Refugee Inflow, Surplus Farm Labor, and Crop Marketization in Rural Africa*

Shunsuke Tsuda†
Brown University

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Abstract

This paper investigates long-term effects of a mass refugee inflow on agricultural households through local labor and crop market interactions. I exploit a natural experiment Tanzania faced when it experienced a refugee inflow from Burundi and Rwanda in the early 1990s. This refugee inflow is distinguishable from a general migration context in terms of food aid and infrastructure development around refugee camps. Empirical analyses using the long-term panel data from refugee-hosting economies, in conjunction with the non-separable household model, show that the refugee inflow causes both benefits and losses for local farmers. The refugee inflow tightens the off-farm labor market participation constraint, implying an increase in surplus farm labor and labor market inefficiency. On the other hand, the refugee inflow has a positive effect on the transition from subsistence into crop marketization. In the long run, this transition is revealed to be primarily due to the decrease in fixed crop market transaction costs, rather than consumption demand shifts. Since the "surplus farm labor effect" and "crop marketization effect" work in opposite directions, the overall impact of the refugee inflow on agricultural labor productivity is insignificant.

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†A Ph.D. student in economics. Contact: Shunsuke_Tsuda@brown.edu

1 Introduction

Civil wars, associated refugee movements, and their interaction with local economic activities are key issues that many developing countries are facing. A third of sub-Saharan African countries have experienced civil wars during the mid-1990s in the last century (Blattman and Miguel 2010). UNHCR (2016) reports that 84% of the world's refugees, about 14.5 million refugees, are hosted by developing areas in 2016. Several influential research have investigated the effects of refugee flows on conflict diffusion (e.g., Salehyan and Gleditsch 2006) or on labor markets in developed nations (e.g., Card 1990; Foged and Peri 2016). On the other hand, little is known about how refugee flows shape local market conditions and household behavior in developing economies. Many conflicts and refugee settlements have been observed in rural areas in Africa and we are facing the "refugee crisis" in Middle East which has caught the world's attention. At the same time, a significant portion of households engages in subsistence agriculture in rural Africa, with much lower productivity than the rest of the world (Udry 2010). Uncovering the linkage between refugee settlements and agricultural household behavior through local market interactions and associated shifts in agricultural productivity, efficiency, and welfare is thus essential from the perspectives of both peace keeping in conflict-prone society and rural development process.

From a micro perspective, selling crops at a market is a significant income source for households in rural developing areas. Crop market participation is, however, naturally constrained by various kinds of transactions costs regarding market access (Barrett 2008; de Janvry and Sadoulet 2006). Factor markets such as the labor market also play significant roles in structural transformation, which is still under process in Africa and receiving a high degree of research attention (Barrett et al. 2018). Historically, transaction costs have been regarded as a significant economic factor. Coase (1937) observed that transaction costs have played central roles for various organizations of economic activities and explain much of the household and firm behaviors. Conceptually, refugee inflow can work to either increase or decrease market transaction costs. It is important to empirically investigate which is the case in each market.

Based on this big picture, this paper attempts to answer the following questions. Does refugee inflow benefit or hurt hosting farmers through local market interactions in the long run? Is market efficiency improved or exacerbated? If so, in which market? This paper empirically investigates mechanisms of long-term effects of a large-scale refugee inflow due to one of the largest political shocks in recent

African history on agricultural household behavior through local output and factor market interactions. I examine them by analyzing the conventional non-separable agricultural household model with labor and crop market transactions costs. Specifically, I exploit the following natural experiment that Tanzania experienced: there was a sudden and unexpected (at least to local Tanzanian farmers) refugee inflow from Burundi and Rwanda into the northwest region of Tanzania in 1994[1]. The effects of this refugee inflow are distinguishable from general migration context due to the following two facts: first, surrounding areas of refugee camps have experienced infrastructure development by aid agencies (Whitaker 1999; Maystadt and Duranton 2016); second, food aid which significantly increased in response to this refugee inflow is concentrated in maize (Alix-Garcia and Saah 2010; WFP FAIS). These two shifts in economic conditions can thus be regarded as a natural experiment which generate the following two aspects: (A) *Transaction costs (such as market access, information, commuting costs) are decreased for output and factor market transactions*; (B) *Consumption demand growth of maize produced by local farmers is relatively low compared with other major crops.* Using a long-term dataset from the northwest region in Tanzania, this paper conducts empirical analyses in conjunction with the household model to answer the above questions.

Refugee inflow can affect local farmers through mainly the following three dimensions. First, through the labor market, because refugee inflow means labor inflow. Second, through the crop market, because refugee inflow means an increase in food consumption demand. Its effect would also be affected by crop composition of food aid. Third, through market transactions costs. Market transactions costs can either decrease (due to the better infrastructure around refugee camps) or increase (due to different ethnicities in labor market, security concern, etc). In such an environment with imperfect factor and output markets and high market transactions costs, a standard labor economics type model to predict the effect of immigration on host economies cannot apply. Rather, a non-separable agricultural household model with market transaction costs, in which households simultaneously make their consumption and production decisions, is useful[2]. This helps us predict household-level market participating behavior in response to the shifts in

[1]Several researchers already have the consensus that this is regarded as a natural experiment (e.g., Baez 2011; Maystadt and Verwimp 2014). I describe the plausibility of regarding this phenomenon as a natural experiment based on their arguments in the later section.

[2]The models with similar motivations are for example, Benjamin (1992), de Janvry et al. (1991), Key et al. (2000), Renkow et al. (2004), etc. The previous literature also widely argues that rural economies in Africa are often characterized by imperfect or missing markets (e.g., Binswanger and McIntire 1987; Binswanger and Townsend 2000; Fafchamps 1993;

local economic conditions and identify the presence and shift of labor and crop market transactions costs in combination with data.

The northwest region of Tanzania called *Kagera* region is a remote agrarian economy where many households engage in subsistence agriculture. I use Kagera Health and Development Survey (KHDS). This is a long-term household-level panel data conducted in Kagera region in Tanzania. I use two waves of this dataset, 1993 (pre-shock: before the refugee inflow) and 2004 (post-shock: after the refugee inflow). The data shows that crop subsistence is prevalent over time. Hired farm labor and off-farm labor market participation are also very few. Taking advantage of having time allocation information in this data, I estimate shadow wages of adult male and female labor of household agricultural production following Jacoby (1993) and Skoufias (1994). I employ conventional difference-in-difference strategy to estimate the impacts of refugee inflow on labor market efficiency, crop marketization, and agricultural productivity. Estimated shadow wages come into play for the investigation of labor market efficiency. For crop marketization, I mainly focus on the three common crops produced in this area: maize (the main aid food crop); bean (a main food crop complementary for the main aid crop); coffee (main cash crop). Empirical analyses examine whether initially subsistence farmers for each crop are more likely to experience transitions into sellers in the refugee inflow area.

The empirical results show that there are important shifts in both labor and crop market conditions caused by the refugee settlement. For the labor market, the refugee inflow tightens off-farm labor market participation constraint. That is, the refugee inflow has a positive impact on the degree of labor market friction. In another word, the "surplus farm labor" is increased by the refugee inflow, implying the efficiency loss in labor markets. For the crop market, the refugee inflow positively affects the transition from subsistence into sellers of main market-oriented food crops, maize and beans. This effect is especially stronger for beans, a crop which is complementary for the main food aid crop, maize. This result implies that food aid crop composition matters for marketization of local farmers in refugee hosting economies. Investigations into possible mechanisms reveal that the observed crop marketization is primarily due to the decrease in fixed market transaction costs, rather than that in proportional transactions costs or the effect of consumption demand shifts. In addition to the physical infrastructure, past experience of a crop marketization (after the refugee inflow in the short run) and its resulting information gain might decrease

Platteau et al. 1998; Udry 1996).

the fixed transaction cost and thus facilitate marketization of such a crop even in the long run. The presence of the effect accruing to the infrastructure development around refugee camps is additionally supported by looking at marketization of coffee, which is a main exporting crop and thus less responsive to local demand and food aid effects.

Finally, the two main results, the "surplus farm labor" effect and the "crop marketization effect" affect agricultural labor productivity in opposite directions. The direct investigation on agricultural labor productivity of local farm households reveals that the total effect of the refugee inflow on it is insignificant. This result implies that the two competing forces offset each other. Therefore, the answer to the primary research question is that the refugee inflow can hurt local farmers in terms of labor market environments. It can also benefit local farmers in terms of crop market transactions due to the decrease in market transaction costs around refugee camps. In total, in terms of agricultural labor productivity, the answer is indeterminate. Rather, an important implication of the results is the distributional impacts attributed to different markets.

This paper contributes to two strands of the literature. The first set is the large literature regarding the empirical applications of non-separable agricultural household models with particular focuses on transaction costs and market participations. Within this literature, this paper's contribution consists of two aspects. Firstly, the investigation into labor market inefficiencies in rural developing areas. This test was previously conducted by Jacoby (1993), Skoufias (1994) and Barrett et al. (2008). They use only short-period data and their empirical results are conflicting. This paper contributes to those studies by examining how the gap between the shadow and market wages is changed by exploiting an exogenous shifter of labor market transaction costs in the long run. More generally, this paper adds to the literature on the tests of separation (Dillon et al. 2017, LaFave and Thomas 2016, and the references therein). This study provides a new evidence that a large-scale political shock shapes conditions organizing the non-separability of agricultural households in the long run. Secondly, the relationship between various transactions costs and crop market participation. Most papers focus on estimating the effect of transaction costs on crop market participation in the very short run or measuring transaction costs (e.g. Goetz 1992; Key et al. 2000; Renkow et al. 2004). Other papers, such as Jacoby (2000) and Jacoby and Minten (2009), focus on measuring the benefits of road infrastructure and the effect of lowering transportation

costs in a short run. There are three potential spaces for contributing to the literature. First, there is a potential endogeneity problem of transactions costs or transportation infrastructure. Second, short-run studies might be missing adjustment time taken by households. Shifting production structure or market participation regimes are not easy and would require time. Shamdasani (2016) is an exceptional study using a long-term panel data from India to see the relationship between rural transportation and agricultural production, which complements this study. Third, a shift in a transaction cost in a particular market, say crop market, can also change a transaction cost in another market, say labor market, at the same time. Many existing studies look at only one-sided aspect of them. This paper contributes to the literature by exploiting the exogenous nature of a natural experiment, using the longer-term panel data, and investigating in both crop and labor market transactions costs in detail.

The second set of literature is the economics of conflict literature which discusses effects of conflicts on local population. A comprehensive review is found in Blattman and Miguel (2010). This paper uncovers spillover effects of an ethnic conflict on a neighbor agrarian economy which tends to be overlooked. Related to this literature, this paper contributes to researches on the economic effects of refugees (e.g., Card 1990; Foged and Peri 2016; Tumen 2016). A few studies have also been conducted in the context of the refugees from Burundi and Rwanda in Tanzania. Baez (2011) showed that the refugee inflow has negative effects on child health, and Maystadt and Verwimp (2014) and Maystadt and Duranton (2016) showed the positive effects on consumption levels in the host economies. These results are somewhat inconsistent and it has not yet been concluded whether the refugee inflow can benefit or hurt local farmers. Specifically, the internal mechanisms behind them are unclear.

The rest of the paper proceeds as follows. Section 2 provides the simple analytical framework based on the non-separable agricultural household model with market transactions costs. Section 3 introduces the local context, describes the data and study area, and shows descriptive evidence. Section 4 describes empirical strategies. Section 5 presents main empirical results. Section 6 conducts robustness checks of the main empirical analyses and investigates additional mechanisms. Finally, Section 7 concludes the paper, discusses policy implications, and provides future research directions.

2 Conceptual Framework

I analyze how the refugee inflow affects agricultural households in hosting economies through output and factor market interactions. I provide the simplest theoretical framework using the conventional agricultural household model (e.g., de Janvry et al. 1991). As the data will show in the next section, households in Kagera region, a remote rural region in Tanizania, are characterized as subsistence behavior in that many of them do not participate in labor and/or crop markets[3]. The focuses in this setting are thus subsistence behavior, labor and crop market transactions costs and participations, and internal wage responses. The model incorporates the non-separability in which households make their production and consumption decision simultaneously. This framework is a partial equilibrium framework in that households take market conditions (market prices and transactions costs) as exogenously given. First, I focus on households' labor market interactions while abstracting their crop market interactions. Second, I focus on households' crop market interactions while postulating the missing labor market environment. Finally, I discuss the aggregate impact of the refugee inflow on agricultural labor productivity, which is a composite of the effects through labor and crop market interactions.

2.1 Labor Market Transactions Costs and Efficiency

I introduce two types of labor market transaction costs. The framework here is then used to identify the presence and change of the transaction cost from data. Note that I simplify the crop market transactions

[3]This situation is also consistent with other settings in Sub-Saharan Africa disscussed in the previous literature (e.g., Binswanger and McIntire 1987; Binswanger and Townsend 2000; Fafchamps 1993; Platteau et al. 1998; Udry 1996).

here for brevity of exposition. A unitary household i solves the following utility maximization problem[4]:

$$\begin{aligned} \max_{c,l,L,L_0} \quad & u(c, l; z_u) \\ \text{s.t.} \quad pc \leq pq + [w(z_l, z_u) - t_l(z_l, z_u)]L_o + M \\ q \leq F(L, A; z_q) \\ l + L + L_o \leq T \\ 0 \leq L_o \leq \bar{L}(z_l, z_u) \end{aligned} \tag{1}$$

where c is the composite of crops with its price p, l and L are leisure and family farm labor, L_o represents off-farm work with market wage w, M is non-labor income, and T is time endowment. Amount of family farm crop production is q organized by a production technology $F()$ with standard characteristics. The farm production use labor input and other fixed inputs A such as land holdings and capital. z_u is household-specific shifters of demand and transaction costs, z_l is labor market-specific shifters of market transaction costs, and z_q is production shifters. Note that all variables are household-specific. I am omitting the notation of household i for simplicity of exposition.

There are two types of labor market transaction costs: (I) proportional transaction cost ($t_l(z_l, z_u)$) and (II) off-farm labor market participation constraint ($\bar{L}(z_l, z_u)$). The proportional transaction cost implies that the return to off-farm employment is proportionally subtracted by a certain amount. The clearest example is the transportation cost from the household location to the work location. The worker gains a daily wage minus a commuting cost in each day he worked outside the household. The participation constraint states that the amount that the household member can work outside the household is limited by a certain amount, due to some institutional reasons. Market wages and these two types of transactions costs might conceptually depend on labor market environments z_l and household characteristics in z_u (such as ethnicity and skills). For notational simplicity, I omit writing them in brackets for market wages and transactions costs hereafter. The market wage and two types of transactions costs are taken as exogenous for each household.

[4]Another possibility that the refugee inflow affects agricultural households in a host economy is via hiring refugees as their farm labor. This part is not incorporated in the model as the data shows that hiring labor is uncommon and that it is not affected by the refugee inflow.

