmer Share} \equiv \frac{p}{p_w m} = \frac{N(k-1)}{N(k-1)+1} < 1$$

In the extreme cases of infinite entry ($N \to \infty$) or a perfectly equal land distribution ($k \to \infty$), prices do not change the extent to which farmers alter their supply to intermediaries, so the full world price is transmitted to farmers.

Ignoring the integer constraint, free entry of traders ensures their profits are driven down to the entry cost. The equilibrium number of traders is given by the free entry condition:

$$\pi_i = \frac{k}{k-1}\frac{1}{N}\frac{a_{\min}^k p^k}{N(k-1)}\left[(p_h s)^{-k+1} - (\theta r/(\delta-1))^{-k+1}\right] = rf. \tag{3.2}$$

where the price paid by the traders is given by Equation 3.1. The number of traders rises with export receipts $p_w m$ and falls with alternative cropping receipts and entry costs. We summarize these observations for farm incomes in Remark 2 below.

Remark 2. (1) The share of the export price transmitted by traders to farmers rises with more intermediaries and greater land equality (Farmer Share rises with N and k).
(3) The elasticity of the farmer share wrt world prices is proportional to the elasticity of the number of traders, $d\ln\text{Farmer Share}/d\ln p_w = (d\ln N/d\ln p_w)/(N(k-1)+1)$.

3.2.3. *Agribusiness Payments.* The total supply of export crops to agribusinesses is $X_B = \int_{a_l}^{\infty} a dG(a) = \frac{k}{k-1} a_{\min}^k a_l^{-k+1}$. Assuming each farmer matches with different agribusinesses with equal probability, the total purchases of agribusiness b from small farmers is

$$x_b \equiv \int 1_{a \text{ meets } b} a dG(a) = X_B/M.$$

The matching assumption captures the observation that small farmers typically have access to monopsonistic buyers due to government policies such as monopsony licenses, zoning regulations and minimum distance rules. Macchiavello and Morjaria (2015a) explain the rationale for these policies by showing that competition among coffee mills in Rwanda undermined relational contracts between mills and farmers, leading to lower farmer welfare and reduced quality of the delivered produce. Similarly, Brambilla and Porto (2011) find that outgrower schemes in Zambian cotton farming broke down with the entry of more

agribusinesses that offered to pay higher prices for farmers who defaulted on the agribusinesses with whom they were previously engaged. We do not micro-found the sources of such breakdown in relationships, but account for the fact that farmers typically have access to a monopsonistic agribusiness.

Agribusinesses pay the farmers their reservation income, and as discussed earlier, this payment is $T(a,b) = \delta pa - \theta r$. Substituting in the profit function of the agribusiness, the optimal quality investment of the agribusiness is $q = [\beta p_w m_b b/r]^{1/(1-\beta)}$, which increases with the size of the agribusiness b. The quality investments directly benefit small farmers who get a quality spillover through δ.

3.2.4. *Market Equilibrium.* Having determined the farm payments, we solve for the number of traders and the rental rate in the economy. The number of traders N is determined by the free entry condition (Equation 3.2). The rental rate is determined by capital market clearing which implies $Mq + Nf = \bar{K}$.[1] Substituting for the optimal quality investment, the rental rate is determined by:

$$M[\beta p_w m_b b/r]^{1/(1-\beta)} + Nf = \bar{K}. \tag{3.3}$$

Given N, entry costs rf increase with the number of agribusinesses M and their size b. The entry decision of traders and the investment decision of agribusinesses are interrelated through the capital market, and this is reflected in the reservation income of small farmers. An increase in the agribusiness' own farm size lowers entry of intermediaries and increases the rental rate, leading to a fall in the earnings of small farmers.

3.3. **The Impact of World Price Changes.** Having determined the market equilibrium, we examine how a change in the world price of the export crop affects the earnings of small farmers. We start with a discussion of changes in entry and rents, and then discuss the impact on earnings of each type of farmers.

[1]In this baseline model, we do not add the capital investments of the farmers selling through agribusinesses to the capital market clearing condition. In the Appendix, we show that the qualitative results of the model would be similar under this extension. Therefore, the capital investments of these farmers can capture investments such as those needed to shift the quality spillover to a different buyer in the event of a disagreement with the agribusiness (e.g. refrigerated trucks for fresh flowers) and those that can be shifted over costlessly but that always need scarce capital to realize the quality gain (such as irrigation facilities).

From the free-entry condition of Equation 3.2,

$$\left(2-\frac{k}{N(k-1)+1}\right)\frac{d\ln N}{d\ln p_w}=k-\left(1-\frac{(k-1)\left(\theta r/(\delta-1)\right)^{-k+1}}{s^{-k+1}-\left(\theta r/(\delta-1)\right)^{-k+1}}\right)\frac{d\ln r}{d\ln p_w}. \tag{3.4}$$

The direct effect of a rise in p_w is to increase entry through higher export earnings. The indirect effect is to decrease entry through a rise in the entry cost which depends on the change in the rental rate of capital.

From capital market clearing, the change in the rental rate of capital inputs is $\frac{Mq}{1-\beta}\frac{d\ln r}{d\ln p_w}=\frac{Mq}{1-\beta}+Nf\frac{d\ln N}{d\ln p_w}$. Substituting for the change in entry from Equation 3.4 and letting $\kappa\equiv\frac{Mq}{1-\beta}+\frac{Nf}{2-\frac{k}{N(k-1)+1}}\frac{s^{-k+1}-k(\theta r/(\delta-1))^{-k+1}}{s^{-k+1}-(\theta r/(\delta-1))^{-k+1}}$, the rental rate rises with an increase in the world price because

$$\frac{d\ln r}{d\ln p_w}=\left(\frac{Mq}{1-\beta}+\frac{kNf}{2-\frac{k}{N(k-1)+1}}\right)/\kappa \tag{3.5}$$

As world prices rise, agribusinesses make greater investments in quality. Entry also rises with world prices because the direct effect of higher earnings dominates the indirect effect of an increase in the competition for scarce capital. More traders enter when world prices are higher, because they expect to earn higher profits. This increases competition for capital, and rental rates increase further. Solving for Equations 3.4 and 3.5, entry rises with world prices because

$$\frac{d\ln N}{d\ln p_w}=\frac{k-1}{2-\frac{k}{N(k-1)+1}}\frac{s^{-k+1}}{s^{-k+1}-\left(\theta r/(\delta-1)\right)^{-k+1}}\frac{Mq}{1-\beta}/\kappa. \tag{3.6}$$

The rise in the rental rate reduces the trickle down of world price increases to farmer incomes due to lower entry of traders. The net effect of higher world prices is to increase the number of traders. As a result, farmers selling to traders experience a rise in the share of the export incomes going to them. The elasticity of the share of the export price transmitted by traders to farmers is

$$\frac{d\ln p/p_w m}{d\ln p_w}=\frac{1}{N(k-1)+1}\left(\frac{d\ln N}{d\ln p_w}\right)\geq 0$$

We summarize this in Remark 3 below.

Remark 3. A rise in the world price of the export crop increases competition for scarce capital inputs ($d\ln r/d\ln p_w > 0$), which dampens the entry of traders. The net effect is a rise in the number of traders ($d\ln N/d\ln p_w > 0$), which increases the share of the export price transmitted by the traders to farmers ($d\ln \text{Farmer Share}/d\ln p_w > 0$).

Subsistence farmers are unaffected by the rise in world prices. But farmers selling through agribusinesses are affected through the change in the price paid by the traders and the rise in the rental rate of capital inputs. A farmer transacting with an agribusiness earns her reservation income of $T(a,b) = \delta\frac{N(k-1)}{N(k-1)+1}p_w ma - \theta r$. Differentiating $T(a,b)$ with respect to world prices, the trickle-down effect of world price changes into farmer incomes is as follows:

$$\frac{d\ln T(a,b)}{d\ln p_w} = \underbrace{\frac{\delta\frac{N(k-1)}{N(k-1)+1}p_w ma}{T(a,b)}}_{\text{Direct Effect on Trader's Prices}}\left[1+\underbrace{\frac{1}{N(k-1)+1}\frac{d\ln N}{d\ln p_w}}_{\text{Indirect Effect on \#Traders}}\right] \underbrace{-\frac{\theta r}{T(a,b)}\frac{d\ln r}{d\ln p_w}}_{\text{Indirect Effect on Input Prices}}.$$

The world price directly affects how much intermediaries receive from sales of the export crop, which in turn is reflected in the price that is paid to farmers. This is the first term in the expression above. The second and third terms are the indirect effects of world price changes. An increase in the world price alters the profitability of intermediation and this is captured in the second term which contains the elasticity of the number of intermediaries with respect to world price. The third term reflects the competition for limited capital resources. An increase in the world price alters the number of intermediaries and the investments of agribusinesses, which change the rental rate of capital. We summarize these channels in Remark 4 below.

Remark 4. When a farmer sells through an agribusiness, the elasticity of the farmer's income wrt world prices consists of: (1) a positive direct effect of a change in world price of the export crop on the export revenue earned by traders, (2) a positive indirect effect on the number of traders, and (3) a negative indirect effect on the cost of farming the non-tradable crop.

For θ close to zero, farmers selling through agribusinesses and farmers selling through traders experience the same trickle down of world prices into their incomes. When $\theta > 0$, farmers selling through agribusinesses cannot immediately divert their harvest to traders. They need to incur some capital costs to take their harvest to the market in the event of a disagreement with their agribusiness. The rise in the rental rate of capital inputs therefore worsens the outside option of the farmers.