The shadow wage of family farm labor can be expressed as:

$$w^*\Big(\equiv p\frac{\partial F(L,A;z_q)}{\partial L}\Big) = \begin{cases} w - t_l + \frac{\eta}{\lambda} & \text{if } L_o = 0 \\ w - t_l & \text{if } 0 < L_o < \bar{L} \\ w - t_l - \frac{\mu}{\lambda} & \text{if } L_o = \bar{L} \end{cases} \tag{2}$$

Using the shadow wage, the household's full income constraint is then

$$pc + w^*l = pq + w\bar{L} + w^*(T - \bar{L} - L) \equiv y^*$$

I consider the situation where off-farm market wage is sufficiently higher than family farm shadow wages in any cases, which is indeed consistent with the data. The (household-specific) measure of labor market efficiency is then characterized by the wage gap between the market wage and shadow wage, $w - w^*(> 0)$. Naturally, the aggregation of each household-specific wage gap into a district-level can convey information on the overall labor market efficiency in that district. When the off-farm employment constraint ($\bar{L}$) is not binding, the proportional transaction cost (t_l) constitutes the wage gap. When the off-farm employment constraint is binding, the shift of the constraint affects a household's wage gap as follows:

$$\frac{d(w - w^*)}{d\bar{L}} = \frac{\frac{\partial l}{\partial y^*}(w - w^*)}{\frac{\partial L}{\partial w^*} + \frac{\partial l}{\partial w^*} + \frac{\partial l}{\partial y^*}(T - \bar{L} - L)} < 0$$

if the substitution effect of wage on leisure demand is sufficiently large relative to its income effect, which is likely to hold in a rural developing economy. If the same condition for the leisure demand holds,

$$\frac{dw^*}{dw} = -\frac{\frac{\partial l}{\partial y^*}\bar{L}}{\frac{\partial L}{\partial w^*} + \frac{\partial l}{\partial w^*} + \frac{\partial l}{\partial y^*}(T - \bar{L} - L)} > 0$$

Note that when the off-farm employment is not binding, the correlation between the market and shadow wages is one. On the other hand, when it is binding, depending on $\bar{L}$, the correlation can be very small. At the same time, the sign of the effect of market wage on the wage gap is ambiguous:

$$\frac{d(w - w^*)}{dw} = \frac{\frac{\partial L}{\partial w^*} + \frac{\partial l}{\partial w^*} + \frac{\partial l}{\partial y^*}(T - L)}{\frac{\partial L}{\partial w^*} + \frac{\partial l}{\partial w^*} + \frac{\partial l}{\partial y^*}(T - \bar{L} - L)}$$

Table 1 summarizes the directions of the effects of (A) market wage, (B) proportional transaction cost, and (C) labor market participation constraint on the three observables (a) labor market participation, (b) wage gap (market wage-shadow wage, among households which supply labor to both family farm and off-farm employment), and (c) correlation between market and shadow wages (among households which supply labor to both family farm and off-farm employment). On the one hand, the refugee camp construction and the resulting infrastructure development would reduce transportation costs faced by workers, which leads to the reduction of the proportional transaction cost t_l. On the other hand, since the refugee-hosting area has come to have mixed ethnic composition in local labor market, some kind of fixed transaction cost might also rise if assimilation is failed. This effect can be reflected in the decrease in $\bar{L}$. Directly measuring t_l and $\bar{L}$ is not possible. However, the three observables (a)-(c) in Table 1 from data infer the presence and the shift of these labor market transactions costs in a relative sense.

Table 1: Shifts in Observables by Changes in Labor Market Conditions

	(a) Labor market participation	(b) Wage gap (: $w - w^*$)	(c) Correlation between wages
(A) $w \uparrow \mid t, \bar{L}$	(i) + (ii) $\sim$	(i) $\sim$ (ii) ?	(i) $\sim$ (ii) ?
(B) $t \uparrow \mid w, \bar{L}$	(i) – (ii) $\sim$	(i) + (ii) +	(i) $\sim$ (ii) ?
(C) $\bar{L} \downarrow \mid w, t$	(i) $\sim$ (ii) –	(i) $\sim$ (ii) +	(i) $\sim$ (ii) ?
(i) $\bar{L}$ does not bind			+
(ii) $\bar{L}$ binds			(+)

Notes: (i) and (ii) correspond with two cases where (i) $\bar{L}$ is sufficiently high so that the participation constraint does not bind in the optimal household labor allocation and (ii) otherwise.

2.2 Crop Market Transactions Costs and Participations

Following Key et al. (2000), consider two types of crop market transactions costs: (I) proportional transaction costs (PTC) and (II) fixed transaction costs (FTCs). I postulate the missing labor market environment as our focus is crop market in this subsection. A household's problem is characterized as

follows:

$$\max_{\{c_j\},l,\{L_j\},\delta_j^s,\delta_j^b} \quad u(\mathrm{c}, l; z_u) \tag{3}$$

$$\text{s.t.} \quad \sum_j [p_j m_j - FTC_j^s \cdot \delta_j^s - FTC_j^b \cdot \delta_j^b] + M = 0$$

$$c_j \leq q_j - m_j \quad \forall j$$

$$q_j \leq F^j(L^j, A^j; z_q^j) \quad \forall j$$

$$l + \sum_j L^j \leq T$$

where j represents crop and m_j is the net sales of crop j (i.e., it takes negative if a household is a buyer of crop j). FTC_j^s and FTC_j^b are the income equivalent of fixed transaction of selling and buying crop j, respectively. δ_j^s and δ_j^b are the indicator functions which take one if a household is a net seller and buyer of crop j, respectively. Note that $\delta_j^s \cdot \delta_j^b = 0$ by construction. With proportional transactions costs, $p_j = p_j^m - PTC_j^s$ if a household is a net seller of crop j and $p_j = p_j^m + PTC_j^b$ if a household is a net buyer of crop j where p_k^m is the market price of crop jm, and PTC_j^s and PTC_j^b are the proportional transactions costs of selling and buying crop j. A household solves this problem following the two-step procedure. First, a household derives its optimal condition based on each crop market participation regime. Next, the household chooses its optimal market participation regime for each crop j.

Letting λ and μ_j be the Lagrange multipliers of the first and the second constraints, the household's decision price of crop j is

$$p_j^* = \begin{cases} p_j = p_j^m - PTC_j^s & \text{if } m_j > 0 \text{ (seller)} \\ \tilde{p_j} = \frac{\mu_j}{\lambda} & \text{if } m_j = 0 \text{ (autarky)} \\ p_j = p_j^m + PTC_j^b & \text{if } m_j < 0 \text{ (buyer)} \end{cases} \tag{4}$$

where $\tilde{p_j}$ is the household-specific shadow price of crop j in the case of subsistence, which corresponds to the marginal utility of endowment in crop j evaluated by the marginal utility of cash income. Using the resulting crop decision prices and a shadow wage, the household's problem can then be expressed as the following two-step problem in which the production and consumption decisions are separable:

Step 1 Solve the profit maximization problem with the crop decision prices and the shadow wage subject

to the technology constraint (the third constraint in (3)). This derives the system of crop supply and farm labor demand functions: $q^{j*} = q^j(p_j^*, w^*; z_q^j)$, $L^{j*} = L^j(p_j^*, w^*; z_q^j)$.

Step 2 Solve the utility maximization problem subject to the full income constraint measured at the decision prices and output supply and factor demand functions:

$$\begin{aligned}\sum_j [p_j^* c_j] + w^* l &= \sum_j [p_j^* q^j(p_j^*, w^*; z_q^j) - w^* L^j(p_j^*, w^*; z_q^j)] + w^* T + M - \sum_j [FTC_j^s \cdot \delta_j^s + FTC_j^b \cdot \delta_j^b] \\ &\equiv y^*\end{aligned}$$

This derives the system of consumption demand functions: $c^{j*} = c_j(\mathrm{p}^*, w^*, y^*)$ (and $l^* = l(\mathrm{p}^*, w^*, y^*) = T - \sum_j L^{j*}$)

Let us now consider crop k's regime choice. Denote the full income before incurring the fixed market transaction cost of crop k by:

$$y_k^*(\mathrm{p}^*, w^*) \equiv \sum_j [p_j^* q^j(p_j^*, w^*; z_q^j) - w^* L^j(p_j^*, w^*; z_q^j)] + w^* T + M - \sum_{j \neq k} [FTC_j^s \cdot \delta_j^s + FTC_j^b \cdot \delta_j^b]$$

Then, letting $V(\mathrm{p}^*, w^*, y^*, z_u)$ be the indirect utility function, the maximum utility attained by each regime of crop k is expressed as:

$$\begin{aligned}V_k^s &= V(p_k, p_{-k}^*, w^{s*}, y_k^*(p_k, p_{-k}^*, w^{s*}) - FTC_k^s; z_u) \quad \text{if net seller of crop } k \\ V_k^b &= V(p_k, p_{-k}^*, w^{b*}, y_k^*(p_k, p_{-k}^*, w^{b*}) - FTC_k^b; z_u) \quad \text{if net buyer of crop } k \\ V_k^a &= V(\tilde{p_k}, p_{-k}^*, w^*, y_k^*(\tilde{p_k}, p_{-k}^*, w^*); z_u) \quad \text{if subsistence for crop } k\end{aligned}$$

Note that the shadow wages in different crop market participation regimes (w^{s*}, w^{b*}, w^*) might also differ. Define $\bar{p_k^s}$ and $\bar{p_k^b}$ as:

$$\begin{aligned}V(\bar{p_k^s}, p_{-k}^*, w^*, y_k^*(\bar{p_k^s}, p_{-k}^*, w^*) - FTC_k^s; z_u) &= V(\tilde{p_k}, p_{-k}^*, w^*, y_k^*(\tilde{p_k}, p_{-k}^*, w^*); z_u) \\ V(\bar{p_k^b}, p_{-k}^*, w^*, y_k^*(\bar{p_k^b}, p_{-k}^*, w^*) - FTC_k^b; z_u) &= V(\tilde{p_k}, p_{-k}^*, w^*, y_k^*(\tilde{p_k}, p_{-k}^*, w^*); z_u)\end{aligned}$$

In words, $\bar{p_k^s} - \tilde{p_k} (> 0)$ measures the ad-valorem amount that a household must need to cover the fixed

cost of entry into the market of crop k as a seller(, keeping the internal price of labor same value). The indirect utility is increasing in crop k's price for its net sellers:

$$\begin{aligned}\frac{dV}{dp_k} &= \frac{\partial V}{\partial y^*}\Big\{\big(\frac{\partial V/\partial p_k}{\partial V/\partial y^*} + q^{k*}\big) + \big(\frac{\partial V/\partial w^{s*}}{\partial V/\partial y^*} + T - \sum_j L^{*j}\big)\Big\} \\ &= \frac{\partial V}{\partial y^*} \underbrace{(q^{k*} - c^{k*})}_{\text{market surplus}} > 0\end{aligned}$$

where the second equality follows from the Roy's identity and the time constraint. Similarly, the indirect utility is decreasing in crop k's price for its net buyers. Therefore, the household's regime choice of crop k becomes:

$$\begin{aligned}&\text{Net seller of crop } k \text{ if} && p_k^m - PTC_k^s > \bar{p_k^s} \Leftrightarrow p_k^m > \bar{p_k^s} + PTC_k^s \\ &\text{Net buyer of crop } k \text{ if} && p_k^m + PTC_k^b < \bar{p_k^b} \Leftrightarrow p_k^m < \bar{p_k^b} - PTC_k^b \\ &\text{Subsistence for crop } k \text{ if} && \bar{p_k^b} - PTC_k^b < p_k^m < \bar{p_k^s} + PTC_k^s\end{aligned} \tag{5}$$

The primary interest lies on the transition from subsistence into sellers of crops as a significant way of raising income sources. Since $\frac{\partial \bar{p_k^s}}{\partial FTC_k^s} = \frac{1}{q^{k*} - c^{k*}} > 0$, as the fixed market transaction cost decreases, the first inequality in (5) is ceteris paribus more likely to hold. Obviously, the inequality is also more likely to hold as the proportional market transaction cost decreases. It is not possible to directly observe from the data which type of the transaction costs has shifted due to the refugee camp construction and the resulting infrastructure development around it. The notable difference is that, *conditional on* being net sellers, the shift in the fixed market transaction cost does not affect crop supply, while the proportional transaction cost does. Therefore, this simple framework generates the following two empirical predictions.

Prediction 1. Among crop subsistence households before the refugee inflow, those located in the refugee-hosting areas will be ceteris paribus more likely to become crop sellers after the refugee inflow.

Prediction 2. If the proportional transaction cost is significantly reduced in the refugee-hosting areas, the overall crop supply by households in those areas will be higher. If only the fixed transaction cost is

reduced in those areas, such a difference in the overall crop supply between the refugee and non-refugee areas will become weaker.

If the refugee-areas has experienced the decrease in either proportional or fixed transaction cost, or both, the first prediction follows. Its magnitude is an empirically important question. By looking at the overall crop supply in the data, whether the effect of proportional transaction costs is significant is investigated. Understanding which type of transaction costs is working is also an important empirical agenda.

Finally, I describe the shift in crop k's decision price and resulting shadow wage response faced by a household if it transits from crop k subsistence into a seller due to the decrease in the fixed transaction cost[5]. Suppose that initially (before the refugee inflow) the fixed transaction cost of selling crop k was FTC_k^s and a household selected into subsistence for crop k. Suppose also that after the refugee inflow the fixed transaction cost was reduced to $FTC_k'^s$ and the household selected into a crop k seller. Note that given other conditions fixed, the shift in the fixed transaction cost does not change the household's internal price of crop k and indirect utility in case it chose subsistence. Then, defining $\bar{p_k'^s}(< \bar{p_k^s})$ similarly as before, the indirect utility level of subsistence is written as:

$$\begin{aligned} V(\tilde{p_k}, p_{-k}^*, w^*, y_k^*(\tilde{p_k}, p_{-k}^*, w^*); z_u) &= V(\bar{p_k^s}, p_{-k}^*, w^*, y_k^*(\bar{p_k^s}, p_{-k}^*, w^*) - FTC_k^s; z_u) \\ &= V(\bar{p_k'^s}, p_{-k}^*, w^*, y_k^*(\bar{p_k'^s}, p_{-k}^*, w^*) - FTC_k'^s; z_u) \\ &< V(p_k, p_{-k}^*, w^{s*}, y_k^*(p_k, p_{-k}^*, w^{s*}) - FTC_k'^s; z_u) \end{aligned} \tag{6}$$

Therefore, given other conditions fixed (including $FTC's_k$), it can be restated that the crop k's *decision price* faced by a household as a market seller increased from $\bar{p_k'^s}$ to p_k from before to after the refugee inflow.

$$\frac{dw^*}{dp^k} = -\frac{\frac{\partial L^k}{\partial p_k} + \frac{\partial l}{\partial p_k} + \frac{\partial l}{\partial y^*} q_k^*}{\sum_j \frac{\partial L^j}{\partial w^*} + \frac{\partial l}{\partial w^*} + \frac{\partial l}{\partial y^*}(T - \sum_j L^{j*})} > 0$$

if the substitution effect of wage on leisure demand is sufficiently large relative to its income effect and food consumption and leisure are substitutes.

[5]In case of the shift of proportional transactions costs or market prices, the argument is similar and simpler.

2.3 Overall Implication for Agricultural Labor Productivity

In a real situation, the total effect of the refugee settlement on agricultural labor productivity of local farmers comes both through the labor and crop market interactions described so far. The shadow wage w^*, the marginal product of labor, is a straightforward measure of the agricultural labor productivity. Therefore, letting $\bar{b}$ be an exogenous variable (from the perspective of local farmers) regarding the labor market condition and p^* be the (household-specific) decision price of a main crop, the total effect of the refugee inflow can be expressed as:

$$\frac{dw^*}{d\,refugee} \approx \underbrace{\frac{d\bar{b}}{d\,refugee}\frac{\partial w^*}{\partial \bar{b}}}_{\text{Labor market effect}} + \underbrace{\frac{dp^*}{d\,refugee}\frac{\partial w^*}{\partial p^*}}_{\text{Crop market effect}} \tag{7}$$

where $\bar{b}$ can be the market wage (w), the proportional transaction cost of labor (t_l), or the off-farm labor market participation constraint ($\bar{L}$). Note that the second term, the crop market effect on shadow wage, vanishes if the off-farm labor market participation constraint ($\bar{L}$) is not binding. The model in the previous subsection with missing labor market oorresponds to the special case where $\bar{L}$=0. The same analysis of the price effect on shadow wage can apply as long as $\bar{L}$ is binding[6].

An insightful illustration in the constrained environment is example is shown in Figure 1. As a clear example, suppose that the refugee inflow (1) tightens the off-farm employment constraint ("surplus farm labor effect") and (2) increases the crop decision price ("crop marketization effect")[7]. The exogenous market wage rate (net of the proportional labor transaction cost) is denoted by w. $\tilde{L}$ is the profit-maximizing level of family labor in which the marginal product of labor equals to the market wage rate. The binding off-farm employment constraint makes the household problem non-separable between consumption and production. In this case the optimal farm labor supply L^* might differ from $\tilde{L}$. w^* is the initial internal wage before any changes. After the refugee inflow, the resulting internal wage with the effects of (1) and (2) is $w^{*\prime\prime}$. This total effect can be decomposed as follows. The effect of (1) on the

[6]On the other hand, if a household is autarky for a crop, then the term $\frac{\partial w^*}{\partial \bar{b}}$ in the labor market effect includes the feedback effect from the shadow crop price. In that case, the sign of $\frac{\partial w^*}{\partial \bar{b}}$ is likely to be kept unchanged under standard assumptions. See Sonoda (2004) for a detail discussion.

[7]The increase in a household's crop decision price can come from any of the following three sources or a combination of them: (i) an increase in the market crop price; (ii) a decrease in the proportional transaction cost; (iii) a decrease in the fixed transaction (and the resulting transition from subsistence into a seller). I empirically investigate which effect is dominating in the later section.

internal wage is $w^{*\prime} - w^{*}$ and the additional effect of (2) is $w^{*\prime\prime} - w^{*\prime}$. In this case, it is expected that $w^{*} > w^{*\prime} < w^{*\prime\prime}$. That is, the "surplus farm labor effect" and the "crop marketization effect" caused by the refugee inflow can shift the internal wage into opposite directions. Attributing the effect of the refugee inflow solely on labor market mechanism would thus miss an essential element in a rural developing area.

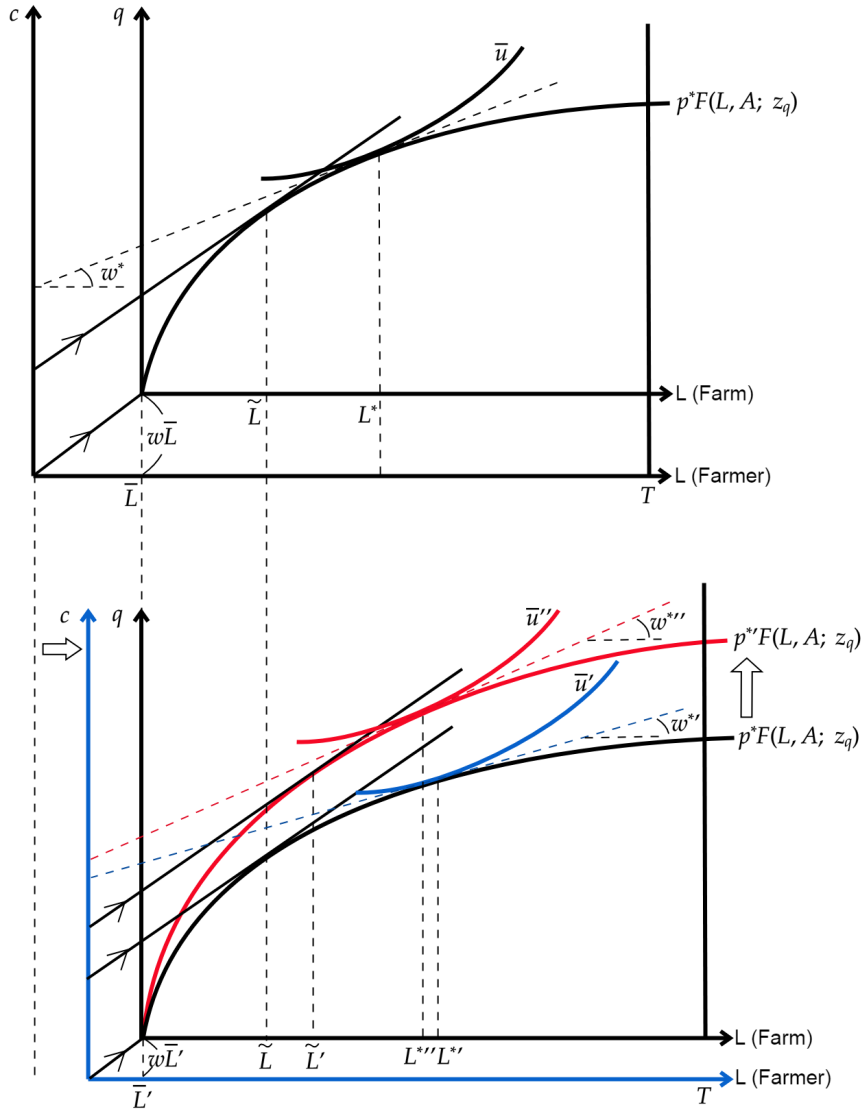

Figure 1: Illustration of the effect of refugee inflow on agricultural labor productivity

3 Institutional Setting, Data, and Descriptive Evidences

3.1 Civil Wars, Refugee Inflow into Tanzania, and Food Aid

In the early 1990s, Tanzania and Democratic Republic of the Congo experienced large-scale refugee inflow from two neighboring countries, Burundi and Rwanda, due to Burundian civil war and Rwandan civil war (UNHCR 2000). These civil wars are classified as ethnic conflicts, between Hutu and Tutsi ethnicities. In Tanzania, the two western areas near borders with Rwanda and Burundi, Kagera region and Kigoma region, received a mass of exodus. Kagera region, the area of my analysis, is located in the northwestern part in Tanzania, between Lake Victoria, Uganda, Rwanda and Burundi. Kagera region is characterized as one of the poorest and the most remote areas in Tanzania depending mostly on agricultural activity (de Weerdt 2009). Kagera region is shown in Figure 2.

The flood of refugee inflow occurred mainly twice in the early 1990s. The first wave is when between 250,000 and 300,000 Burundian Hutu refugees came into Tanzania after October 21, 1993. This refugee inflow was triggered by the assassination of the democratically elected president Mekchior Ndadaye with Hutu ethnicity in Burundi by Tutsi extremists. This event was also a trigger for the genocide by Hutu resulting in the long-term Burundian civil war lasting to 2005. The second wave is when about 250,000 Rwandan refugees fled into Tanzania within 24 hours from April 28, 1994 (Rutinwa, 2002). This sudden refugee inflow is closely related to the initiation of the Rwandan genocide, triggered by the crash of the airplane carrying the presidents of Burundi and Rwanda. In addition, following that Tutsi Rwandan Patriotic Front (RPF) finally gained the control of the country and established the new government led by Paul Kagame at the end of the genocide on July 1994, another nearly million Hutu ethnic refugees were fleeing Rwanda to escape from the revenge by Tutsi ethnics, known as so called “Great Lakes Refugee Crisis”. As a result, about 700,000 refugees remained in Kagera in 1995 where the local population size at that time was about 1.5 million, which means that nearly half of the Kagera population were refugees at the peak (Maystadt and Verwimp 2014). After the repatriation of Rwandan refugees in 1996, about 500,000 Rwandan and Burundian refugees have been steadily remaining in Tanzania (UNHCR, 2000). Locations of the refugee camps are shown in Figure 3.

In response to these refugee inflow, food aid into Tanzania has drastically increased in 1994. The

total amount of food aid into Tanzania and its crop composition are shown in Figure 4 (and Table 16 in Appendix A for precise numbers) obtained from Food Aid Information System, World Food Programme. As is apparent from Figure 4, the amount of maize has a significant share in food aid delivered to Tanzania in any period. Maize is also one of the main crops produced by local farmers in Kagera region as shown in the later subsection. Therefore, this crop composition of food aid concentrating on maize has an important implication that the increase in demand of maize *produced by local farmers* would be relatively low compared to other main food crops.

3.2 Data: Kagera Health and Development Survey (KHDS)

Kagera Health and Development Survey (KHDS) collected by Economic Development Initiatives (EDI) and the World Bank is used throughout the empirical analyses in this paper[8]. This data is famous for one of the longest-term panel data in Africa, starting from Wave1 in 1991 and continuing to Wave5 in 2010. Within this span, the baseline survey at Wave 1 was conducted for 919 households and 6353 individuals in 1991. The two-step stratified random sampling was conducted. The 51 village clusters were chosen and then the almost equal number of the households with poverty status were surveyed from each village cluster. One unique feature of this data is the very high tracking rates. In the follow up survey in 2004, 832 households out of the original 919 households were re-interviewed and there became 2719 households in 2004 mainly due to the splits of the original households when children from the original households become adults and independent of the original households after their marriages. In terms of individuals, 88 percent of the original respondents were tracked. This dataset is on the basis of the LSMS survey of the World Bank and contains the comprehensive contents, e.g., education, health, migration, fertility, farming, non-farm household business, and consumption.

This paper relies on the following information from this dataset. First, the information on household-level agricultural activity plays a central role in my empirical analysis. This information includes family farm crop production, inputs, and crop market transactions. Second, the information on individual-level time allocation is used to capture labor allocation between family farm work and off-farm family wage employment. Combined with the information on crop production, this time allocation data is also

[8]The detail explanation of this dataset is found in Ainsworth et al. 2004 and Beegle et al. (2006).

used to estimate shadow wages of family farm labor. Finally, the information on the refugee settlements are obtained from two sources. One source is the community survey of KHDS, which collects the community-level information on whether there are any refugee settlements in the village, in the ward, or in a neighboring ward. Another source is a geographic information collected by another researcher, which is publicly available in the EDI website[9] This additional information contains the distance between the center of each village and each refugee camp. The main empirical analyses are conducted by the two-period panel data consisting of 1993 (the pre-shock period) and 2004 (the post-shock period) data[10]. Note that each of Wave 2 and Wave 3 contains the half-year information. Combining these two waves, I construct the annual data in 1993. The annual data from Wave 5 is used as the post-shock data in 2004. The quasi-balanced panel data is constructed by choosing households in 1993 and their related households in 2004. For main empirical analyses, I drop households which are observed in only either year and whose related households in the other year are not found. As is shown in the next subsection, households in the quasi-balance panel and in the whole sample share common characteristics in crop and labor market transaction patterns. Throughout the analyses, all quantitative measures are transformed into real values in 1991 TSHS using the Laspeyres index.

3.3 Descriptive Statistics

Table 2 summarizes the basic geographic information. According to the 1988 Tanzanian census data, the total population size of this region was about 1.4 million in 1988, and this region consists of 4 geographic zones (Tree Crop zone, Riverine zone, Annual Crop zone and Urban zone), 6 districts (Karagwe, Bukoba Rural, Bukoba Urban, Muleba, Biharamu and Ngara), and about 550 villages with each village having about 500 households[11]. The tree crop zone is located in the northern part of Kagera and the main crops produced there are coffee and banana. The annual crop zone is located in the southern part of Kagera

[9]This geographic information is provided by Jean-Francois Maystadt and used by his papers (Maystadt and Verwimp 2014; Maystadt and Duranton 2016). I appreciate his generosity for making it publicly available.

[10]As a pre-shock period, the baseline data from 1991 seems to be useful as well. However, Tanzanian rural economies in the period between 1991 and 1993 are thought to be still susceptible to the government's agricultural reforms and liberalization which have been taking place during the 80's. Moreover, cooperative union activities have significantly declined by 1993 (Putterman 1995 and the references therein). The complicated shift in Tanzanian rural economies during 1991 and 1993 is preferred to be separated from the impact of the refugee settlement, the main focus of this paper. Therefore, I construct the two-period panel with 1993 and 2004.

[11]The 1988 census data is available in the publicly accessible KHDS data set explained in the next subsection.

and the main crops produced there are beans, cassava, and maize. The riverine zone is located between these two zones and the main crops produced there are also mixed between main crops in the these two zones. The refugee inflow is concentrated in the western part of Kagera simply because it is closer to the borders with Rwanda and Burundi. On the other hand, an important related fact is that the refugee inflow is not concentrated in either northern or southern region. That is, the variation in the intensity of refugee settlements is mostly across longitudes. Combining with the fact that geographic and thus agricultural characteristics do not significantly differ across longitudes within a same latitude, geographic zones which produce any of the main crops produced in Kagera region (coffee, banana, beans, cassava, and maize) have both refugee areas and non-refugee areas.

Table 3 summarizes the production of main crops by the sample households in three periods. In all the periods, it is apparent that coffee, banana, beans, cassava, and maize are common crops produced in this region, in terms of both the number of households and the mean of harvest amounts among producers. Moreover, comparing the total sample size and the number of observation of each crop production, it is apparent that significant portion of the sample households engage in joint production of multiple main crops.

Table 4 summarizes the market transaction patterns by the sample households focusing on crop and labor markets. Panel (A) looks at the quasi-panel sample used in the main empirical analyses and panel (B) looks at the whole sample from the two years. Crop market participation in this table is defined as whether the household sells at least one crop at a crop market. In both samples, we see increasing share of autarky households, decreasing share of households which use hired labor for family farms, and increasing share of households which supply labor to off-farm wage employment from 1993 (pre-shock) to 2004 (post-shock).

Table 5 summarizes market transaction patterns of main crops. panel (A) and panel (B) follow the same classification as the previous table. In both periods, the market transaction of the main cash crop, coffee, is most frequently observed. In addition, the market transaction of the market oriented food crop, maize, is increasing from 1993 to 2004. The other food crops also have low rate of market transactions, while their increasing or decreasing trends are unclear because they are slightly different across the two panels. Combining with the information on food consumption expenditure, Figure 5 shows the net sales

of each crop before (1993) and after (2004) the refugee inflow for main food crops. The net sales measure is the value of crop sales minus the value of crop purchased for each crop. The significant share of zero net sales in this figure represents subsisters which produce the crop but does neither sell nor buy that crop[12]. The distributions of net sales look very similar between the pre-shock and the post-shock periods over time. Both periods have significant share of subsistence households. Is this structure being affected by the refugee inflow? Figure 6 shows the same distributions in the post-shock period (2004) among households in the refugee inflow areas and other areas. I choose the post-shock households whose related households in the pre-shock period were subsisters (non-sellers) for each crop. This figure clearly shows that there are less proportions of subsistence farmers and more proportions of sellers for maize and beans in the refugee inflow areas in 2004. By contrast, there are more proportions of subsistence farmers for plantain in the refugee areas and there no visible distributional differences for cassava.