To understand the underlying economic channels determining the extent of trickle-down, we discuss the earnings under $\theta = 0$ and $\theta > 0$. When $\theta = 0$, earnings of farmers selling through agribusinesses is affected by rental rates only through the number of traders and not directly. The entry response of intermediaries is decreasing in Nf because:

$$\frac{d\ln N}{d\ln p_w} = \frac{k-1}{2-\frac{k}{N(k-1)+1}}\frac{Mq}{1-\beta}\Big/\left(\frac{Mq}{1-\beta}+\frac{Nf}{2-\frac{k}{N(k-1)+1}}\right).$$

The returns to quality decline as agribusinesses invest more and more capital. So more traders can enter when the share of capital use by agribusinesses is high relative to the capital use by traders. This occurs when entry cost f is relatively low and the size of agribusinesses b is relatively high which ensure Nf is low. The pass-through of world prices into prices received by farmers who sell through intermediaries ranges from 1 to $\frac{2N(k-1)+1}{2N(k-1)-(k-2)}$.

Once we build in the interconnections through competition for scarce capital, the trickle down effects for farmers selling through agribusinesses depend crucially on the capital costs incurred to divert the harvest to the market through θ. A rise in the world price disproportionately increases the rental rate of capital inputs, and this implies that essential inputs required for diverting the export crop become more scarce. The trickle down effect would be negative for high levels of capital requirement θ and greater than one for low levels of θ. Agribusinesses gain at the expense of the small farmers as θ rises. The negative trickle down rises with the size of the agribusiness. This is because a bigger agribusiness makes larger quality investments which intensifies competition for scarce capital. Higher entry costs also increase competition for capital and the losses are bigger. We summarize this result in Remark 5.

Remark 5. The trickle-down effect of world price changes to incomes of farmers selling through agribusinesses falls with the capital required to divert the export crop to traders

in the event of a disagreement with the agribusiness. For $\theta = 0$, the elasticity of farmer incomes to world prices is greater than one. For $\theta > 0$, increases in world prices can have a negative trickle down effect, and the loses to farmers rise with the size of agribusiness and with the entry costs of intermediaries.

Finally, the main point that is key in our model is that the trickle down effect of agribusinesses is lower than the trickle down effect of traders when farmers need capital inputs to divert their export crops away from the agribusiness. The capital requirement θ is crucial in determining the extent to which farmers share with agribusinesses in the gains from trade, and we summarize this finding in Proposition 6 below (Details are in the Appendix).

Proposition 6. *When farmers need scarce inputs for the export crop ($\theta > 0$), they get a lower trickle down of world price changes from agribusinesses, compared to traders.*

In extreme cases, this would mean that large reductions in world prices would wipe out the gains in income from productivity spillovers for farmers who sell through agribusinesses. More generally, the productivity gains might still overwhelm the trickle down effect and farmers would continue to sell through agribusinesses, but with a smaller share in the gains from trade. The next Section will empirically examine the difference in the trickle down rates of traders and agribusinesses. But before proceeding to the empirics, we finish the theory by extending the model to allow for capital inputs in subsistence farming and export crop farming for traders.

3.4. **Extension: Capital Inputs for All Crops and Sales.** We assumed earlier that capital inputs are needed for the quality of the export crop but not for farming in general. This is likely to capture capital inputs such as port facilities that are specific to the export crop. But there are other capital inputs, such as credit collateral, that are needed for selling both the export crop and the non-tradable crop. We now extend the model to include capital requirements for the non-tradable crops. Let α denote the units of capital needed in farming. Then farmers earn $s - \alpha r$ from the non-tradable crop and $pa - \alpha r$ from selling the export crops to traders.

The key difference is that capital market clearing changes to $Mq + Nf + \alpha = \bar{K}$, and the qualitative results continue to be similar to Propositions 2, 3 and 4. The new finding is that subsistence farmers see an absolute reduction in their incomes when the world price of the export crop rises ($d(s - \alpha r)/dp_w < 0$). This is because the rise in the world price bids

up the rental rate of capital. As capital inputs are needed for non-tradable crops, farmers growing the non-tradable crop are worse-off. This is not to say that there are welfare losses from trade in aggregate because higher world prices increase profits and induce entry. But there is a distributional effect - the size of the pie and the share of the pie going to different agents in the economy changes. The lowest income farmers suffer a decline in income. We summarize this result in Proposition 7 below, and details are provided in the Appendix.

Proposition 7. *Earnings of small farmers growing the non-tradable crop fall with a rise in the world price of the export crop.*

This result is consistent with Brambilla and Porto (2011) which finds that failure of outgrower schemes between Zambian cotton farmers and monopsonistic agribusinesses caused farmers to move back to subsistence farming, and led to reductions in cotton yields of over 40%.

Another finding is that the trickle down of world prices changes to incomes of farmers who grow the export crop and sell through traders can now range between 0 and 1 (and does not have to be greater than 1). The rise in the rental rate of scarce inputs makes the trickle down from traders to small farmers incomplete. We however do not stress this result of the level of trickle down from traders in the empirical work of the next Section because incomplete trickle down arises in other theoretical models that do not feature agribusinesses (such as the model of Section 3 under no agribusinesses and a more general productivity distribution for export crops).

4. Testing for Differences in the Trickle Down Effects

This Section compares the trickle down rate of world prices into farmer earnings across farmers who sell to traders and agribusinesses. We use data from a household panel collected during three surveys in Kenya during 2000, 2004, and 2007. We start with an explanation of why Kenya is a suitable application for our analysis. Then we discuss the stylized facts of smallholder farming in the context of Kenyan agriculture. Finally, we estimate the trickle down effects from small traders and large agribusinesses to farmers.

4.1. **Kenyan farming.**

The application to Kenyan agriculture captures the institutional context of small farmers selling through traders and agribusinesses in an economy that is highly dependent on agriculture. Kenya is a lower middle-income country in sub-Saharan

Africa, where agriculture makes up 25% of GDP and 75% of the labor force.[2] Exports from the agricultural sector make up about two-thirds of the total exports of Kenya. About 80% of Kenya's population lives in rural areas and depends on agriculture directly or indirectly. A majority of the rural labor force is in smallholder farming, and our dataset consists of households that own less than 50 acres of land. The median household owns less than 5 acres of land, and earns Ksh 1,430 per month which is roughly USD 19.3.[3]

While a vast majority of people continue to be employed in agriculture, productivity growth has been slow and yields per acre of land are low. Kenyan agriculture typifies the broad debate on how to cope with declining agricultural productivity in a predominantly smallholder agricultural economy. A principal solution proposed to address this problem is to encourage large scale agribusinesses to improve the inputs and technologies used in farming and to expand revenues through access to markets (Collier and Dercon 2014). We inform this debate by examining the extent to which agribusinesses differ from small traders in sharing the gains from access to world markets with farmers. The Kenyan survey records the type of buyer that each farmer sells to, which allows us to disentangle the trickle down rates across different types of buyers.

4.2. **Data.** The survey was implemented by Egerton University in Nairobi. The sampling frame was designed in consultation with the Kenya National Bureau of Statistics. The surveys randomly sample over 1,300 rural households that represent eight different agricultural-ecological zones in Kenya (see Chamberlin and Jayne 2013 for details of the stratified random sampling). Compared to similar surveys in developing countries, the attrition rates of the original Kenya sample are low – about 90% of the households are resampled. This is particularly important because standard datasets of rural household in low income countries can have attrition rates as high as 20% (Suri et al. 2009) or even 50% (as in the World Bank's LSMS datasets).

4.3. **Summary statistics for Kenyan farming.** Section 2 documented that developing country agriculture is dominated by a large number of farmers with small land holdings. This is a characteristic of farming in Kenya, as shown in Table 1 which contains summary

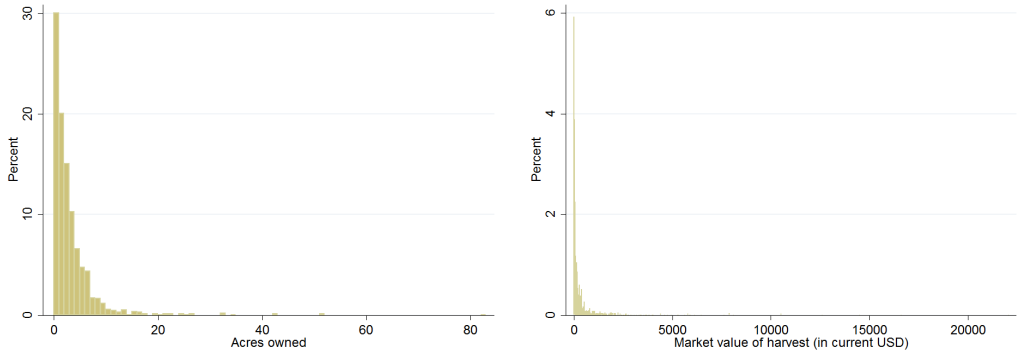
[2]http://www.fao.org/fileadmin/user_upload/fsn/docs/Ag_policy_Kenya.pdf

[3]For comparison, the average household expenditure per adult equivalent per month is Ksh 2,270 in rural areas of Kenya. Source: http://inequalities.sidint.net/kenya/abridged/consumption-expenditure/

TABLE 1. Summary statistics for Kenyan households

	Mean	Median	S.D.	Min	Max	#obs
Acres owned	3.3	2.1	6.6	0.0	250.1	4,251
Farm income (current USD)	734.2	231.4	2,165.6	0.0	94,943.9	4,251

FIGURE 4.1. Distribution of acres and farm incomes of households in 2000



(A) Land Ownership (B) Farm Earnings

statistics for the acres owned by the household and their yearly income from farming. Most households own small farms, with a median ownership of 2.1 acres. Figure 4.1 shows that most farms are very small and the vast majority of households earn less than USD 100 per year. While we do not observe large farms with more than 50 acres of land, the first stylized fact is confirmed for Kenyan farming - there are several small farmers and a highly skewed distribution of farm size. This is also reflected in the distribution of farm incomes.