Table 6 summarizes labor market participation patterns. Not surprisingly, almost all agricultural households use family labor for their family farms. Having both off-farm wage employment and hired farm labor is also uncommon, implying that there would not be a significant heterogeneity of workers between family labor and hired labor in rural Africa. Table 7 summarizes gender-specific hourly wages that the sample agricultural households receive. This information consists of two sources. The first part is the observed hourly wage of off-farm wage employment The second part is the estimated shadow wage of family labor for own farm. The estimation procedure of the shadow wage simply follows the pioneer literature Jacoby (1993) and Skoufias (1994) for meaningful comparisons. The estimation procedure is described in Appendix B. Off-farm labor market participation is low. Off-farm labor market participation was very low in 1991 (baseline) and 1993 (pre-shock) but has been increased after 10 year in 2004 (post-shock). Especially, female labor market participation is much lower than male (less than half of male off-farm labor market participation) in both periods, and the market wage of male labor is mush higher than that of female in the post-shock period. On the other hand, female labor engage in farm production more than male and female shadow wage is higher than male in both 1993 (pre-shock) and 2004 (post-shock). Figure 7 shows the distributions of gender-specific shadow wages in 1993 and 2004 in the upper row and for crop sellers and subsisters in the post-shock period the lower row. As is the same pattern as the crop net sales distributions, the over all distributions of shadow wages look very similar over time for

[12]Note that, not surprisingly, the share of households which both sell and buy the same crop is extremely low.

both gender. The distribution is slightly shifted towards right among crop sellers relative to subsistence farmers. Figure 8 shows the distributions of gender-specific shadow wages in the post-shock period (2004) in refugee areas and other areas. Although this simple comparison cannot be solely from the causal effect of the refugee inflow, the clear difference between the two areas is importantly highlighted. For both male and female, the shadow wages are shifted towards right among households in non-refugee areas. This pattern is consistent with the hypothesis that the refugee inflow generated the "surplus farm labor" of local agricultural households.

4 Empirical Analyses

As the main identification strategy, I first emphasize the exogeneity of refugee treatment by exploiting the natural experimental setting of the refugee inflows. The following arguments augment the plausibility of this assumption. First, the massive exodus from Burundi and Rwanda were triggered by sudden political events, which were unrelated to and unexpected by local Tanzanian agricultural households residing in Kagera region. Second, the very large scale refugee inflow happened in the very short span (e.g. 250,000 Rwandan refugees within 24 hours in April 1994) made UNHCR almost impossible to search for places to locate the refugee camps where economic conditions around them are favorable, leading to the exogenous placements of the refugee settlements. Third, the plausibility of this exogeneity is agreed by the previous research in the same context (Baez 2011; Maystadt and Verwimp 2014; Maystadt and Duranton 2016).

4.1 Tests of Labor Market Efficiency

The test of labor market efficiency consists of the three observations, in conjunction with Table 1. I look at (1) the correlation between shadow and market wages, (2) the impact of the refugee inflow on the shadow and market wage gap, and (3) the impact of the refugee inflow on labor market participation for each gender.

The first test, which simply looks at the correlation between shadow and market wages, is conducted

by estimating the following regression:

$$\begin{aligned}\log Shadow\,Wage_{dhjt} = \alpha_{0j} + \alpha_{1j}X_{dht} + \alpha_{2j}Year2004_t + \alpha_{3j}\log MarketWage_{dht} \\ +\alpha_{4j}(\log MarketWage_{dht} \times Year2004_t) + \alpha_{5j}(Refugee_d \times Year2004_t) \\ +\alpha_{6j}(Refugee_d \times \log MarketWage_{dht} \times Year2004_t) + c + \epsilon_{dhjt}\end{aligned} \tag{8}$$

where d represents villages, h represents households, $j = m, f$ represents gender, and t represents time periods. $Refugee_d$ is the village-level treatment variable regarding refugee location, X_{dht} includes additional controls, and c represents village fixed effects or initial household fixed effects. The indications of efficiently functioning labor market are that $\alpha_{3j} > 0$ (wage equalization motive across multiple labor opportunities). Note that this coefficient of interest captures correlation, not a causal effect. Our interest here is also the correlation. α_{4j} looks at whether such equalization is promoted over time, α_{5j} looks at the impact of refugee inflow on shadow wages, and α_{6j} looks at how the wage equalization process over time is affected by the refugee inflow.

The second and third tests are conducted by estimating the impact of the refugee inflow on wage gap between market and shadow wages and the off-farm labor market participation. I estimate these impacts by the following difference-in-difference specification:

$$Y_{dhjt} = \beta_{0j} + \beta_{1j}X_{dht} + \beta_{2j}Year2004_t + \beta_{3j}(Refugee_d \times Year2004_t) + c + \epsilon_{dhjt} \tag{9}$$

where Y_{dhjt} takes ($|\log MarketWage_{dht} - \log Shadow\,Wage_{dhjt}|$[13]) and labor market participation dummies for each gender. For the former specification, the subsample of households which supply labor to both family farm and off-farm wage employment is used for the estimation.

The combinations of β_{3j}s in the two specifications in (9) and α_{3j} in (8) and the predictions in Table 1 help us identify the form of labor market transaction cost and its shift caused by the refugee inflow. As an example, suppose that we obtain $\beta_{3j} > 0$ for the wage gap equation and $\beta_{3j} < 0$ for the labor market participation. Then, according to Table 1, we cannot distinguish between the two possibilities: (i) the

[13]Taking the absolute value is for obtaining the size of labor market inefficiency, whichever wage is larger than the other. However, recall that wages of outside job are much higher than shadow wages of own-farm family labor as shown in the previous section. Therefore, taking the absolute value might be mostly redundant.

proportional labor market transaction cost (t) has increased in the environment where the labor market participation constraint ($\bar{L}$) is not binding; (ii) the labor market participation constraint has tightened in the environment where the constraint is binding. Adding the test of the correlation helps us identify which is the case. If (i) is the case, we should observe a strong correlation between shadow and market wages. If (ii) is the case, on the other hand, we should observe a much weaker correlation between them.

4.2 Food Crop Marketization

In order to estimate the impact of the refugee inflow on the transition from crop subsistence into marketization, I estimate the following equation:

$$Y_{dhjt} = \beta_{0j} + \beta_{1j} X_{dht} + \beta_{2j} Year2004_t + \beta_{3j}(Year2004_t \times Refugee_d) + c + \epsilon_{dhjt} \tag{10}$$

where j represents crop. The dependent variable Y_{dhjt} takes seller dummy, value of sales, fraction sold out of harvest, for each crop $j \in \{maize, beans, plantain, cassava\}$. For each crop-level estimation, I use the subsamples of the that crop's subsistence households in 1993 (pre-shock) and their related households in 2004 (post-shock). Note again that β_{3j}, the impact of the refugee inflow, captures two components: the food demand effect (due to the food aid composition in response to the refugee inflow) and the transaction cost effect (due to the infrastructure development around the refugee camps). If the latter effect is present, the empirical hypothesis is $\beta_{3j} > 0$ for all crops. However, crop-specific heterogeneous effect would be expected because of the food aid crop composition. Recall that maize has the significant share of food aid delivered into Tanzania in response to the refugee crisis. Given that beans consumption is complementary for maize, while plantain and cassava consumptions are relatively substitutable for maize, additional conjecture on the coefficient of interest is that $\beta_{3beans} > \beta_{3j}$ where $j \in \{maize, plantain, cassava\}$. On the other hand, the relationship between β_{3j} is not easily expected.

5 Results

The following three types of treatment variables are prepared: (i) a dummy which takes 1 if one of the refugee camps is located within 50km from center of the village where each household lives; (ii) a

dummy which takes 1 if one of the refugee camps is located within own ward or the neighborhood wards of the village where each household lives; (iii) log of the distance between center of the village where each household live and the nearest refugee camp. The treatment variable (i) is mainly used and its results are shown in this section. Results with alternative treatment variables are shown as robustness checks in the next section. Since the treatment unit is village level, following the essence of Abadie et al. (2017), robust standard errors clustered at village level are adopted in all the specifications.

5.1 Tightening Labor Market Participation Constraints

Table 8 presents the results of the estimation of (8). Panel (A) shows that we do not find significant correlation between market and shadow wages. This result implies the presence of labor market inefficiency because the shadow wages do not have a tendency to comove with the off-farm employment wage. The presence of labor market inefficiency itself is not a surprising result because Jacoby (1993) and Skoufias (1994) also found the coefficient (corresponding to α_{3j} here) significantly smaller than 1, in Peru and India, respectively. However, they found statistically positively significant coefficients. On the other hand, here in Sub-Saharan African context, even after controlling for various controls and village- or household-specific fixed components, we do not observe even positive significant correlation at all, which is the striking difference from the previous literature. This is seemingly a surprising result, but actually plausible if there is a ceiling on off-farm labor market participation. A household's shadow wage can be much less sensitive to the level of market wage when its labor market participation constraint is binding than when the constraint is not binding. Therefore, statistically insignificant correlation between the market and shadow wages is possible and the indication of the binding participation constraint. Rather, what is more important is whether the degree of labor market constraint is affected by the refugee inflow. Since the direction of the effect of the refugee inflow, i.e., whether the refugee inflow increases or decreased the labor market transaction cost, is conceptually unclear as discussed before, this is an important empirical problem. Panel (B) of Table 8 indicates that the negative effect of the refugee inflow on the labor market efficiency dominates. Especially for male labor, the refugee inflow has significantly (both statistically and economically) positive effect on the wage gap between market and shadow wages. Finally, Table 9 completes the discussion. Panel (A) of Table 9 shows that off-farm labor market

participation is significantly lower in the refugee areas (while hired farm labor is not changed by that). Decomposing this result into gender, panel (B) of Table 9 shows that the negative effect is entirely due to the decreased male labor market participation. Regardless of the refugee inflow, female labor market participation would just be very low as the descriptive statistics showed.

To sum up, combining these two results show that the refugee inflow has decreased male off-farm labor market participation and increased the gap between male shadow wage and market wage. From Table 1, either an increase in proportional transaction cost or a tightening labor market participation constraint can explain these two results. In addition, we saw from panel (A) of Table 8 that the participation constraint would not be unbinding. As long as the participation constraint is binding, the change in the proportional transaction cost does not affect the wage gap. An increase in the proportional transaction cost increases the wage gap only if that increase makes the household's labor market participation constraint unbinding. If such households dominate, however, then we would see the positive correlation between the resulting market and shadow wages which we do not observe at all. Therefore, it can be concluded that the labor market participation constraint is tightened by the refugee inflow (or that effect dominates other potential effects). In another word, the surplus farm labor is increased by the refugee inflow[14].

5.2 Transitions from Subsistence into Sellers of Food Crops

Table 10 presents the results of the estimation of (10) for food crop market participations (seller dummies). The strongest effect in terms of both statistically and economically is found in the transition from subsistence into sellers in beans, shown in panel (A). Among households related to initially bean subsistence households in the pre-shock period, controlling for the household-specific fixed unobservable components, the probability of transforming into beans sellers in the post-shock period is 20% higher in the refugee area than other areas. The effect of the refugee inflow on maize marketization among initially maize subsistence households is economically much more modest: the corresponding point estimate is

[14]Note also that the negative effect on labor market participation would not be because the refugee inflow moved down market wages. Columns (1), (2), (4), and (5) in Table 19 in Appendix A implies that the difference in market wage movement between refugee and non-refugee areas on average is insignificant. Following the results including initial household fixed effects in columns (3) and (6), even if considering the possibility that the refugee inflow has a negative effect on market wage, it is theoretically very unlikely that it can *solely* explain the increased wage gap. The conclusion that the surplus labor has increased is also unchanged.

7.81% and the equality of these coefficients of the two crops is statistically rejected. Panel (B) of Table 10 shows insignificant effects for staple crops substitutable for maize. Note that as columns (1) & (4) show, the refugee area itself does not have such a bean-oriented characteristics. Recall that bean is a market-oriented crop which has a complementary role for the main food aid crop maize. Therefore, the increase in beans demand produced by local farmers seems to justify this result.

However, as later sections will discuss, it turns out to be that the main mechanism of the food crop marketization is not the consumption demand shift but the decreased fixed transaction costs. In addition, the beans marketization shows a similar pre-trends and thus the maize marketization result is rather important. The detail discussions are provided in the next section.

6 Discussions

I provide the discussions on the present results from two aspects: justifications for causality and an underlying mechanism behind the results. For the causality, although there is a consensus among economists that the refugee settlement is a natural experiment from the standpoint of local farmers, its justification is still not perfect relative to a pure random experiment. I first show the robust results with alternative definitions of a treatment variable. Next, the placebo test shows that there does not exist any pre-trends with the same orientations as the above main findings in the labor market effects. On the other hand, the effect on bean marketization shows similar pre-trends and thus it must be interpreted with caution. For the mechanism, I first argue that the transition from food crop subsistence into market sellers is mainly due to the decrease in crop-specific market transactions costs, rather than due to the consumption demand shift. I then show the suggestive evidence that the decrease in the transactions costs is that in fixed transactions costs rather than proportional transactions costs.

6.1 Robustness Checks and Empirical Concerns

A village-level treatment variable based on the straight distance to a refugee camp might not be able to capture the influence of the refugee inflow because the actual accessibility might not be purely correlated with the straight distance. As the first robustness check, the effects of an alternative measure of the

refugee treatment which does not rely on the straight distance is examined. Here, I use the following treatment variable: a dummy which takes 1 if one of the refugee camps is located within own ward or the neighborhood wards of the village where each household lives. Table 20 – Table 23 in Appendix A correspond to the main results Table 8 – Table 11 in the previous section with only the difference in the definition of a treatment variable. All the results are qualitatively same (except for the specifications with plantain for crop marketization).

Another possibility is that the estimation results might be susceptible to the choice of distance (50km in my main specification) for a treatment variable. As the second robustness check, log of the distance between the center of the village each household lives and its nearest refugee camp is used as another alternative treatment variable. Table 24 – Table 27 in Appendix A correspond to the main results Table 8 – Table 11 with only the difference in the definition of a treatment variable. All the results are qualitatively same (except for losing statistical significances in the wage gap specifications while the coefficient directions are kept totally consistent).

One possible problem is potential measurement errors in key variables. Usage of reported market wages and estimated shadow wages always bring the concerns of measurement errors. Given such possibilities, the market and shadow wages themselves or the value of the wage gap itself might not capture their true values and thus they might not be meaningful measures. However, this concern is not a problem in the difference-in-difference framework adopted in my empirical analyses. What is our interests here is the difference in wage gap in a *relative* sense between the refugee area and the other areas. As long as the measurement errors, if any, are systematic and not correlated with the refugee treatment, the difference-in-difference estimators convey the meaningful information. If the observed or estimated wages are symmetrically distributed around true wages or systematically underestimating or overestimating true wages, then the relative difference of our interests still makes sense. The potential measurement error of the reported market wage depends on the structure of questionnaire or the protocol of interviewers. The potential measurement error of the estimated shadow wage depends on the functional specification of production function, the choice of input variables, or measurement errors of output or input variables from questionnaires. There are no reasons that either of them is associated with the refugee area or not.

6.2 Placebo Test

Another potential problem is the possibility that the main empirical results would just capture inherent differential time trends between refugee areas and non-refugee areas, which cannot be controlled for by fixed effects. If that is the case, the present results cannot be interpreted as the pure impact of the refugee settlement. In order to check the underlying trend, I exploit another set of a two-period (1991 & 1993) panel data, in which both periods are before the refugee inflow. I test the "treatment effect" of the refugee area in the exactly same difference-in-difference framework as the main framework except the time periods. As noted earlier in the data section, Tanzanian rural economies around 1990 in Tanzania were susceptible to agricultural reforms and liberalization. So, the placebo test presented here is not an ideal test. Therefore, the placebo results presented in this subsection and their relationships with the main results should be interpreted carefully and the discussion on causality should not rely only on this subsection. At the same time, this is the only possible way to make some inferences for pre-trends. In the following, I present the placebo results for the labor market effects and the crop market effects in turn.

The placebo labor market effect is shown in Table 28 in Appendix A, which corresponds to panel (B) of Table 8 and Table 9 in the main results. Recall that Table 9 shows that the refugee inflow has the negative impact on households' labor market participations. On the other hand, panel (A) and (B) of Table 28 do not show such pre-trends. Though only weakly significant (both statistically and economically), panel (B) implies even the opposite pre-trend to the negative impact of the refugee inflow on male labor market participations. For the gap between market and shadow wages, recall that Table 9 shows that the refugee inflow has the positive impact on it. On the other hand, panel (C) of Table 28 does not show any significant pre-trends.

The placebo crop market effect is shown in Table 29 in Appendix A, which corresponds to Table 10 in the main results. Recall that Table 10 shows that the refugee inflow has the positive effects on households' transitions from subsistence into sellers for the two main market oriented food crops, maize and beans. Panel (A) of Table 29 does not show any significant pre-trends for maize. In contrary, the same panel shows the similar pre-trends for beans as the main result.

It is difficult to reason that the refugee hosting area, where there are not any other particular pre-trends, has already been experiencing the upward mobility of bean subsisters for becoming sellers before

the refugee inflow. Note that whether particular areas experience the refugee inflow is the variation across longitude along the similar latitude where geographic conditions are similar. A straightforward interpretation of the main result in Table 10 is that, because the food aid was concentrated on maize, crop marketization of bean, a food crop with a complementary role for maize, has been accelerated after the refugee inflow. If the placebo result is by chance spurious or stemming from period-specific institutional reasons related to the Tanzanian reform, which will not directly drive the bean crop marketization after the refugee inflow, then my primary interpretation would be supported. On the other hand, If the placebo result purely captures the regional structural change of agricultural production and marketing, which will also continue after the refugee inflow, then the previous interpretation would not be supported. The result should rather be interpreted that the bean food aid was small, whether it was intended or not, so that the rising trend of the bean marketization of local farmers has not been crowded out by the food aid. In the latter case, the maize marketization after the refugee inflow, which happens even though maize was the main aid crop, becomes the most important result. Uncovering which is the true case is a future task. Whichever the case, the next subsection shows that a driving force of crop marketizations is a decrease in fixed transaction costs of crop market participation.

To sum up the placebo results, all the mains results except for the bean market transition are shown to be unrelated to any pre-trends. On the other hand, the result for the transition from subsistence into sellers of beans should be interpreted with much more caution.

6.3 Mechanisms

6.3.1 Driving Forces of Food Crop Marketization

This section investigates into the driving forces of the main results of the food crop marketizations shown in Table 10 and Table 11. As described in the conceptual framework before, there are three plausible causes of the food crop marketizations: (i) decrease in fixed transactions costs; (ii) decrease in proportional transactions costs; (iii) local consumption demand shift in response to the food aid crop composition.

First, I argue the possibility of the local consumption demand effect. Note first that, Alix-Garcia and Saah (2010) shows the significant increase in beans price and the moderate or insignificant change in

maize price in the short run. These results are fairly reasonable given that maize is the main food aid crop and thus local consumption demand of other crops, especially crops complementary to maize, would increase, which results in the price increase. Although precise population size of remaining refugees in Kagera in 2004 is not available, it is still natural to hypothesize this mechanism as a driving force to significant bean marketization. In fact, Figure 4 shows that the food aid of maize is still large and also significantly higher than that of beans in 2004. However, the data reveals that this mechanism is not working. Table 12 and Figure 9 show the market prices received by selling farmers for maize and bean. In the long run, it is not shown that the refugee inflow has any positive effects on food crop prices, unlike in the short run shown by Alix-Garcia and Saah (2010). At least in the partial equilibrium framework, this result indicates that farmers' bean marketization is not due to the higher selling price.

Therefore, it is reasonable to conclude that the food crop marketization is due to the decreases in transactions costs. There is still another remaining question. Which type of transactions costs between proportional and fixed costs? The transition from initially subsistence farmers into market sellers can be explained by a decrease in either proportional or fixed transactions costs. So, the main results in the main results in Table 10 and Table 11 are not informative for this distinction. As Prediction 2 discusses, on the other hand, conditional on market entry, the amount of crop supply is affected only by proportional transactions costs and not affected by fixed ones. Table 30 in Appendix A shows the estimation results with the same specification as that in Table 11 except that I use the subsample of initial sellers and their corresponding households for each crop in Table 30. In contrast to the significant increases in crop supplies to markets among initial subsisters in the refugee region, there are no such trends among initial sellers for both maize and beans. If the decrease in the proportional transactions costs were the dominant force of crop marketization, then there would also be similar positive effects on crop supplies among initial sellers. Therefore, this result suggests that the dominant force of the crop marketization shown in the main results is the decrease in the fixed crop market transactions costs. Note also that, according to the short-run positive effects on crop prices in Alix-Garcia and Saah (2010), caused by consumption demand growth due to the refugee inflow, it is reasonable to presume that such a rise in food crop demand would have promoted crop marketization by local farmers. Therefore, in addition to the physical infrastructure, past experience of a crop marketization (after the refugee inflow in the short

run) and its resulting information gain might have facilitated crop marketization in the long run.

Finally, the following investigation into the cash crop marketization also supports the view that the main source of crop marketization is due to the decrease in transactions costs, rather than the local consumption demand effect. A useful test to isolate the former effect is to estimate the analogue of (10) for the main cash crop in Africa, coffee. Since coffee is mainly produced for exports to outside the region, it would be less responsive to the local food demand and food aid effects. Table 13 and Table 14 show the results. One difference from the previous specification is that the meaningful treatment variable is the refugee area in Rwanda side (middle-northern part) in consistent with the geographically suitable region for coffee production as described in Table 2. In terms of the extensive margin, panel (A) and (B) of Table 13 that among households related to initially coffee producers and subsisters[15] in the pre-shock period the refugee area has strong effects on being coffee producers and sellers in the post-shock period. In terms of the intensive margin, panel (A) and (B) of Table 14 show that initial subsisters increased sales value of coffee in the refugee area in the post-shock period while they are decreased on average among initial producers, implying higher degree of competition in areas with improved infrastructure. Though statistically and economically significant effects of infrastructure development on the cash crop marketization and competition around refugee camps are found, which are by themselves important, these cannot be generalizable to other crops and the overall effect of infrastructure development is unclear. Further research will be expected.

[15]Coffee subsister would not be a realistic classification because coffee is an exporting crop. However, as Table 3 and Table 5 show, non-trivial number of households in the pre-shock period produce coffee without selling at markets. I interpret such coffee farmers as initial-stage coffee farmers, analogous to subsistence farmers.

6.3.2 Implication for Agricultural Productivity and Gender Division of Labor

In order to further learn the the effect of refugee inflow on agricultural labor productivity, interacting with crop marketiztions, the following model is estimated:

$$\begin{aligned}\log(ShadowWage_{dhjt}) = \beta_0 + \beta_1 X_{dht} + \beta_2 Year2004_t + \beta_3(Year2004_t \times Refugee1_d) \\ +\beta_4(Year2004_t \times BeanSeller_{dht}) + \beta_5(Year2004_t \times CoffeeSeller_{dht}) \\ +\beta_6(Year2004_t \times Refugee1_d \times BeanSeller_{dht}) \\ +\beta_7(Year2004_t \times Refugee1_d \times CoffeeSeller_{dht}) \\ +c + \epsilon_{dhjt}\end{aligned}$$

Panel (B) of Table 15 shows that the food crop marketization is positively associated only with female shadow wage, while the cash crop marketization is positively associated with shadow wages of both gender. Also, the association between cash crop marketization and female shadow wage has a negative response to the refugee treatment, while that between food crop marketization and female shadow wage does not. These observations are some indirect indications of so called gender-division of labor across crops. The unitary household model with gender-specific participation constraint in a certain crop production process cannot explain the observed pattern. Further research will be expected.

The overall effect of the refugee inflow on agricultural productivity is insignificant (Panel (A) of Table 15). Recall that the two main results of this paper, the "surplus farm labor" effect and the "crop marketization effect" affect agricultural labor productivity in opposite directions theoretically. This insignificant result on the total effect implies that the two competing forces offset each other. Therefore, the answer to the primary research question is that the refugee inflow can hurt local farmers in terms of labor market environments. It can also benefit local farmers in terms of crop market transactions due to the infrastructure development around refugee camps. In total, in terms of agricultural labor productivity, the answer is indeterminate. Rather, an important implication of the results is the distributional impacts attributed to different markets.

7 Concluding Remarks

This paper investigates long-term effects of a mass refugee inflow on local agricultural households through local labor and crop market interactions. I exploit a natural experiment Tanzania faced when it experienced a refugee inflow from Burundi and Rwanda in the early 1990s. This refugee inflow is distinguishable from a general migration context in terms of food aid and infrastructure development around refugee camps. Empirical analyses using the long-term panel data from refugee-hosting economies, in conjunction with the non-separable household model, show that the refugee inflow causes both benefits and losses for local farmers.

The present empirical results are important from two contexts: the long-term effect of refugee inflow on hosting economies, and market-specific transactions costs and non-separation of agricultural households. First, in the context of investigating economic effects of refugee inflow, this paper demonstrates that looking only at consumption level or wage level as the literature is insufficient to uncover underlying mechanisms, at least in developing countries. The results indicate that labor market transaction cost is increased and crop market transaction cost is decreased by the refugee inflow. In both markets, fixed costs play important roles. The transition from crop subsistence into marketization is observed. However, the surplus labor is increased by the refugee inflow, which is against a favorable direction of structural transformation. In order to accelerate structural transformation in Sub-Saharan Africa, this study suggests that assimilation of refugees in local hosting economies is one of the key policy issues. Second, the non-separable agricultural household models receive a high degree of research attention again by a recent work LaFave and Thomas (2016), which draws the opposite conclusion to the seminal work Benjamin (1992). This study provides a new perspective in this context by demonstrating how a large-scale political shock shapes conditions organizing the non-separability of agricultural households in the long run.

The external validity is an important agenda. This study focuses on the largest scale of refugee movements in recent African history. However, after that, refugee movements are still observed in many other regions in Sub-Saharan Africa. Many aspects, such as ethnic compositions, agricultural conditions, and refugee camps and aid policies, might have different faces across regions. Including data collections in post-conflict and refugee inflow areas, further research to generalize the linkage between conflicts, refugees, and rural economic mobility in Africa is expected.

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Figures

Figure I.1: Kagera Region, Tanzania

Figure 2: Kagera region (source: Ainsworth et al. 2004)

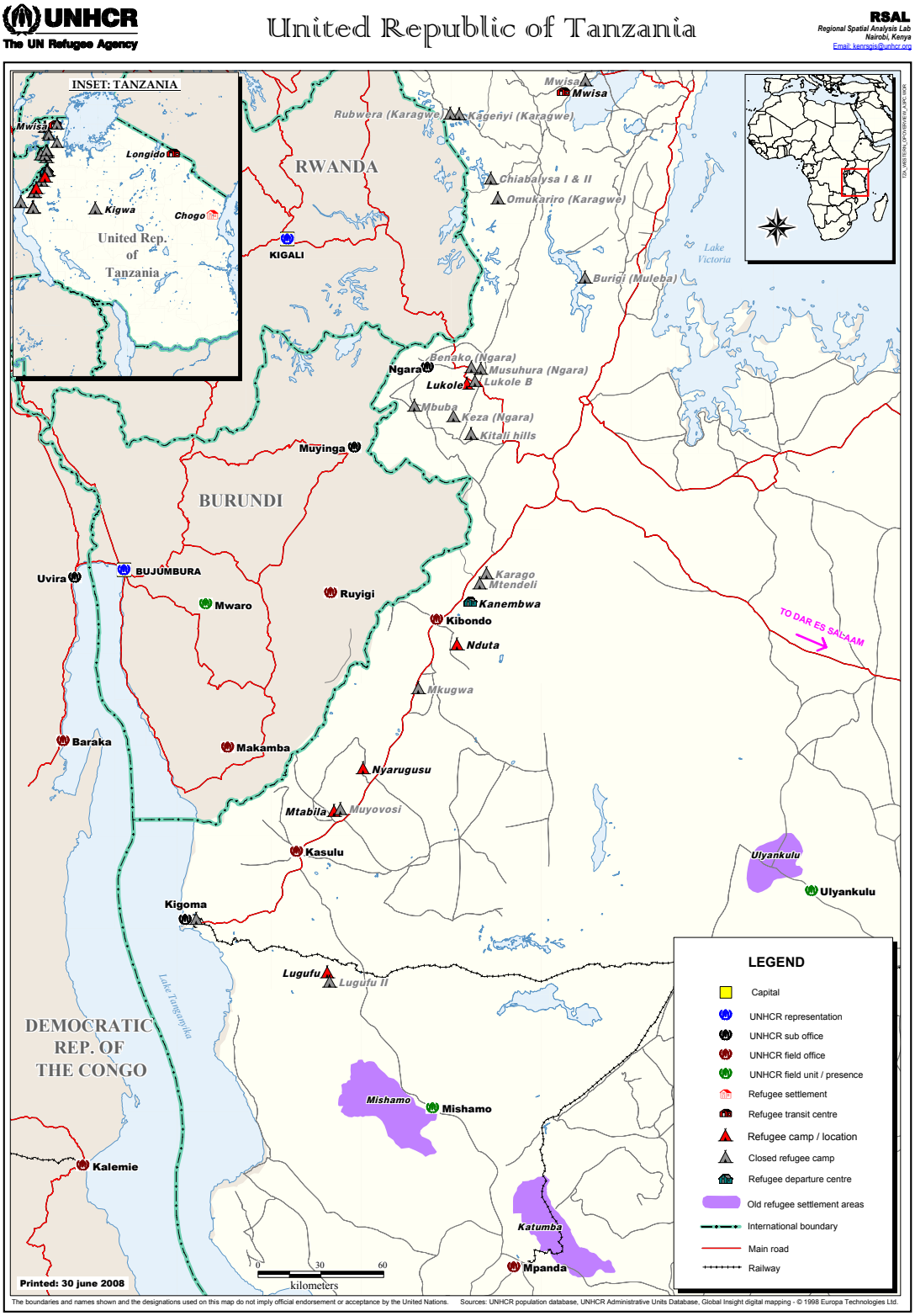

Figure 3: Refugee Camps in Tanzania (source: UNHCR)