The main crops for farmers in Kenya are maize, tea, sugarcane, coffee cherries, bananas, wheat and tomatoes. In each of these crops, Kenya is an exporter but makes up less than 1% of world exports. We define the main crop as the crop that provides the highest income share for the household. Maize is the most important main crop every year and the ranking of the other main crops changes slightly across years. Table 2 contains the percentage of households that grow each crop as their main crop in 2000, and the ranking of each crop by average share of household income in each year.

Farmers can sell their produce to a number of different types of buyers. We categorize the buyers into four types - consumers, cooperatives, small traders and large firms. A large

TABLE 2. Percentage of households by main crops and Share of income from main crops (average across households) in 2000

Main crop	% of households	% Income from crop
Maize dry	15.0	23.1
Tea	12.1	14.5
Sugarcane	10.1	11.8
Coffee cherries	9.7	5.5
Bananas	8.5	4.6
Wheat	4.3	7.1
Tomatoes	2.9	4.9

TABLE 3. Households by buyer types: Prevalence (% selling mainly to) and Average acres owned & farm incomes across buyer types

Buyer types	% Households	Acres	Farm Income (USD)
Consumer	14.5	2.6	216.3
Cooperative	7.9	2.0	645.4
Small trader	49.9	3.4	531.4
Large firm	27.7	4.5	1,640.3

firm refers primarily to a large company or to a miller, Kenya Tea Development Agency Holding Ltd (which is one of the largest private tea management agencies in Kenya) or the National Cereals and Produce Board of Kenya (which is one of the largest commodity trade and grain management corporations in Kenya). Table 3 shows the share of the sample selling through different buyers. About 15 per cent of the farmers sell directly to consumers and a small share sell mainly to cooperatives. The second stylized fact that small farmers sell through intermediaries is confirmed. The bulk of the sales - about 78% - are to firms which could be small traders or large agribusiness firms. The share of farmers who sell through large agribusiness firms has also grow over time from 26% in 2000 to 35% in 2007 (details are in the Online Appendix). Table **??** shows that the bigger farmers in terms of acreage and incomes tend to select into selling through large firms, so there is positive assortative matching of farmers and firms. This is also consistent with the third fact that small farmers tend to get technical transfers from agribusinesses.

4.4. **Empirical Strategy.** Having described the main features of Kenyan farming, we examine whether farmers selling through agribusinesses see a higher trickle down effect of world price changes to their incomes. For each household i, the trickle down of world prices to farmer incomes is estimated as:

$$\ln(income_{it}) = \alpha_i + \alpha_t + \beta \ln p_{it} + \sum_k BuyerType_k + \sum_k \ln p_{it} \cdot BuyerType_k + \varepsilon_{it} \tag{4.1}$$

where $income_{it}$ is the income from farming received by household i in year t, and p_{it} is the world price faced by the household in that year. Since the surveys report the sales revenues for each crop, we first aggregate the revenues to obtain the household incomes. We then compute the world price p_{it} as a weighted average of the international prices of all crops grown by the household. Our baseline specifications use the initial income shares of the crops as the weights. More specifically, the world price faced by household i in year t is constructed as $p_{it} = \sum_a \omega_{ai0} p^w_{at,Comtrade}$, where ω_{ai0} is the initial income share of crop a in household i, and $p^w_{at,Comtrade}$ is the COMTRADE international price of the same crop. From the COMTRADE data, we have the value and volumes of the world exports of the different products (6-digit level HS96 classification). With this information, we compute the average international price of a given crop, using the value of the transactions as weights. Having computed the international price p^w, we match these to the crops reported by the households.With constant shares across time, all the within household variation in $\ln p_{it}$ comes from the changes in world prices of individual crops.

Our unit of analysis is the household, rather than the household-crop level, because most households engage in multicropping and the relevant welfare metric is income (and not income from a particular crop). This is illustrated in Figure 4.2 which shows the distribution of the number of crops across households and Table 2 which shows that the share of income per household-crop is not concentrated in just one or two crops.

4.4.1. *Variable Summary.* Table 4 contains the summary statistics for changes in household incomes and prices used in estimating Equation 4.1 and Figures 4.4a and 4.4b graph the variation in incomes and prices in our sample. The household level price changes shown in Figure 4.4b hold the weight of each crop constant to illustrate the variation in world prices of the crops.

FIGURE 4.2. Number of crops grown by a household in 2000

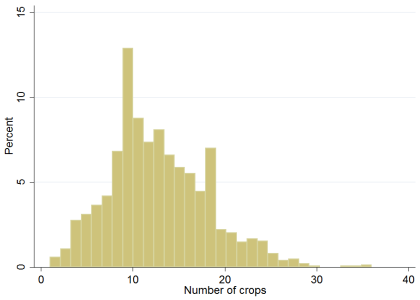
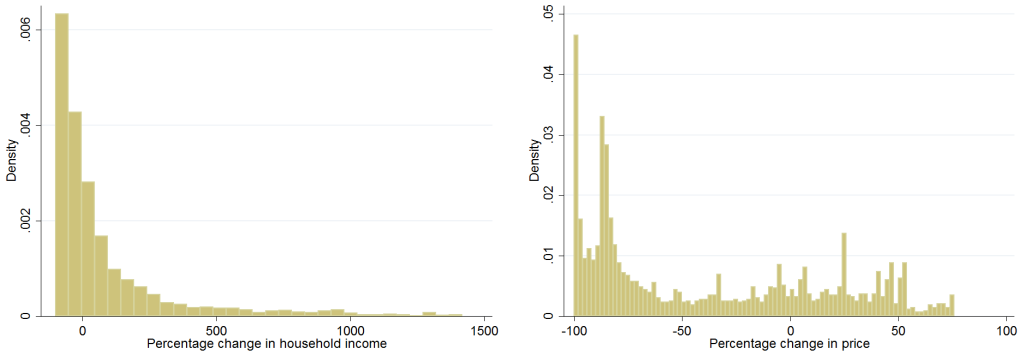


TABLE 4. Summary statistics for Income and Price Changes

	Mean	Median	S.D.	Min	Max	#obs
Change in household income	4.75	-0.01	4.30	-1	1,576.5	2,287
Change in household price	-0.33	-0.51	0.59	-1	1.79	2,266

FIGURE 4.3. Distribution of changes (%) in household incomes and prices



(A) Household incomes (B) Household prices

4.4.2. *Baseline Estimates.* Having described the variables, we proceed to the baseline results examining how the trickle down effects vary across small traders and large agribusiness firms. The results of the baseline specifications are reported in Table 5. Column (1) contains the cross-sectional results to show the correlations between income changes and price changes for the households. Column (2) adds household fixed effects and year fixed effects to focus on changes within a household and to net out economy-wide changes (such

as exchange rate fluctuations). The average trickle down rate is 12%. Columns (3) and (4) show that the trickle down rates vary by the type of buyer that the farmer sells to, as expected from the theory. Column (4) contains our preferred specification with household fixed effects and year fixed effects.

We find that on average, a 1 percentage point increase in world prices faced by a household change the household's income by 0.19% when the farmer sells directly to consumers. Farmers that sell indirectly have higher incomes as reflected in the premia estimated on selling through small traders, large firms and cooperatives. But the farmers selling through small traders barely see any further trickle down of world price changes into their incomes, as shown in the statistically insignificant and small coefficient on the interaction between $\ln p_{it}$ and the indicator variable for selling mainly through small traders $Trader_{it}$.

Large firms pay an even bigger premium to farmers as seen in the positive coefficient on $Large_{it}$. This could be due to cherry-picking of bigger farmers by agribusinesses or due to quality spillovers from agribusinesses. The trickle down effect from large agribusinesses to farmers is however much smaller than that from small traders or consumers, as seen in the negative coefficient on the interaction between $\ln p_{it}$ and the indicator variable for selling mainly through large firms $Large_{it}$.

To disentangle whether the trickle down rates are coming from changes in cropping patterns or changes in prices, we repeat our analysis holding the initial quantity pattern for each household fixed. Table 6 contains the results with $\ln(income_{it} \cdot q_{i0}/q_{it})$ as the dependent variable. For ease of reference, Column (1) contains the baselines results for log income, and Column (2) contains the results for incomes at fixed quantities. We continue to find that compared to Small Traders, Large Firms have higher income premia and lower trickle down effects. The income premia coefficient falls from 1.7 to 0.7 (coefficient on $Large_{it}$) and the trickle-down estimate is 4 percentage points higher when quantities are held fixed (from -29.1 earlier to -25.6 now).

Another way of disentangling the "price" response is to use the income per acre of the household as the dependent variable for the trickle down effect. The income per acre captures the price that the farmer receives per unit of land. Column (3) of Table 6 show that the trickle down effect is estimated to be even lower for farmers selling through Large Firms, compared to farmers selling through Small Traders.

TABLE 5. Baseline: Trickle Down Effects using average COMTRADE prices weighted by initial income shares

Dependent variable: $\ln(income_{it})$				
	(1)	(2)	(3)	(4)
$\ln p_{it}$	0.360***	0.115***	0.271***	0.190***
	(0.0286)	(0.0290)	(0.0617)	(0.0607)
$Trader_{it}$			1.109***	0.633***
			(0.0937)	(0.0901)
$Large_{it}$			2.669***	1.694***
			(0.0991)	(0.115)
$Coop_{it}$			1.054***	0.484***
			(0.144)	(0.149)
$\ln p_{it} \cdot Trader_{it}$			-0.0102	-0.0321
			(0.0695)	(0.0649)
$\ln p_{it} \cdot Large_{it}$			-0.132*	-0.291***
			(0.0731)	(0.0735)
$\ln p_{it} \cdot Coop_{it}$			0.306**	0.385***
			(0.124)	(0.103)
Constant	9.773***		8.380***	
	(0.0408)		(0.0869)	
Household FE α_i	No	Yes	No	Yes
Year FE α_t	No	Yes	No	Yes
N	3492	3336	3492	3336
R^2	0.060	0.729	0.296	0.772

Omitted category is Consumer. Standard errors in parentheses

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

4.5. **Robustness.** In this sub-section, we start with examining the robustness of the baseline results to changes in the variable definitions. Then we examine if the lower trickle down of large firms could be driven by insurance provided by agribusinesses to farmers.

4.5.1. *World Bank Prices.* The COMTRADE data provides unit values, and we can also get annual prices in US dollars for many primary products from the World Bank's Pink Sheet (World Bank Commodity Price Data). Although the information is not as complete as that from COMTRADE (which has about 100 crop prices per year), these are true per unit prices rather than unit values. Their main disadvantage though is that the World Bank prices are collected from just the main players in the world export market (e.g. Sri

TABLE 6. Robustness: Trickle down effects from income at fixed quantity & income per acre, and from incomes using World Bank prices & concurrent income shares

	Baseline	$\ln(income_{it} \cdot q_{i0}/q_{it})$	Income/Acre	World Bank Price	Concurrent Share
	(1)	(2)	(3)	(4)	(5)
$\ln p_{it}$	0.190***	0.331***	0.134*	0.288***	0.239***
	(0.0607)	(0.0810)	(0.0749)	(0.0627)	(0.0771)
$Trader_{it}$	0.633***	0.0428	0.544***	0.490***	0.639***
	(0.0901)	(0.0986)	(0.111)	(0.110)	(0.0849)
$Large_{it}$	1.694***	0.672***	1.443***	1.810***	1.784***
	(0.115)	(0.137)	(0.139)	(0.146)	(0.109)
$Coop_{it}$	0.484***	0.308*	0.491***	0.545***	0.502***
	(0.149)	(0.177)	(0.186)	(0.185)	(0.181)
$\ln p_{it} \cdot Trader_{it}$	-0.0321	-0.0963	-0.0512	0.0335	-0.131
	(0.0649)	(0.0836)	(0.0796)	(0.0374)	(0.0814)
$\ln p_{it} \cdot Large_{it}$	-0.291***	-0.256**	-0.304***	-0.130***	-0.477***
	(0.0735)	(0.103)	(0.0896)	(0.0460)	(0.0907)
$\ln p_{it} \cdot Coop_{it}$	0.385***	0.387**	0.310**	0.0196	0.173
	(0.103)	(0.167)	(0.133)	(0.0814)	(0.147)
Household FE α_i	Yes	Yes	Yes	Yes	Yes
Year FE α_t	Yes	Yes	Yes	Yes	Yes
N	3336	3222	3492	2791	3646
R^2	0.772	0.899	0.754	0.771	0.768

Omitted category is Consumer. Standard errors in parentheses

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

Lanka, India for tea), making them potentially more noisy and less relevant for Kenya. Nonetheless, it is reassuring from Column (4) of Table 6 that our main results are similar - farmers selling through agribusinesses earn a premium but get lower trickle down effects of world price changes into their incomes. The coefficients on the premia and the trickle down rates are smaller, but this might have to do with higher average price levels recorded in the World Bank data.

4.5.2. *Weighting of Crop Prices.* In the baseline estimation, the change in world price was weighted by the initial income share of the crop for the household. Households are likely to adjust production in response to price changes so that initial income shares as weights may understate price movements by placing less weight on crops with rising prices. To test

the robustness of our baseline results, we use the concurrent income shares to construct the world price changes of Equation 4.1. Column (5) of Table 6 confirms the baseline result that large firms are associated with higher income premia for farmers, but lower trickle-down effects of world price changes into farmer incomes. This is reassuring but unsurprising because the correlation between initial crop weights and concurrent crop weights is high (0.755).

4.5.3. *Variance of Income by Buyer Types.* We find that the trickle down rate is lower for agribusinesses, and interpret it as farmers getting lower than the full potential gains from trade. But one reason for lower trickle down from agribusinesses could be that they provide a lower variance in incomes for farmers (e.g. Allen and Atkin, 2016). Farmers would choose to trade off their income changes for lower variance in incomes if they are risk averse. In this case, the lower trickle down effects from Large Firms would reflect an insurance motive.

One way of addressing this insurance motive is to examine if the variance in income of households that sell through agribusinesses is lower than that for small traders. If agribusinesses insure farmers against income shocks, then we would expect lower variance in the incomes of their farmers, compared to other buyers. We compute the variance in income of each household over the three time periods in our sample. Columns (1) and (3) of Table 7 shows that the variance in income for the average household that sells to Large Firms is an order of magnitude higher than the average household that sells to Small Traders. This is true whether we look at the household income from all crops or the household income from a given crop.[4]

While variance in income is the welfare-relevant metric, one concern with using variances is that it might just be picking up the sorting of bigger farmers with agribusinesses. To address this, we compute the coefficient of variation (CV) in income, and Columns (2) and (4) of Table **7** shows that the variation in income of households selling through large firms is not much lower than for farmers selling through small traders or the average buyer.

[4]Results are similar when we regress the variances on indicators for each buyer type, with and without district fixed effects in household level regressions and crop-district fixed effects in household crop regressions.

TABLE 7. Summary Statistics for the Variance in Income (in '000) of Households Over Time by Buyer Type

	Within Household					Within Household-Crop				
		(1) Variance		(2) CV			(3) Variance		(4) CV	
Buyer Type	#Obs	Mean	SD	Mean	SD	#Obs	Mean	SD	Mean	SD
Consumer	173	289	1,443	86.0	38.9	560	29	320	68.2	38.3
Cooperative	156	679	3,350	69.8	33.4	818	62	392	72.5	37.9
Small trader	581	720	3,786	74.7	37.0	2,569	83	1,176	69.4	38.2
Large firm	328	6,132	68,054	66.2	37.5	1,462	769	13,811	64.4	37.7
Total	1,238	2,089	35,194	73.4	37.5	5,409	260	7,233	68.4	38.1

TABLE 8. Summary Statistics for the Variance ('000) and CV in Consumption Expenditure of Households Over Time by Buyer Type

		Variance		CV	
Buyer Type	#Obs	Mean	Std. Dev.	Mean	Std. Dev.
Consumer	145	46.7	82.8	92.3	34.4
Cooperative	148	38.2	99.7	91.7	26.8
Small trader	583	56.5	160.0	88.9	32.1
Large firm	306	51.7	171.1	94.3	31.9
Total	1,182	51.8	149.3	91.1	31.8

4.5.4. *Consumption Smoothing.* Another metric to test for the insurance motive is to test whether farmers selling through Large Firms have systematically lower variation in consumption expenditure. This would directly let us examine if the variation in purchasing power of farmers selling through large firms differs systematically from that of farmers selling through other buyers. Table 8 shows that farmers selling through large firms do not have sysematically lower variation in consumption expenditures, compared to small traders or other buyers.[5]

4.5.5. *Asymmetric Effects for Price Rise and Price Drops.* It may be the case that agribusinesses insure farmers against just the income shocks arising from world price fluctuations. Then agribusinesses provide insurance against world price shocks but not general income

[5]Consumption expenditure is the amount of household spending on products to meet their everyday needs. It includes the following: maize grain, packaged sifted maize meal, posho meal, beans/dried peas/legumes, millet/sorghum, wheat flour, rice, cassava, matoke/cooking bananas, Irish potatoes, meat, sugar, cooking oil, wheat bread, sweet potatoes, milk, eggs, and fish.

shocks, so we need not see lower variance in incomes for farmers selling through agribusinesses even when there is insurance provided against price shocks. One way of addressing this is to allow the trickle down effect to be estimated separately for a rise in world prices and a fall in world price. Large agribusinesses would insure their farmers by passing on more of the world price change when there is a rise in world prices and less when there is a drop in world prices. To test this, we allow the trickle down effect to vary by price rises and price drops for each buyer type. The price rise indicator $Rise_{it}$ is defined as 1 when household i at time t experiences an increase in its average price compared to the previous year, i.e. $p_{it} - p_{it-1} = \sum_a \omega_{ai0} p^w_{at,Comtrade} - \sum_a \omega_{ai0} p^w_{at,-1Comtrade} > 0$. Column (1) of Table 9 shows that the estimated trickle down from world prices to incomes of farmers selling through large firms is lower when there is a rise in world prices, which runs contrary to the insurance motive. It might be that the insurance is specific to the crop being purchased by the large firm, so we repeat our analysis at the household-crop level where $Rise_{it}$ indicates an increase in the world price of that crop. Columns (2) and (3) show that the trickle down to the farmer's income from that crop or the price received for the crop is not systematically greater when there is a price rise.

Therefore, the lower trickle down rate of large firms is unlikely to be a reflection of higher welfare for farmers through greater insurance. This is consistent with the anecdotal evidence mentioned earlier that small farmers in developing economies have limited recourse to getting their contracts reinforced after the harvest.