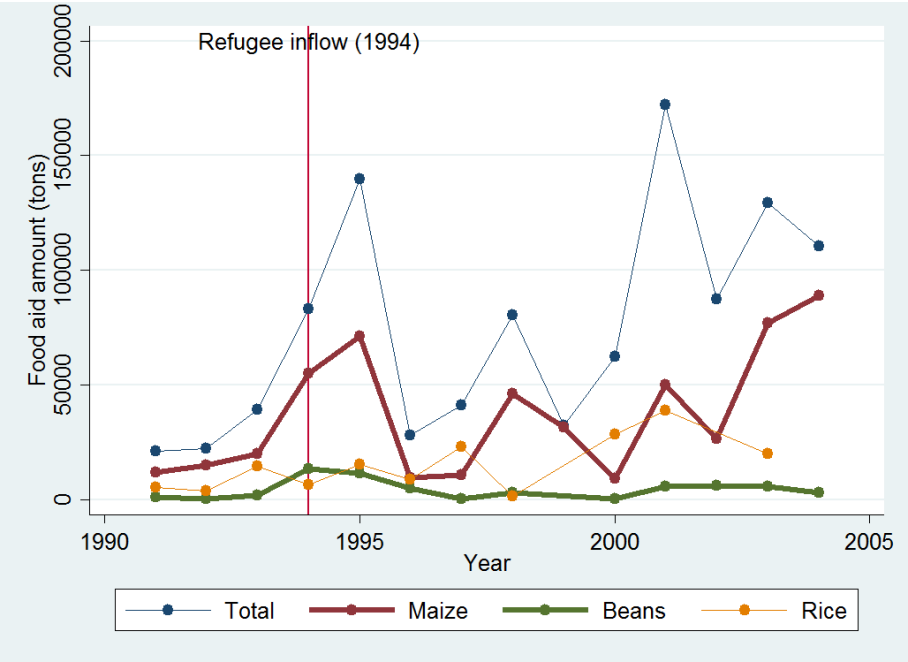

Figure 4: Food Aid Delivered to Tanzania
(Source: WFP *Food Aid Information System*)

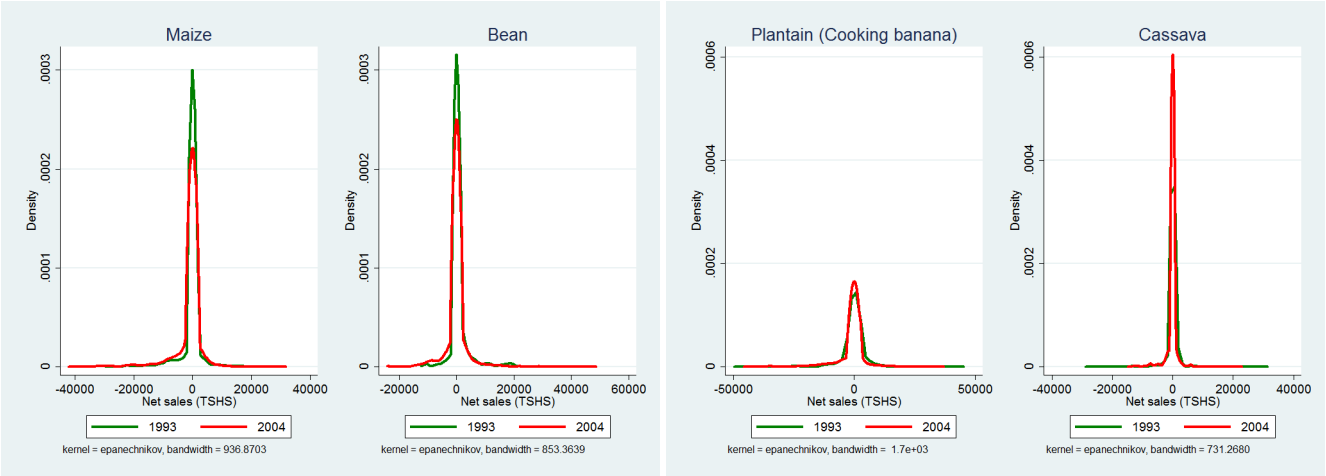

Figure 5: Pre-Shock (1993) and Post-Shock (2004) Net Sales of Food Crops

Notes: Net sales of each crop is defined as the amount sold minus the amount purchased in the real values in 1991. A negative value means that a household is a (net) buyer of a crop. A zero value for a crop means subsistence, i.e., a household produces that crop while it does not sell or purchase that crop.

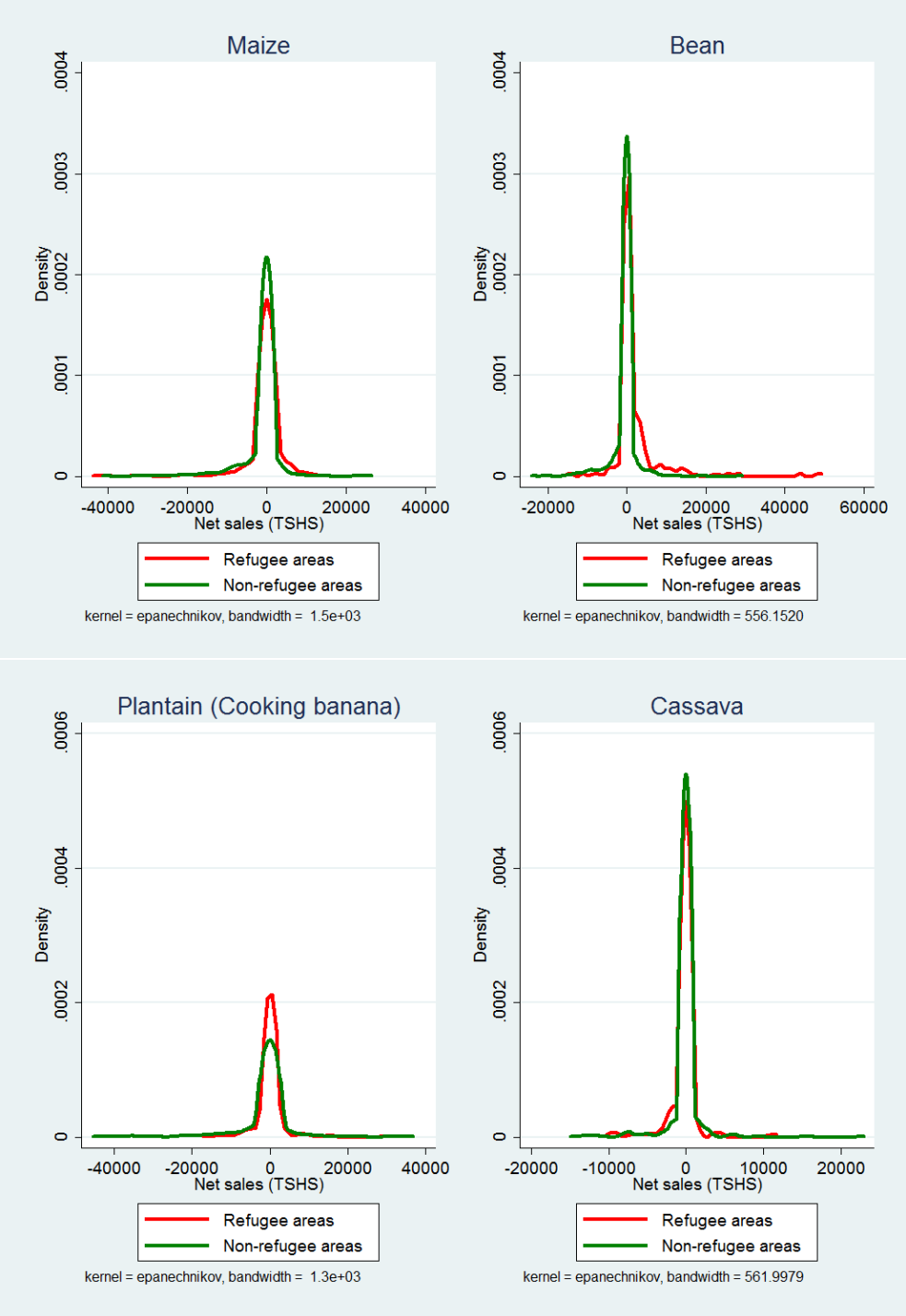

Figure 6: Post-Shock (in 2004) Net Sales of Food Crops by Initial Subsisters

Notes: Net sales of each crop is defined as the amount sold minus the amount purchased in the real values in 1991. A negative value means that a household is a (net) buyer of a crop. A zero value for a crop means subsistence, i.e., a household produces that crop while it does not sell or purchase that crop. A household's location is defined as in the refugee area if one of the refugee camps is located within 50km from center of the village where each household lives.

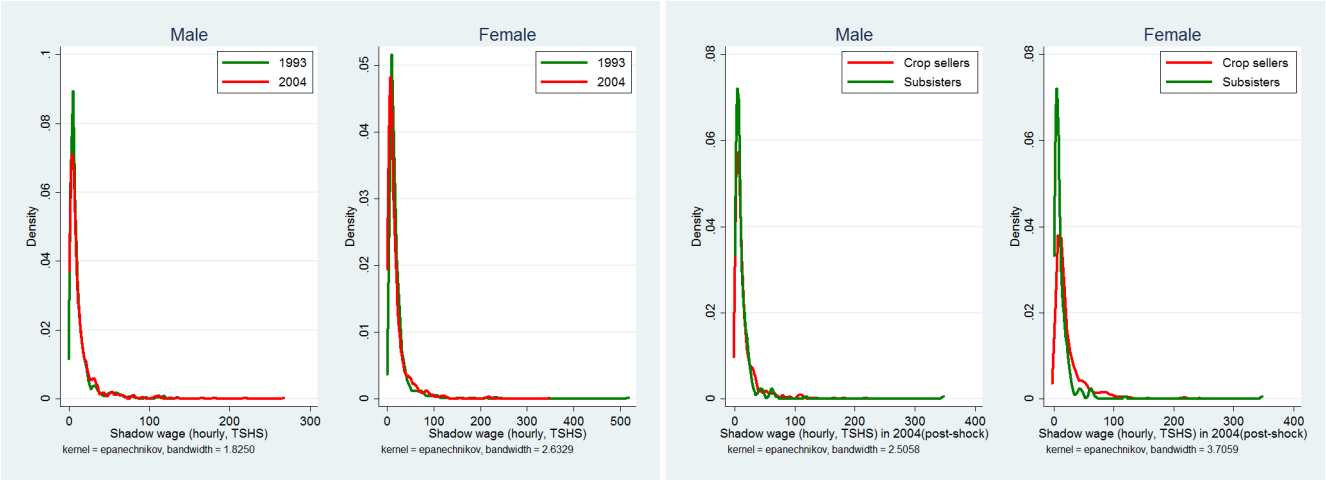

Figure 7: Distributions of Shadow Wages

Notes: The estimation procedure of shadow wages follows the conventional literature (Jacoby 1993; Skoufias 1994) and is described in Appendix B. The estimated shadow wages are in hourly basis and the real values in 1991.

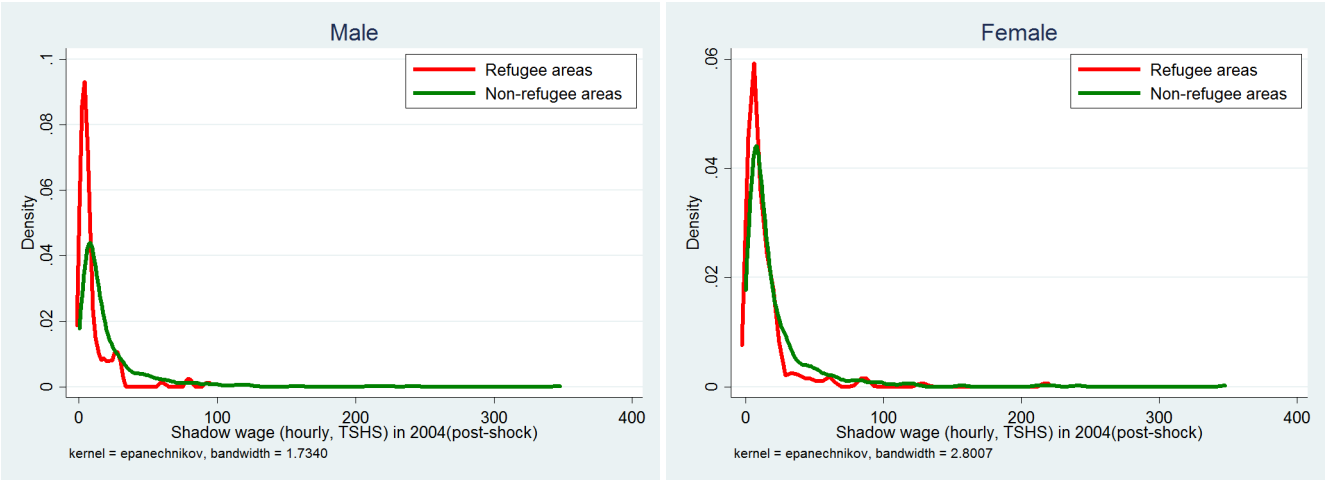

Figure 8: Distributions of Shadow Wages in Refugee and Non-Refugee Areas

Notes: The estimation procedure of shadow wages follows the conventional literature (Jacoby 1993; Skoufias 1994) and is described in Appendix B. The estimated shadow wages are in hourly basis and the real values in 1991. A household's location is defined as in the refugee area if one of the refugee camps is located within 50km from center of the village where each household lives.

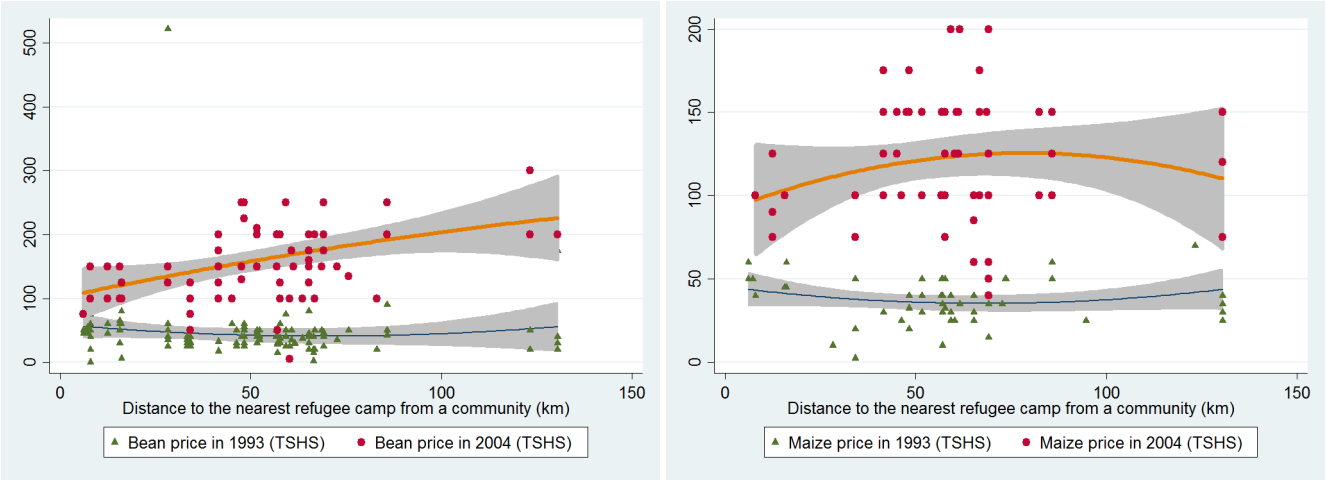

Figure 9: Refugee Camp Proximity and Food Crop Prices

Notes: Quadratic fits and their 95% intervals are shown. The price observations are from the household-level information of crop sales at markets. The unit of each crop price is per kilogram.