4.6. **Back to Theory.** Having tested the key prediction of the model, we go back to the theory to test the mechanism for the lower trickle down from agribusinesses and to estimate the potential gains from trade to farmers.

4.6.1. *Testing the Mechanism: Prices of Scarce Inputs.* The main mechanism underlying relatively lower trickle down from agribusinesses is that farmers have to incur higher costs of scarce inputs needed in agriculture. It is difficult to capture this effect if it manifests itself in lower quality. For example, a water pump is less effective when the water table is lower due to greater irrigation of fields with export crops. But we can still examine how farmers change their observed inputs that are recorded in the survey. We use the input

TABLE 9. Robustness: Asymmetric Trickle Down Effects for Price Rise and Price Drop by Buyer Type

	(1)ln $income_{it}$	(2)ln $income_{it}$	(3)ln $price_{it}$
$\ln p_{it}$	0.169	0.844	-1.942***
	(0.176)	(0.579)	(0.601)
$Trader_{it}$	0.857***	0.267	-0.401
	(0.280)	(0.301)	(0.270)
$Large_{it}$	1.646***	0.301	-0.0538
	(0.315)	(0.322)	(0.306)
$Coop_{it}$	0.571	0.773	-0.0418
	(0.367)	(0.470)	(0.374)
$\ln p_{it} \cdot Trader_{it}$	0.145	-0.200	-0.345
	(0.191)	(0.474)	(0.445)
$\ln p_{it} \cdot Large_{it}$	**-0.133**	**-0.148**	**0.775***
	(0.201)	(0.502)	(0.441)
$\ln p_{it} \cdot Coop_{it}$	0.465*	0.522	0.705
	(0.243)	(0.565)	(0.508)
$Rise_{it}$	0.345	0.0360	0.152
	(0.347)	(0.294)	(0.279)
$Rise_{it} \cdot \ln p_{it}$	0.858*	0.326	1.293***
	(0.448)	(0.520)	(0.429)
$Rise_{it} \cdot Trader_{it}$	-0.614	-0.117	0.289
	(0.396)	(0.333)	(0.298)
$Rise_{it} \cdot Large_{it}$	-0.406	0.00462	0.189
	(0.368)	(0.337)	(0.306)
$Rise_{it} \cdot Coop_{it}$	-0.347	-0.423	-0.0327
	(0.519)	(0.440)	(0.470)
$Rise_{it} \cdot \ln p_{it} \cdot Trader_{it}$	-0.757	-0.0455	0.366
	(0.461)	(0.562)	(0.493)
$Rise_{it} \cdot \ln p_{it} \cdot Large_{it}$	**-0.737**	**0.290**	**-0.812***
	(0.468)	(0.557)	(0.457)
$Rise_{it} \cdot \ln p_{it} \cdot Coop_{it}$	-1.026	-0.151	-0.949*
	(0.632)	(0.595)	(0.573)
Unit FE α_i	Yes	Yes	Yes
Year FE α_t	Yes	Yes	Yes
Unit of Observation	Household	Household-Crop	
Observations	2156	8247	7949
R^2	0.852	0.927	0.853

Omitted category is Consumer. Standard errors in parentheses.

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

expenditure per acre of the household as a proxy for the resource price per unit of land cultivated by the household.[6]

One way of examining the mechanism then is to test whether districts that are (or become) more exposed to agribusinesses have lower trickle down from large firms and higher input costs per acre. To determine which districts are more exposed to large firms, we first construct the value of potential incomes defined as the sum of the observed quantity of the household-crop valued at world prices ($\sum_a p^w_{ait} \cdot q_{ait}$). The potential income uses world prices to avoid understating the share of buyers who pay less to farmers. We define $ShareLargeFirm_{dt}$ as the share of potential income of farmers that sell mainly to Large Firms in district d at time t.

Table 10 shows that households that sell through large firms in districts that are more exposed to large firms drive the lower trickle down effect. Examining the input costs, Table 11 shows that districts that are more exposed to large firms also see a greater rise in the input cost per acre faced by the households. Putting the two results together, we can examine how world price changes affect incomes and input prices for a district where the share of large firms approaches one. The results imply that a 1% change in the world price has a 0.48% lower trickle down to incomes of households selling through agribusinesses, compared to small traders. In such districts, a 1% increase in world price raises the input price by 0.22% which is 0.46% more than a district that has no exposure to large firms.

4.6.2. *Counterfactual: Potential Gains from Trade.* The previous subsection shows that farmers selling through large firms face higher costs of investing scarce resources into farming when world prices rise. We can then use the model to ask the question: how much more would the farmer have gained from the world price increase if investments into scarce inputs had not been driven up? A natural way for a policymaker to address this is to guarantee constant rates for the scarce inputs, in the event of a breakdown in negotiations be ween a farmer and an agribusiness. This would not change the cropping and selling decisions of farmers, but would increase the outside option of farmers selling through agribusinesses. The farmer gets $\delta pa - \theta r$ from selling through agribusinesses.

[6]Input expenditure is the household spending on goods and services for the purpose of production. It includes the following: fertilizer, pesticide, insecticide, herbicide, plough, sprayer, AT equipment, technical support, fungicide, water, planter cost, harvester cost, transport, sheller cost, fuels, gunny bags, ridger cost, land rent, land preparation, farm implements, farm machinery, irrigation equipment, and baler.

TABLE 10. Mechanism: Trickle Down by share of large firms in districts

Dependent variable: $\ln(income_{it})$			
$\ln p_{it}$	0.0518	$\ln p_{it} \cdot ShareLarge_{dt}$	0.236
	(0.156)		(0.244)
$Coop_{it}$	0.573	$Coop_{it} \cdot ShareLarge_{dt}$	-0.134
	(0.386)		(0.581)
$Trader_{it}$	0.989***	$Trader_{it} \cdot ShareLarge_{dt}$	-0.518
	(0.245)		(0.408)
$Large_{it}$	1.067***	$Large_{it} \cdot ShareLarge_{dt}$	0.952**
	(0.273)		(0.431)
$\ln p_{it} \cdot Coop_{it}$	0.641**	$\ln p_{it} \cdot Coop_{it} \cdot ShareLarge_{dt}$	-0.486
	(0.301)		(0.450)
$\ln p_{it} \cdot Trader_{it}$	-0.0496	$\ln p_{it} \cdot Trader_{it} \cdot ShareLarge_{dt}$	0.0444
	(0.177)		(0.287)
$\ln p_{it} \cdot Large_{it}$	**0.0152**	$\ln p_{it} \cdot Large_{it} \cdot ShareLarge_{dt}$	**-0.482***
	(0.176)		(0.290)
HH FE α_i	Yes	$ShareLarge_{dt}$	-0.266
Year FE α_t	Yes		(0.407)
Observations	3189	R^2	0.811

Omitted category is Consumer. Standard errors in parentheses

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

TABLE 11. Mechanism: Input prices by share of large firms in districts

Dependent variable: $\ln(input\ cost\ per\ acre_{it})$		
	(1)	(2)
$\ln p_{it}$	-0.211*	-0.248*
	(0.127)	(0.132)
$ShareLarge_{dt}$	1.601***	0.548**
	(0.198)	(0.252)
$\ln p_{it} \cdot ShareLarge_{dt}$	0.405**	0.464**
	(0.191)	(0.199)
HH FE α_i	Yes	Yes
Year FE α_t	No	Yes
Observations	2293	2293
R^2	0.733	0.767

Omitted category is Consumer. Standard errors in parentheses

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

The farmer would get δpa if the policymaker guarantees a payment of θr to farmers in the event of a disagreement with the agribusiness. Then the potential gains from trade to farmers is $\Delta\delta pa$, which we will recover in this counterfactual exercise.

The trickle down estimate gives the actual change in incomes with respect to world price changes. From the trickle down estimation of Equation 4.1, the actual gains from trade to a farmer selling through an agribusiness is $\hat{\beta}_{Large}\left[\left(p_t^w - p_0^w\right)/p_0^w\right] income_0$ when the world price of the export crop changes from p_0^w to p_t^w. The actual gains from trade to a farmer selling through a small trader is $\hat{\beta}_{Trader}\left[\left(p_t^w - p_0^w\right)/p_0^w\right] income_0$.

To get the potential gains from trade, we need to estimate the quality spillover δ from agribusinesses to farmers. Taking the theory to guide us, we can recover the quality spillover by estimating the following equation:

$$income_{it} = \alpha_i + \alpha_t + \sum_k \eta_k BuyerType_{kit} + \sum_k \gamma_k \left(p_{it}^w a_{it}\right) \cdot BuyerType_{kit} + \varepsilon_{it}$$

where we compute the RHS variable $p_{it}^w a_{it}$ using the observed world prices of the crops and the cropping pattern a_{it} of the household. Then $\hat{\delta} = \hat{\gamma}_{Large}/\hat{\gamma}_{Trader}$ is the quality spillover which is estimated using the within-household variation in prices, cropping patterns and buyer types. Table 12 estimates that farmers selling through large firms experience a doubling of their productivity, compared to small traders. Combining this estimate with the trickle down estimates of Column 4 in Table 5, the potential gains from trade are about six times higher than the actual gains from trade, i.e. Potential GFT/Actual GFT = $\hat{\delta}\hat{\beta}_{Trader}/\hat{\beta}_{Large} = 5.72$ (relative to 2000). Figure 4.4 plots the log differences between these potential gains from trade ($\hat{\delta}\hat{\beta}_{Trader}\left[\left(p_t^w - p_0^w\right)/p_0^w\right] income_0$) and the actual gains from trade for each household. Although households with higher initial incomes get bigger levels of the potential gains from trade under the counterfactual policy, the lowest income farmers mostly see a rise in incomes from their very low initial levels. At a time when cooperatives are losing their market share, protecting farmers from investment cost increases, that reduce their bargaining power, can ensure that farmers get more of the gains from trade.

5. CONCLUSION

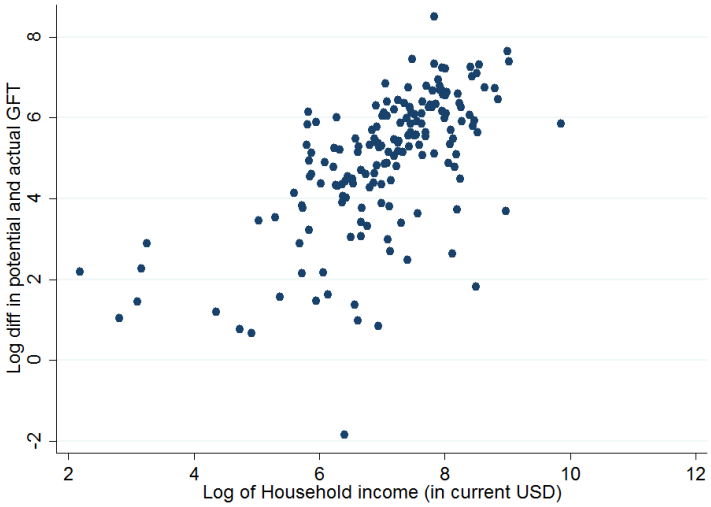
Agricultural markets in developing economies typically consist of a large number of small farmers who sell their produce through small traders and big agribusinesses with

TABLE 12. Counterfactual: Quality Spillover

Dependent variable: $income_{it}$			
$(p_{it}^w a_{it}) \cdot Trader_{it}$	3.684^{***}	$Trader_{it}$	162.2^{***}
	(0.913)		(55.67)
$(p_{it}^w a_{it}) \cdot Large_{it}$	7.746^{***}	$Large_{it}$	548.0^{***}
	(2.195)		(86.51)
$(p_{it}^w a_{it}) \cdot Coop_{it}$	24.31^{***}	$Coop_{it}$	3.889
	(8.819)		(124.4)
HH FE α_i	Yes	Year FE α_t	Yes
Observations	3880	R^2	0.836

Omitted category is Consumer. Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

FIGURE 4.4. Potential and Actual Gains from Trade by Initial Income



market power. We develop a flexible analytical framework that embeds the complexity of the industrial organization of agricultural markets.

Incorporating a richer market structure shows that a farmer receives a greater share of the world price when there is greater equality in land ownership and more competition among intermediaries. Farming by large agribusinesses increases farm incomes through productivity transfers. But agribusinesses also increase competition for scarce capital, which is necessary for growing and marketing farm produce. These conflicting forces

imply that the trickle down effect of increases in world commodity prices ranges from negative to greater than one, depending on the degree to which small farmers have invested in their relationship with big agribusinesses.

Testing for the degree of lock-in of small farmers to agribusinesses in Kenyan farming, we find that farmers selling through large firms have higher incomes but lower trickle down of world price increases to their own household incomes. Compared to farmers selling directly to consumers and farmers selling through small traders, farmers that sell through agribusinesses share less in the gains from trade. When the world price faced by farmers rises by 1%, the rise in the incomes of farmers selling through large agribusinesses is about 30% less than that of farmers who sell to small traders. We show that the lower trickle down is unlikely to be due to insurance provided by agribusinesses. We find that input unit values rise with changes in world prices when large firms have higher market shares, and this suggests that the potential gains form trade to small farmers could be raised by shielding them from increases in the costs of investing in export products. This would enable farmers to get the initial gains from technical spillovers from agribusinesses and to not have these gains lowered by future reductions in world prices.

Our findings suggest that although farmers might experience higher productivity by selling through large agribusinesses, they do not share much in the gains from trade that agribusinesses obtain from favorable movements in the prices of crops in world markets. We find a sizable productivity spillover and lock-in of farmers selling to agribusinesses. Future work can identify the sources of the productivity gain and the lock-in of farmers to agribusinesses, which is a subject of a vast literature on the agricultural productivity gap in developing countries (e.g. Lagakos and Waugh, 2013; Conley and Udry, 2010).

REFERENCES

Allen, Treb, "Information Frictions in Trade," *Econometrica*, 2014, *82* (6), 2041–2083.

_____ **and David Atkin**, "Volatility and the Gains from Trade," Technical Report, National Bureau of Economic Research 2016.

Antràs, Pol and Arnaud Costinot, "Intermediated Trade*," *The Quarterly journal of economics*, 2011, *126* (3), 1319–1374.

Ashraf, Nava, Xavier Giné, and Dean Karlan, "Finding missing markets (and a disturbing epilogue): Evidence from an export crop adoption and marketing intervention in Kenya," *American Journal of Agricultural Economics*, 2009, *91* (4), 973–990.

Atkin, David and Dave Donaldson, "Who's getting globalized? the size and nature of

intranational trade costs," *Yale University and MIT, unpublished mimeo*, 2012.

Balat, Jorge, Irene Brambilla, and Guido Porto, "Realizing the gains from trade: Export crops, marketing costs, and poverty," *Journal of International Economics*, 2009, *78* (1), 21–31.

Bardhan, Pranab, Dilip Mookherjee, and Masatoshi Tsumagari, "Middlemen margins and globalization," *American Economic Journal: Microeconomics*, 2013, *5* (4), 81–119.

Bardhan, Pranab K., "Interlocking factor markets and agrarian development: A review of issues," *Oxford Economic Papers*, 1980, pp. 82–98.

Barrett, Christopher B., "Smallholder market participation: Concepts and evidence from eastern and southern Africa," *Food Policy*, 2008, *33* (4), 299–317.

_____ **and Emelly Mutambatsere**, *Agricultural markets in developing countries*, Vol. 2nd Edition, London: Palgrave Macmillan, Forthcoming, 2008.

Bernard, Andrew B. and Swati Dhingra, "Contracting and the Division of the Gains from Trade," Technical Report, Working paper 2015.

Bhagwati, Jagdish N., Arvind Panagariya, and Thirukodikaval N. Srinivasan, *Lectures on international trade*, MIT press, 1998.

Brambilla, Irene and Guido G. Porto, "Market structure, outgrower contracts, and farm output. Evidence from cotton reforms in Zambia," *Oxford Economic Papers*, 2011.

Burke, Marshall, "Selling low and buying high: An arbitrage puzzle in Kenyan villages," in "Working Paper" 2014.

Carr, Stephen, "What happens to the small farmers when the large ones take over?," *Thrive, CGIAR Research Program on Water, Land and Ecosystems*, February 2013.

Chamberlin, Jordan and T. S. Jayne, "Unpacking the meaning of 'market access': evidence from rural Kenya," *World development*, 2013, *41*, 245–264.

Chau, Nancy, Hideaki Goto, and Ravi Kanbur, "Middlemen, Non-Profits, and Poverty," Technical Report, Cornell University, Department of Applied Economics and Management 2009.

Collier, Paul and Stefan Dercon, "African Agriculture in 50Years: Smallholders in a Rapidly Changing World?," *World development*, 2014, *63*, 92–101.

Conley, Timothy G. and Christopher R. Udry, "Learning about a new technology: Pineapple in Ghana," *The American Economic Review*, 2010, *100* (1), 35–69.

Devadoss, Stephen and Wongun Song, "Oligopsony Distortions and Welfare Implications of Trade*," *Review of International Economics*, 2006, *14* (3), 452–465.

Dragusanu, Raluca, Daniele Giovannucci, and Nathan Nunn, "The economics of fair trade," *The Journal of Economic Perspectives*, 2014, *28* (3), 217–236.

Dries, Liesbeth, Michael Dumitrashko, Matthew Gorton, A. Ignat, N. Mkrtchyan, G. Sardaryan, A. Skripnik, V. Urutyan, Anneleen Vandeplas, and J. White, "Farmer-processor relationships in the CIS dairy sector: key findings from the SIDCISA research project," 2007.

Eckel, Carsten, "International trade and retailing," 2009.

Fafchamps, Marcel and Ruth V. Hill, "Price transmission and trader entry in domestic commodity markets," *Economic Development and Cultural Change*, 2008, *56* (4), 729–766.

Feenstra, Robert C., "Monopsony distortions in an open economy: A theoretical analysis," *Journal of International Economics*, 1980, *10* (2), 213–235.

Fold, Niels and Katherine V. Gough, "From smallholders to transnationals: the impact of changing consumer preferences in the EU on Ghana's pineapple sector," *Geoforum*, 2008, *39* (5), 1687–1697.

Goodman, David and Michael Watts, *Globalising food: agrarian questions and global restructuring*, Psychology Press, 1997.

Jaffee, Steve and Oliver Masakure, "Strategic use of private standards to enhance international competitiveness: Vegetable exports from Kenya and elsewhere," *Food Policy*, 2005, *30* (3), 316–333.

Key, Nigel and David Runsten, "Contract farming, smallholders, and rural development in Latin America: the organization of agroprocessing firms and the scale of outgrower production," *World development*, 1999, *27* (2), 381–401.

Lagakos, David and Michael E. Waugh, "Selection, agriculture, and cross-country productivity differences," *The American Economic Review*, 2013, *103* (2), 948–980.

Likulunga, Mwikisa L., "The status of contract farming and contractual arrangements in Zambian agriculture and agribusiness," *Report prepared for FARNPAN*, 2005.