Tables

Table 2: Characteristics of the Sample Villages by Geographic Zones

Geographic Zones	Tree Crop zone	Riverine zone	Annual Crop zone	Urban zone
Number of the sample villages	15	12	10	10
Area	Northern part	Middle part	Southern part	The town of Bukoba
Soil characteristics	Low Fertility soils	Alluvial and colluvial soils	Low to Medium Fertility soils	
Rainfall patterns	High	Require Flood Control	Low	
Main crops	Bananas, Coffee	Mixed	Bean, Cassava, Maize	
Mean population (1988)	2066.8	2449.4	2980.3	3125.9
Mean adult population (1988)	811.1	981.3	1245	1461.1
Mean of number of households (1988)	411	481.5	612.6	695.6
Number of villages within 50km from a refugee camp	1	5	6	2
Number of villages with a refugee camp within own or neighborhood ward	2	3	6	1
Mean distance to the nearest refugee camp from Village centers (km)	65.5	52	44.5	68

Source: Beegle et al. (2006) and the 1988 census.

Notes: No information regarding agriculture on urban areas.

Table 3: Value of Crop Harvests of Sample Households

Crops	Obs.	Mean Value	Std. Dev.	Min	Max
1991 (Baseline: Wave1) (n=893)					
Coffee	603	108292	1220771	40	2.84e+07
Plantain (Cooking banana)	790	179127	2689130	100	7.50e+07
Sweet banana	677	48480	924866	50	2.40e+07
Other bananas	469	143382	2027173	30	4.32e+07
Cassava (row)	760	16881	25987	50	377300
Yams, Cocoyams or Sweet potatoes	732	15099	26713	20	319500
Maize	809	38948	62589	100	1013000
Millet or Sorgum	193	11174	17801	100	106500
Rice	13	45060	42109	1200	126000
Beans	855	33435	33534	200	415100
Groundnuts	293	14957	19436	150	123620
Oil palm/Palm oil	146	13404	22920	20	170500
Sugar, Candy, Honey or Sweet potatoes	350	4967	11540	40	126570
1993 (Pre-shock: Wave 2 & 3) (n=863)					
Coffee	669	23128	63931	80	1113600
Plantain (Cooking banana)	804	55098	60054	160	577900
Sweet banana	763	5584	10477	100	124200
Other bananas	669	6693	26510	50	501750
Cassava (row)	807	16015	21916	100	224000
Yams, Cocoyams or Sweet potatoes	795	13143	16764	30	152100
Maize	800	24180	30400	50	346500
Millet or Sorgum	269	9074	19686	20	197440
Rice	13	48632	145370	500	531500
Beans	840	29144	22154	70	186700
Groundnuts	357	10563	12840	100	125320
Oil palm/Palm oil	221	5365	6399	20	49440
Sugar, Candy, Honey or Sweet potatoes	552	2926	9802	40	210320
2004 (Post-shock: Wave 5) (n=1222)					
Coffee	501	140250	2348523	12	5.26e+07
Plantain (Cooking banana)	1032	131663	161005	300	1490000
Sweet banana	543	17934	49862	100	720000
Other bananas	469	20761	42830	2	504000
Cassava (row)	967	51381	95470	200	2195000
Yams, Cocoyams or Sweet potatoes	1009	55252	75672	300	773000
Maize	1103	68080	78584	100	625900
Millet or Sorgum	87	30640	35007	250	180000
Rice	18	82806	57504	1000	177000
Beans	1114	63847	70147	200	1260000
Groundnuts	375	24954	26377	1200	216000
Oil palm/Palm oil	102	37181	51304	50	303200
Sugar, Candy, Honey or Sweet potatoes	309	11115	18823	100	144000

Notes: All values represented here are nominal values in TSHS in corresponding years. Value of crop harvests include (i) values of products sold, (ii) value of products lost, (iii) value of products given to other people, (iii) value of products kept as stock, and (iv) value of products consumed by own household members. n represents the corresponding sample size. In 1991 and 1993, this corresponds to households which engage in agriculture. In 2004, this corresponds to households which engage in agriculture, live within Kagera region, and whose information on agricultural production are available.

Table 4: Market Participation Regimes of Sample Agricultural Households

Household Market Participation Regimes	1993 (Pre-Shock)		2004 (Post-Shock)	
	Percent	Cumulative	Percent	Cumulative
(A) The quasi-panel sample	(n=485)		(n=928)	
1. Autarky (Neither crop nor labor market participation)	5.15	5.15	28.34	28.34
2. No crop market participation with off-farm wagework only	0.82	5.97	7.33	35.67
3. No crop market participation with hired farm labor only	1.86	7.83	1.4	37.07
4. No crop market participation with off-farm wagework and hired farm labor	0	7.83	0.54	37.61
5. Crop market participation without labor market participation	43.92	51.75	28.77	66.38
6. Crop market participation with off-farm wagework only	5.98	57.73	14.33	80.71
7. Crop market participation with hired farm labor only	36.7	94.43	14.44	95.15
8. Crop market participation with off-farm wagework and hired farm labor	5.57	100	4.85	100
(B) The whole sample	(n=805)		(n=955)	
1. Autarky (Neither crop nor labor market participation)	7.2	7.2	29.01	29.01
2. No crop market participation with off-farm wagework only	0.99	8.19	7.33	36.34
3. No crop market participation with hired farm labor only	2.48	10.67	1.36	37.7
4. No crop market participation with off-farm wagework and hired farm labor	0.12	10.79	0.52	38.22
5. Crop market participation without labor market participation	41.24	52.03	28.38	66.6
6. Crop market participation with off-farm wagework only	5.59	57.62	14.24	80.84
7. Crop market participation with hired farm labor only	36.65	94.27	14.35	95.19
8. Crop market participation with off-farm wagework and hired farm labor	5,71	100	4.82	100

Notes: Crop market participation is simply defined as selling at least one crop at a market.

Table 5: Crop Market Participation Regimes of Sample Agricultural Households

	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
(A) The quasi-panel sample	**1993 (Pre-Shock, n=485)**					**2004 (Post-shock, n=928)**				
(1) Coffee seller	307					357				
(2) Maize seller	33	47				51	120			
(3) Bean seller	66	32	108			78	59	154		
(4) Plantain seller	88	20	41	123		110	37	55	164	
(5) Cassava seller	54	14	21	30	75	48	33	24	35	79
(B) The whole sample	**1993 (Pre-Shock, n=805)**					**2004 (Post-shock, n=958)**				
(1) Coffee seller	481					360				
(2) Maize seller	53	84				51	122			
(3) Bean seller	114	52	176			79	59	157		
(4) Plantain seller	151	34	71	207		112	37	56	166	
(5) Cassava seller	82	24	40	49	119	48	33	24	35	79

Table 6: Off-Farm Wage Employment and Hired Labor Use by Sample Agricultural Households

		1993 (Pre-Shock)		2004 (Post-Shock)	
		Hired harvest labor (past 12 months)		Hired harvest labor (past 12 months)	
		No	Yes	No	Yes
(A) The quasi-panel sample			(n=485)		(n=928)
Use family harvest labor	No	0.206	0.206	1.078	0.216
(past 12 months)	Yes	55.670	43.918	77.694	21.012
Off-farm wage employment	No	49.072	38.557	57.112	15.841
(past 12 months)	Yes	6.804	5.567	21.659	5.388
Off-farm agricultural wage employment	No	54.021	43.093	68.750	19.396
(past 12 months)	Yes	1.856	1.030	10.022	1.832
Off-farm non-agricultural wage employment	No	50.515	39.588	66.379	17.349
(past 12 months)	Yes	5.361	4.536	12.392	3.880
(B) The whole sample			(n=805)		(n=955)
Use family harvest labor	No	0.124	0.373	1.033	0.207
(past 12 months)	Yes	54.907	44.596	78.202	21.798
Off-farm wage employment	No	48.447	39.130	57.955	15.496
(past 12 months)	Yes	6.584	5.839	21.281	5.268
Off-farm agricultural wage employment	No	52.671	43.975	69.421	19.008
(past 12 months)	Yes	2.360	0.994	9.814	1.757
Off-farm non-agricultural wage employment	No	50.186	40.000	67.045	16.942
(past 12 months)	Yes	4.845	4.969	12.190	3.823

Table 7: Wages of Agricultural Household Member

	Obs	Mean	Std. Dev.	Min	Max
1991 (Baseline: Wave1)					
Adult male shadow wage	587	13.867	20.448	.784	248.018
Adult female shadow wage	712	13.772	26.576	.449	473.893
Adult market wage	87	59.637	102.105	1.397	712.251
Adult male market wage	67	54.596	80.756	1.397	507.246
Adult female market wage	22	76.633	148.187	9.804	712.251
1993 (Pre-shock: Wave 2 & 3)					
Adult male shadow wage	635	13.355	22.874	.896	324.253
Adult female shadow wage	736	22.218	40.716	2.013	541.02
Adult market wage	100	51.802	76.848	1.773	451.128
Adult male market wage	73	51.659	74.532	2.325	451.128
Adult female market wage	30	50.509	80.197	1.773	451.128
2004 (Post-shock: Wave 5)					
Adult male shadow wage	599	14.142	24.241	.066	267.568
Adult female shadow wage	799	19.835	28.313	.09	347.941
Adult market wage	314	107.975	216.047	.014	2952.126
Adult male market wage	234	115.619	237.586	.014	2952.126
Adult female market wage	104	84.231	125.356	3.749	1097.738

Notes: All values are the real values in 1991. Wage variables are estimated and calculated in hourly basis. The estimation procedure of shadow wages follows the conventional literature (Jacoby 1993; Skoufias 1994) and is described in Appendix B. If multiple members in a household engage in outside wage works, then I take the average wage across them to obtain household-level market wage indicators.

Table 8: Refugee Inflow and Labor Market Efficiency

(A)	**Dep. Var.: log (shadow wage of own farm work)**					
	(1)	(2)	(3)	(4)	(5)	(6)
	Male	Male	Male	Female	Female	Female
Dummy: Year2004	0.146	-0.0902	-3.016*	0.0556	0.308	0.678
	(0.585)	(0.655)	(1.786)	(0.457)	(0.415)	(0.978)
Dummy: *Refugee1*	-0.114			0.414		
	(0.313)			(0.340)		
log (wage of off-farm job)	0.109	0.0418	-0.641	0.0885	0.106	0.292
	(0.132)	(0.175)	(0.472)	(0.105)	(0.107)	(0.283)
log (wage) × Year2004	-0.0707	0.0473	0.903*	-0.00452	-0.0241	-0.199
	(0.164)	(0.191)	(0.515)	(0.135)	(0.130)	(0.303)
Refugee1 × Year2004	0.207	-0.154	0.714	-0.165	-0.608*	-1.126*
	(0.485)	(0.636)	(0.954)	(0.299)	(0.347)	(0.594)
Refugee1 × log (wage) × Year2004	-0.0449	-0.125	-0.582***	-0.0943	-0.104	-0.218
	(0.119)	(0.112)	(0.171)	(0.0755)	(0.0914)	(0.130)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	262	262	262	297	297	297
R-squared	0.079	0.074	0.263	0.082	0.090	0.206
(B)	**Dep. Var.: Absolute value of wage gap (log)**					
	(1)	(2)	(3)	(4)	(5)	(6)
	Male	Male	Male	Female	Female	Female
Dummy: Year2004	0.356*	0.110	-0.0104	0.388**	0.340**	0.931**
	(0.196)	(0.194)	(0.436)	(0.185)	(0.163)	(0.357)
Dummy: *Refugee1*	0.0907			-0.543		
	(0.322)			(0.386)		
Refugee1 × Year2004	0.459	1.106***	3.649***	0.732*	1.276***	0.961
	(0.406)	(0.375)	(0.907)	(0.386)	(0.379)	(0.746)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	262	262	262	297	297	297
R-squared	0.100	0.084	0.263	0.073	0.101	0.191

Notes: Robust standard errors clustered at the village level in parentheses. Wages are referred to only adult labor (age≥15). Household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee1* is a dummy which takes 1 if one of the refugee camps is located within 50km from center of the village where each household lives. The sample consists of households in 1993 (pre-shock) and 2004 (pre-shock) which have *both* own-farm family labor and a member engaging in an outside job.
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Refugee Inflow and Labor Market Participation

(A)	**Dummy: Off-Farm Employment**			**Dummy: Hired Farm Labor**		
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy: Year2004	0.183***	0.192***	0.197***	-0.141***	-0.140***	-0.175***
	(0.0347)	(0.0346)	(0.0396)	(0.0321)	(0.0327)	(0.0322)
Dummy: *Refugee1*	-0.0130			0.00410		
	(0.0462)			(0.0855)		
Refugee1 × Year2004	-0.130**	-0.116**	-0.117**	0.0721	0.0637	0.0493
	(0.0573)	(0.0536)	(0.0522)	(0.0945)	(0.0918)	(0.0921)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	1,386	1,386	1,386	1,386	1,386	1,386
R-squared	0.048	0.041	0.050	0.102	0.105	0.129
(B)	**Dummy: Gender-Specific Off-Farm Employment**					
	(1)	(2)	(3)	(4)	(5)	(6)
	Male	Male	Male	Female	Female	Female
Dummy: Year2004	0.145***	0.158***	0.171***	0.0659**	0.0652**	0.0590**
	(0.0279)	(0.0273)	(0.0306)	(0.0246)	(0.0249)	(0.0252)
Dummy: *Refugee1*	0.0512			-0.0457**		
	(0.0443)			(0.0199)		
Refugee1 × Year2004	-0.138**	-0.127***	-0.129***	-0.0157	-0.0115	-0.00271
	(0.0514)	(0.0472)	(0.0454)	(0.0271)	(0.0272)	(0.0274)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	1,386	1,386	1,386	1,386	1,386	1,386
R-squared	0.039	0.039	0.048	0.025	0.017	0.021

Notes: Robust standard errors clustered at the village level in parentheses. Size of land area and household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee1* is a dummy which takes 1 if one of the refugee camps is located within 50km from center of the village where each household lives.