Lowder, Sarah K., Jakob Skoet, and Saumya Singh, "What do we really know about the number and distribution of farms and family farms in the world?," *FAO*, 2014.

Macchiavello, Rocco and Ameet Morjaria, "Competition and Relational Contracts: Evidence from Rwanda's Coffee Mills," Technical Report, Working Paper, LSE and Harvard 2015.

_____ **and** _____, "The value of relationships: evidence from a supply shock to Kenyan rose exports," *The American Economic Review*, 2015, *105* (9), 2911–2945.

Markusen, James R. and Arthur J. Robson, "Simple general equilibrium and trade with a monopsonized sector," *Canadian Journal of Economics*, 1980, pp. 668–682.

McCulloch, Rachel and Janet L. Yellen, "Factor market monopsony and the allocation of resources," *Journal of International Economics*, 1980, *10* (2), 237–247.

Minot, Nicholas, "Contract farming in sub-Saharan Africa: opportunities and challenges," in "policy seminar: Smallholder-led Agricultural Commercialization and Poverty Reduction: How to Achieve It" 2011, pp. 18–22.

Minten, Bart, Lalaina Randrianarison, and Johan F. M. Swinnen, "Global retail chains and poor farmers: Evidence from Madagascar," *World Development*, 2009, *37* (11), 1728–1741.

Mitra, Sandip, Dilip Mookherjee, Maximo Torero, and Sujata Visaria, "Asymmetric information and middleman margins: An experiment with west bengal potato farmers," Technical Report 2013.

Provost, C. and E. Kabendera, "Tanzania: 'large-scale farming turns small farmers into mere labourers'," *The Guardian*, February 2014.

_____, L. Ford, and M. Tran, "New Alliance condemned as new wave of colonialism in Africa," *The Guardian*, February 2014.

Raff, Horst and Nicolas Schmitt, "Endogenous vertical restraints in international trade," *European Economic Review*, 2005, *49* (7), 1877–1889.

Reardon, Thomas and C. Peter Timmer, "Transformation of markets for agricultural output in developing countries since 1950: How has thinking changed?," *Handbook of agricultural economics*, 2007, *3*, 2807–2855.

Robbins, Peter and R. S. B. Ferris, *The impact of globalization on the agricultural sectors of East and Central African countries*, Vol. 1, Iita, 2003.

Rogers, Richard T. and Richard J. Sexton, "Assessing the importance of oligopsony power in agricultural markets," *American Journal of Agricultural Economics*, 1994, pp. 1143–1150.

Runsten, David, "Transaction Costs in Mexican Fruit and Vegetable Contracting: Implications for Asociación en participación," *Atlanta*, 1994, *10*, 12.

Sheveleva, Yelena and Kala Krishna, "Wheat or Strawberries? Intermediated Trade with Limited Contracting," *American Economic Journal: Microeconomics*, 2016.

Simmons, Phil, "Overview of smallholder contract farming in developing countries," *Rome: FAO*, 2002.

Suri, Tavneet, David Tschirley, Charity Irungu, Raphael Gitau, Daniel Kariuki, and Others, *Rural incomes, inequality and poverty dynamics in Kenya*, Egerton university. Tegemeo institute of agricultural policy and development, 2009.

Unctad, "World Investment Report 2009: Transnational Corporations, Agricultural Production and Development," 2009.

Warning, Matthew and Nigel Key, "The social performance and distributional consequences of contract farming: An equilibrium analysis of the Arachide de Bouche program in Senegal," *World Development*, 2002, *30* (2), 255–263.

Whitfield, Lindsay, "Developing technological capabilities in agro-industry: Ghana's experience with fresh pineapple exports," *Journal of Development Studies*, 2012, *48* (3), 308–321.

APPENDIX A. ONLINE APPENDIX: NOT FOR PUBLICATION

A.1. **Equilibrium Existence.** This Section sketches the conditions needed to ensure the existence of an equilibrium that has well-defined prices and more than one intermediary. Let $r_{low} \equiv k^{1/(k-1)} p_h s (\delta - 1)/\theta$ which will be the lower bound on rental rates to guarantee that the value of export crops with intermediaries rises with world prices. Let $r_{K1} \equiv \beta p_w m_b B / M^{\beta} (\bar{K} - f)^{1-\beta}$ denote the rental rate implied by the capital-market condition when there is only one intermediary in the economy. Similarly, let

$$r_{FE1} \equiv (k-1)^{k-1} (a_{\min} p_w m/k)^k / (p_h s)^{k-1} f$$

denote the rental rate implied by the free entry condition when there is only one intermediary in the economy. To ensure the existence of a unique equilibrium, we assume the following parameter conditions on B and f.

Assumption. $r_{low} \leq r_{K1} \leq r_{FE1}$.

The assumptions ensure that the market equilibrium is in the region where rental rates are such that there is at least one intermediary in the market and the value of exports with intermediaries rises with world prices. We explain this in greater detail below.

The market equilibrium can be summarized by the following two equations - free entry and capital market clearing. The equilibrium values for the number of intermediaries N and the rental rate r are determined by the free entry condition and the capital-market clearing condition as follows:

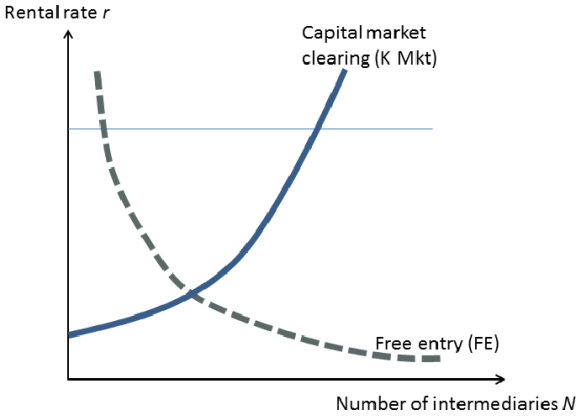
$$\frac{k}{k-1}\frac{1}{N}\frac{1}{N(k-1)+1} a_{\min}^k \left(\frac{N(k-1)p_w m}{N(k-1)+1}\right)^k \left[(p_h s)^{-k+1} - (\theta r/(\delta-1))^{-k+1}\right] = rf \qquad \text{FE}$$

$$M (\beta p_w m_b B / Mr)^{1/(1-\beta)} + Nf = \bar{K} \quad \text{K Mkt}$$

The equilibrium existence conditions are explained through Figure A.1. The equilibrium values of N and r are given by the intersection of the FE and K Mkt curves. The FE curve is downward-sloping in (N, r) space. Higher entry lowers profits of intermediaries through greater competition, so rental rates must fall to maintain profits net of entry costs. FE implies $d\ln r/d\ln N = -\frac{(p_h s)^{-k+1} - (\theta r/(\delta-1))^{-k+1}}{(p_h s)^{-k+1} - k(\theta r/(\delta-1))^{-k+1}} \left(2 - \frac{k}{N(k-1)+1}\right) < 0$ and FE asymptotes as r and N get close to zero. The K Mkt curve is upward-sloping because higher entry drives up capital market competition and increases rental rates, $d\ln r/d\ln N = Nf(1-\beta)/Mq > 0$.

For $N \geq 1$, K Mkt gives $r \geq \beta p_w m_b B / M^{\beta} (\bar{K})^{1-\beta} \equiv r_{K1}$ and the first inequality in our Assumption ensures that the curve lies above r_{low} which ensures that the value of exports of intermediaries rise with world prices. The first inequality in our Assumption also guarantees that there are some farmers that would choose to sell to agribusinesses because $r \geq k^{1/(k-1)} (\delta - 1) p_h s/\theta > (\delta - 1) p_h s/\theta$. We also need to ensure that there is in fact an intersection for values of $N \geq 1$. The second inequality guarantees that at $N = 1$,

FIGURE A.1. Market Equilibrium



the rental rate implied by free entry is higher than the rental rate implied by capital market clearing so that equilibrium is restored at a point where at least one intermediary operates in the market.

A.2. **Impact of World Price Changes.** From free entry of intermediaries, $d\ln r/d\ln p_w = \frac{(p_h s)^{-k+1}-(\theta r/(\delta-1))^{-k+1}}{(p_h s)^{-k+1}-k(\theta r/(\delta-1))^{-k+1}}\left[k-\frac{2N(k-1)-k+2}{N(k-1)+1}d\ln N/d\ln p_w\right]$. From optimal quality choice, $d\ln q/d\ln p_w = [1-d\ln r/d\ln p_w]/(1-\beta)$. From capital market clearing, the change in entry from $Mqd\ln q/d\ln p_w + Nfd\ln N/d\ln p_w = 0$. Substituting for the changes in quality and rental rates, the change in entry is

$$\left[Nf+\frac{(p_h s)^{-k+1}-(\theta r/(\delta-1))^{-k+1}}{(p_h s)^{-k+1}-k(\theta r/(\delta-1))^{-k+1}}\frac{2N(k-1)-k+2}{N(k-1)+1}\frac{Mq}{1-\beta}\right]\frac{d\ln N}{d\ln p_w}$$
$$=\frac{(k-1)(p_h s)^{-k+1}}{(p_h s)^{-k+1}-k(\theta r/(\delta-1))^{-k+1}}\frac{Mq}{1-\beta}$$

The RHS is positive and the square bracket term on the LHS is also positive under the Assumption of Section A.1, so that entry rises with world prices. This directly implies that $d\ln p/d\ln p_w \geq 1$. Substituting for the change in entry, we see that the rental rate also

rises with world prices because

$$\begin{aligned}\frac{d\ln r}{d\ln p_w} =& \frac{(p_h s)^{-k+1}-(\theta r/(\delta-1))^{-k+1}}{(p_h s)^{-k+1}-k(\theta r/(\delta-1))^{-k+1}}\left[k-\frac{2N(k-1)-k+2}{N(k-1)+1}d\ln N/d\ln p_w\right]\\ =& \frac{(p_h s)^{-k+1}-(\theta r/(\delta-1))^{-k+1}}{(p_h s)^{-k+1}-k(\theta r/(\delta-1))^{-k+1}}\left[k-\frac{\frac{(k-1)(p_h s)^{-k+1}}{(p_h s)^{-k+1}-k(\theta r/(\delta-1))^{-k+1}}\frac{2N(k-1)-k+2}{N(k-1)+1}\frac{Mq}{1-\beta}}{Nf+\frac{(p_h s)^{-k+1}-(\theta r/(\delta-1))^{-k+1}}{(p_h s)^{-k+1}-k(\theta r/(\delta-1))^{-k+1}}\frac{2N(k-1)-k+2}{N(k-1)+1}\frac{Mq}{1-\beta}}\right]\\ \geq& \frac{2N(k-1)-k+2}{N(k-1)+1}\frac{Mq}{1-\beta}>0\end{aligned}$$

The change in the income from agribusinesses is $d\ln T/d\ln p_w=(\delta pa/T)\,d\ln p/d\ln p_w-(\theta r/T)\,d\ln r/d\ln p_w$. Clearly, if θ is close to zero, the trickle down effect is the same as from intermediaries which is greater than one. As the ratio of capital demanded by agribusinesses relative to intermediaries becomes arbitrarily small, the change in entry becomes arbitrarily small and the trickle down from intermediaries gets close to one. The rental rate change becomes $\frac{d\ln r}{d\ln p_w}=k\frac{(p_h s)^{-k+1}-(\theta r/(\delta-1))^{-k+1}}{(p_h s)^{-k+1}-k(\theta r/(\delta-1))^{-k+1}}$ so that the change in income from agribusinesses is $\frac{d\ln T}{d\ln p_w}=\frac{\delta pa}{T}-\frac{\theta r}{T}k\frac{(p_h s)^{-k+1}-(\theta r/(\delta-1))^{-k+1}}{(p_h s)^{-k+1}-k(\theta r/(\delta-1))^{-k+1}}$. At the cutoff point, the change in income is $\frac{T}{\theta r}\frac{d\ln T}{d\ln p_w}=\frac{\delta}{\delta-1}-k\frac{(p_h s)^{-k+1}-(\theta r/(\delta-1))^{-k+1}}{(p_h s)^{-k+1}-k(\theta r/(\delta-1))^{-k+1}}$ which is negative for all $\delta\geq k/(k-1)$.

A.3. **Capital in Farming.** Let $\alpha\geq 0$ denote the units of capital needed to grow or sell the non-tradable crop. Then the payoff to farmers is $s-\alpha r$ from subsistence farming, $pa-\alpha r$ from selling the export crop to small traders and $\delta pa-\alpha r-\theta r$ from selling the export crop to big agribusinesses. The cutoff between subsistence and traders is $a_s\equiv s/p$ and the cutoff between traders and agribusinesses is $a_l\equiv \theta r/(\delta-1)\,p$. The equilibrium price paid by intermediaries continues to be $p=N(k-1)p_w m/(N(k-1)+1)$ and the optimal quality investment as earlier is $q^{1-\beta}=\beta p_w m_b B/Mr$. The free entry condition and the capital market clearing condition change as follows:

$$\frac{k}{k-1}\frac{1}{N}\frac{1}{N(k-1)+1}\left(\frac{N(k-1)}{N(k-1)+1}a_{\min}p_w m\right)^k\left[s^{-k+1}-(\theta r/(\delta-1))^{-k+1}\right]=rf \qquad \text{FE}$$

$$M(\beta p_w m_b B/Mr)^{1/(1-\beta)}+Nf+\alpha+\theta\left(\frac{a_{\min}}{\delta-1}\frac{N(k-1)}{N(k-1)+1}\frac{p_w m}{\theta r}\right)^k=\bar{K} \quad \text{K Mkt}$$

The capital market clearing condition above can be written either without the last term which would imply that the investments don't need to be made unless there is a disagreement, or with this last term present which implies that the investments are necessary to realize higher quality from agribusinesses. In either case, the qualitative results hold whether the investments are fixed as in the first case or sunk as in the second case.

From the equilibrium price and quality, the changes in price and quality with respect to world price are the same as before - $\frac{d\ln p}{d\ln p_w} = 1 + \frac{1}{N(k-1)+1}\frac{d\ln N}{d\ln p_w}$ and $\frac{d\ln q}{d\ln p_w} = \frac{1}{1-\beta}\left(1 - \frac{d\ln r}{d\ln p_w}\right)$. The changes in the cutoffs are $\frac{d\ln a_s}{d\ln p_w} = -\frac{d\ln p}{d\ln p_w}$ and $\frac{d\ln a_l}{d\ln p_w} = -\frac{d\ln p}{d\ln p_w} + \frac{d\ln r}{d\ln p_w}$. From the free entry condition (FE),

$$\frac{d\ln r}{d\ln p_w}\left[1 - \frac{(k-1)\,a_l^{-k+1}}{a_s^{-k+1} - a_l^{-k+1}}\right] = k - \left(1 + \frac{(N-1)\,(k-1)}{N(k-1)+1}\right)\frac{d\ln N}{d\ln p_w}$$

and from capital market clearing,

$$\left[Nf + \frac{k\theta a_{\min}^k / a_l^k}{N(k-1)+1}\right]\frac{d\ln N}{d\ln p_w} = \left[\frac{Mq}{1-\beta} + k\theta a_{\min}^k / a_l^k\right]\left[-1 + \frac{d\ln r}{d\ln p_w}\right].$$

Solving for the changes in entry and rental rates, we find that both increase with a rise in the world price for $N \geq 1$. This is because free entry and capital market clearing give

$$\left[\frac{Nf + \frac{k\theta a_{\min}^k / a_l^k}{N(k-1)+1}}{\frac{Mq}{1-\beta} + k\theta a_{\min}^k / a_l^k} + \left(1 + \frac{(N-1)\,(k-1)}{N(k-1)+1}\right)\frac{a_s^{-k+1} - a_l^{-k+1}}{a_s^{-k+1} - k a_l^{-k+1}}\right]\frac{d\ln N}{d\ln p_w} = \frac{(k-1)\,a_s^{-k+1}}{a_s^{-k+1} - k a_l^{-k+1}}.$$

The RHS is positive and the LHS is also positive for all $k, N \geq 1$. Therefore, entry rises with world prices. It follows that the price paid by small traders rise by more than one. The change in rental rate is $\frac{d\ln r}{d\ln p_w} = 1 + \left[\frac{Nf + \frac{k\theta a_{\min}^k / a_l^k}{N(k-1)+1}}{\frac{Mq}{1-\beta} + k\theta a_{\min}^k / a_l^k}\right]\frac{d\ln N}{d\ln p_w}$ which is also positive. Therefore, the rental rate rises and subsistence farmers are worse off after an increase in the world price of the export crop.

APPENDIX B. EMPIRICAL RESULTS

B.1. **Household Incomes and Prices in the Baseline Regression.** Figure B.1 plots the variation in household incomes and prices against each other.

B.2. **Summary Statistics for Buyer Types.** Farmers can sell their produce to a number of different types of buyers. We categorize the buyers into four types - consumers, cooperatives, small traders and large firms. A large firm refers to any one of the following: large company, miller, Kenya Tea Development Agency Holding Ltd (which is one of the largest private tea management agencies in Kenya) or the National Cereals and Produce Board of

FIGURE B.1. Scatter plot of changes (%) in household incomes and prices

Kenya (which is one of the largest commodity trade and grain management corporations in Kenya). Table 13 shows the share of the sample selling through different buyers. About 15 per cent of the farmers sell directly to consumers and a small share sell mainly to cooperatives. the second stylized fact that small farmers sell through intermediaries is confirmed. The bulk of the sales are to firms - small traders and large firms. Within the category of large firms, most farmers sell to large companies as shown in Table 14. The share of farmers who sell through large agribusiness firms also grows over time from 26% in 2000 to 35% in 2007. Table **??** shows that the bigger farmers in terms of acreage and incomes tend to select into selling through large firms, so there is positive assortative matching of farmers and firms. This is also consistent with the third fact that small farmers tend to get technical transfers from agribusinesses.

TABLE 13. Frequency and percentage of households across buyer types in each year

Buyer types	year							
	2000		2004		2007		Total	
	No.	Col %	No.	Col %	No.	Col %	No.	Col %
Consumer	194	14.6	173	13.3	194	15.5	561	14.5
Cooperative	162	12.2	60	4.6	84	6.7	306	7.9
Small trader	631	47.4	766	59.0	541	43.2	1,938	49.9
Large firm	344	25.8	299	23.0	432	34.5	1,075	27.7
Total	1,331	100.0	1,298	100.0	1,251	100.0	3,880	100.0

TABLE 14. Frequency of households across large buyers in each year

Large buyers	year			
	2000	2004	2007	Total
	No.	No.	No.	No.
Large company	169	91	118	378
Kenya Tea Development Agency Holdings Ltd	153	173	182	508
National Cereals and Produce Board	11	11	15	37
Miller	3	24	34	61
Exporter	0	0	14	14
Processor	0	0	60	60
Pyrethrum board	0	0	1	1
National Irrigation Board	7	0	8	15
Other institutions	1	0	0	1
Total	344	299	432	1,075