*** p<0.01, ** p<0.05, * p<0.1

Table 10: Refugee Inflow and Transition from Subsistence to Sellers of Food Crops

(A)	Dep. Var.: Seller dummies					
Market oriented crops	(1)	(2)	(3)	(4)	(5)	(6)
	Maize	Maize	Maize	Beans	Beans	Beans
Dummy: Year2004	0.124***	0.122***	0.118***	0.119***	0.110***	0.0900***
	(0.0241)	(0.0243)	(0.0271)	(0.0250)	(0.0240)	(0.0246)
Dummy: *Refugee1*	-0.00864			0.0176		
	(0.0172)			(0.0271)		
Refugee1 × Year2004	0.101***	0.0864***	0.0781**	0.237***	0.224***	0.200***
coefficient $\equiv \beta$	(0.0277)	(0.0304)	(0.0329)	(0.0483)	(0.0510)	(0.0526)
Coefficient equality test of β				=(1)	=(2)	=(3)
p-value				0.0028	0.0050	0.0125
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	1,235	1,235	1,235	1,169	1,169	1,169
R-squared	0.073	0.059	0.064	0.149	0.070	0.078
(B)	Dep. Var.: Seller dummies					
Staple crops	(1)	(2)	(3)	(4)	(5)	(6)
	Plantain	Plantain	Plantain	Cassava	Cassava	Cassava
Dummy: Year2004	0.208***	0.208***	0.208***	0.105***	0.0998***	0.101***
	(0.0319)	(0.0301)	(0.0316)	(0.0176)	(0.0177)	(0.0196)
Dummy: *Refugee1*	0.0326			-0.0150		
	(0.0251)			(0.0146)		
Refugee1 × Year2004	-0.0301	-0.0256	-0.0388	0.00444	0.00801	0.0300
	(0.0361)	(0.0374)	(0.0417)	(0.0218)	(0.0226)	(0.0242)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	1,100	1,100	1,100	1,213	1,213	1,213
R-squared	0.068	0.063	0.068	0.041	0.039	0.045

Notes: Robust standard errors clustered at the village level in parentheses. For each crop-level estimation, we use the subsamples of the that crop's subsistence households in 1993 (pre-shock) and their related households in 2004 (post-shock). Size of land area and household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee1* is a dummy which takes 1 if one of the refugee camps is located within 50km from center of the village where each household lives.
*** p<0.01, ** p<0.05, * p<0.1

Table 11: Refugee Inflow and Food Crop Supplies to Markets

(A)	Value of crop sales (z-score)						Fraction of a crop sold					
Market oriented crops	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Maize	Maize	Maize	Beans	Beans	Beans	Maize	Maize	Maize	Beans	Beans	Beans
Dummy: Year2004	0.339**	0.317***	0.304**	0.131***	0.130***	0.0719**	0.0274***	0.0264***	0.0264***	0.0204***	0.0197***	0.0154***
	(0.134)	(0.112)	(0.123)	(0.0383)	(0.0386)	(0.0307)	(0.00726)	(0.00676)	(0.00766)	(0.00571)	(0.00587)	(0.00506)
Dummy: *Refugee1*	-0.0320			-0.0352			8.70e-05			-0.000286		
	(0.0622)			(0.0913)			(0.00661)			(0.0158)		
Refugee1 × Year2004	0.215***	0.170**	0.116	0.446***	0.405***	0.432***	0.0213**	0.0187**	0.00844	0.0796***	0.0702***	0.0825***
coefficient $\equiv \beta$	(0.0798)	(0.0780)	(0.0801)	(0.136)	(0.139)	(0.160)	(0.00868)	(0.00895)	(0.00743)	(0.0187)	(0.0192)	(0.0236)
Coefficient equality test of β				=(1)	=(2)	=(3)				=(7)	=(8)	=(9)
p-value				0.1119	0.1022	0.0445				0.0004	0.0034	0.0009
Village fixed effects	N	Y	N	N	Y	N	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y	N	N	Y	N	N	Y
Observations	1,234	1,234	1,234	1,168	1,168	1,168	1,175	1,175	1,175	1,128	1,128	1,128
R-squared	0.052	0.047	0.057	0.099	0.027	0.027	0.042	0.037	0.043	0.150	0.046	0.069
(B)	Value of crop sales (z-score)						Fraction of a crop sold					
Staple crops	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Plantain	Plantain	Plantain	Cassava	Cassava	Cassava	Plantain	Plantain	Plantain	Cassava	Cassava	Cassava
Dummy: Year2004	0.167***	0.161***	0.144***	0.167**	0.141**	0.138**	0.0441***	0.0405***	0.0342***	0.0298***	0.0250***	0.0228***
	(0.0596)	(0.0568)	(0.0433)	(0.0716)	(0.0602)	(0.0578)	(0.0123)	(0.0102)	(0.00887)	(0.01000)	(0.00835)	(0.00765)
Dummy: *Refugee1*	0.0589*			-0.00258			0.00695			-0.000976		
	(0.0350)			(0.0370)			(0.00755)			(0.00736)		
Refugee1 × Year2004	-0.0549	-0.0427	-0.0144	0.00551	0.00683	0.0204	-0.0152*	-0.0149*	-0.0131	0.00740	0.00512	0.00669
	(0.0516)	(0.0512)	(0.0355)	(0.0341)	(0.0330)	(0.0327)	(0.00811)	(0.00807)	(0.00805)	(0.00869)	(0.00882)	(0.00794)
Village fixed effects	N	Y	N	N	Y	N	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y	N	N	Y	N	N	Y
Observations	1,100	1,100	1,100	1,213	1,213	1,213	1,015	1,015	1,015	1,063	1,063	1,063
R-squared	0.009	0.008	0.012	0.037	0.032	0.050	0.037	0.035	0.041	0.034	0.031	0.047

Notes: Robust standard errors clustered at the village level in parentheses. For each crop-level estimation, we use the subsamples of the that crop's subsistence households in 1993 (pre-shock) and their related households in 2004 (post-shock). Size of land area and household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee1* is a dummy which takes 1 if one of the refugee camps is located within 50km from center of the village where each household lives.
*** p<0.01, ** p<0.05, * p<0.1

Table 12: Refugee Inflow and Food Crop Market Prices

	Dep. Var.: log (crop price per kilogram)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Bean	Bean	Bean	Bean	Maize	Maize	Maize	Maize
Dummy: Year2004	1.430***	1.419***	0.310	0.345	1.142***	1.141***	0.683*	0.667
	(0.124)	(0.122)	(0.480)	(0.453)	(0.0844)	(0.0747)	(0.386)	(0.494)
Dummy: *Refugee1*	0.0823	0.191			-0.179	-0.171		
	(0.122)	(0.141)			(0.197)	(0.134)		
Refugee1 × Year2004	-0.196	-0.206			0.182	0.257		
	(0.184)	(0.184)			(0.183)	(0.186)		
Refugee3 (log distance)			-0.0478	-0.0346			-0.0624	0.250
			(0.0889)	(0.183)			(0.0913)	(0.154)
Refugee3 × Year2004			0.271**	0.260**			0.133	0.144
			(0.127)	(0.119)			(0.101)	(0.121)
District fixed effect	N	Y	N	Y	N	Y	N	Y
Observations	204	204	204	204	120	120	120	120
R-squared	0.526	0.552	0.532	0.557	0.654	0.710	0.651	0.714

Notes: Robust standard errors clustered at the village level in parentheses. The price observations are from the household-level information of crop sales at markets. *Refugee1* is a dummy which takes 1 if one of the refugee camps is located within 50km from center of the village where each household lives. *Refugee3* is log of the distance between the center of the village each household lives and its nearest refugee camp.
*** p<0.01, ** p<0.05, * p<0.1

Table 13: Refugee Inflow, Cash Crop Production, and Cash Crop Market Participation

	Coffee producer dummy			**Coffee seller dummy**		
	(1)	(2)	(3)	(4)	(5)	(6)
(A) **Initial coffee producers**						
Dummy: Year2004	-0.451***	-0.435***	-0.401***	-0.294***	-0.286***	-0.262***
	(0.0354)	(0.0340)	(0.0327)	(0.0523)	(0.0496)	(0.0479)
Dummy: *Refugee1*	-0.0862			0.0453		
	(0.0974)			(0.149)		
Dummy: *Refugee1 (Rwanda)*	0.112			0.0732		
	(0.0903)			(0.126)		
Refugee1 × Year2004	-0.207***	-0.225***	-0.124*	-0.229*	-0.247*	-0.211
	(0.0623)	(0.0650)	(0.0708)	(0.106)	(0.127)	(0.140)
Refugee1 (Rwanda) × Year2004	0.287***	0.310***	0.220***	0.208	0.228*	0.202
	(0.0603)	(0.0629)	(0.0746)	(0.134)	(0.132)	(0.144)
Observations	1,251	1,251	1,251	1,251	1,251	1,251
R-squared	0.263	0.253	0.300	0.144	0.146	0.182
(B) **Initial coffee subsisters**						
Dummy: Year2004	-0.420***	-0.465***	-0.464***	0.461***	0.407***	0.407***
	(0.0488)	(0.0476)	(0.0534)	(0.0519)	(0.0496)	(0.0489)
Dummy: *Refugee1*	-0.0670			0.0439		
	(0.206)			(0.183)		
Dummy: *Refugee1 (Rwanda)*	0.0892			-0.0337		
	(0.204)			(0.182)		
Refugee1 × Year2004	-0.259**	-0.210	-0.159	-0.153	-0.0819	-0.0149
	(0.111)	(0.162)	(0.181)	(0.112)	(0.161)	(0.189)
Refugee1 (Rwanda) × Year2004	0.362***	0.475***	0.610***	0.275**	0.343**	0.488**
	(0.112)	(0.156)	(0.186)	(0.111)	(0.164)	(0.222)
Observations	811	811	811	811	811	811
R-squared	0.149	0.142	0.170	0.105	0.077	0.113
(C) **The whole (quasi-)panel sample**						
Dummy: Year2004	-0.326***	-0.316***	-0.310***	-0.207***	-0.207***	-0.198***
	(0.0327)	(0.0294)	(0.0289)	(0.0488)	(0.0445)	(0.0431)
Dummy: *Refugee1*	-0.447***			-0.308**		
	(0.145)			(0.0877)		
Dummy: *Refugee1 (Rwanda)*	0.510***			0.444***		
	(0.125)			(0.118)		
Refugee1 × Year2004	0.213***	0.189***	0.231***	0.151	0.130	0.144
	(0.0656)	(0.0553)	(0.0699)	(0.0998)	(0.0914)	(0.107)
Refugee1 (Rwanda) × Year2004	-0.180**	-0.123**	-0.170**	-0.198*	-0.157	-0.181
	(0.0679)	(0.0580)	(0.0725)	(0.114)	(0.103)	(0.113)
Observations	1,383	1,383	1,383	1,383	1,383	1,383
R-squared	0.205	0.169	0.232	0.121	0.104	0.144
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y

Notes: Robust standard errors clustered at the village level in parentheses. In panel (A) I use the subsample consisting of coffee producer households in the pre-shock period (1993) and their related households in the post-shock period (2004). In panel (B), I use the subsample consisting of coffee producer without market participations in the pre-shock period (1993) and their related households in the post-shock period (2004). Size of land area and household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee1* is a dummy which takes 1 if one of the refugee camps is located within 50km from center of the village where each household lives. *Refugee1 (Rwanda)* is the corresponding dummy but restricted to the Rwandan refugee areas in northern part of Karega.
*** p<0.01, ** p<0.05, * p<0.1

Table 14: Refugee Inflow and Cash Crop Supply to Markets

	Value of coffee sales (z-score)			Fraction of coffee sold		
	(1)	(2)	(3)	(4)	(5)	(6)
(A) **Initial coffee producers**						
Dummy: Year2004	0.0360	0.0263	0.0877	0.217***	0.205***	0.184***
	(0.153)	(0.151)	(0.192)	(0.0541)	(0.0490)	(0.0453)
Dummy: *Refugee1*	-0.542***			0.227		
	(0.186)			(0.153)		
Dummy: *Refugee1 (Rwanda)*	0.728***			-0.147		
	(0.186)			(0.142)		
Refugee1 × Year2004	0.380**	0.365**	0.443**	0.189	0.121	-0.0364
	(0.158)	(0.147)	(0.191)	(0.196)	(0.223)	(0.244)
Refugee1 (Rwanda) × Year2004	-0.619***	-0.684***	-0.841***	-0.361*	-0.251	-0.0581
	(0.168)	(0.171)	(0.273)	(0.198)	(0.224)	(0.244)
Observations	1,250	1,250	1,250	827	827	827
R-squared	0.108	0.090	0.111	0.083	0.061	0.087
(B) **Initial coffee subsisters**						
Dummy: Year2004	0.372***	0.332***	0.350**	0.576***	0.542***	0.548***
	(0.110)	(0.107)	(0.137)	(0.0485)	(0.0508)	(0.0490)
Dummy: *Refugee1*	-0.0458			0.390**		
	(0.224)			(0.166)		
Dummy: *Refugee1 (Rwanda)*	-0.102			-0.455**		
	(0.194)			(0.170)		
Refugee1 × Year2004	-0.149	-0.0672	-0.150	0.303***	0.489***	0.459***
	(0.144)	(0.150)	(0.0916)	(0.144)	(0.0750)	(0.106)
Refugee1 (Rwanda) × Year2004	0.353*	0.460*	0.631***	-0.313**	-0.497***	-0.363**
	(0.198)	(0.237)	(0.225)	(0.149)	(0.0930)	(0.155)
Observations	811	811	811	447	447	447
R-squared	0.043	0.029	0.032	0.300	0.255	0.300
(C) **The whole (quasi-)panel sample**						
Dummy: Year2004	0.0500	0.0390	0.0835	0.216***	0.205***	0.184***
	(0.139)	(0.140)	(0.172)	(0.0540)	(0.0492)	(0.0453)
Dummy: *Refugee1*	-0.524***			0.225		
	(0.176)			(0.153)		
Dummy: *Refugee1 (Rwanda)*	0.736***			-0.146		
	(0.188)			(0.142)		
Refugee1 × Year2004	0.336**	0.321***	0.353**	0.226	0.182	-0.0364
	(0.129)	(0.116)	(0.132)	(0.179)	(0.195)	(0.244)
Refugee1 (Rwanda) × Year2004	-0.605***	-0.629***	-0.789***	-0.395**	-0.309	-0.0581
	(0.153)	(0.143)	(0.235)	(0.180)	(0.197)	(0.244)
Observations	1,382	1,382	1,382	835	835	835
R-squared	0.104	0.084	0.103	0.087	0.064	0.087
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y

Notes: Robust standard errors clustered at the village level in parentheses.In panel (A) I use the subsample consisting of coffee producer households in the pre-shock period (1993) and their related households in the post-shock period (2004). In panel (B), I use the subsample consisting of coffee producer without market participations in the pre-shock period (1994) and their related households in the post-shock period (2004). Size of land area and household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee1* is a dummy which takes 1 if one of the refugee camps is located within 50km from center of the village where each household lives. *Refugee1 (Rwanda)* is the corresponding dummy but restricted to the Rwandan refugee areas in northern part of Karega.
*** p<0.01, ** p<0.05, * p<0.1

Table 15: Refugee Inflow, Crop Market Participations, and Shadow Wages

(A)	Dep. Var.: log (shadow wage)					
Overall	(1)	(2)	(3)	(4)	(5)	(6)
	Male	Male	Male	Female	Female	Female
Dummy: Year2004	0.220	0.290**	0.385***	0.172	0.252**	0.298***
	(0.135)	(0.126)	(0.129)	(0.118)	(0.105)	(0.108)
Dummy: *Refugee1*	-0.0958			-0.0527		
	(0.143)			(0.186)		
Refugee1 × Year2004	-0.218	-0.263	-0.336	-0.279	-0.323	-0.343
	(0.199)	(0.215)	(0.214)	(0.205)	(0.220)	(0.232)
Land area	0.190***	0.246***	0.252***	0.271***	0.317***	0.340***
	(0.0375)	(0.0345)	(0.0423)	(0.0406)	(0.0330)	(0.0512)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	956	956	956	1,205	1,205	1,205
R-squared	0.109	0.102	0.114	0.108	0.117	0.132
(B)	Dep. Var.: log (shadow wage)					
Decomposition	(1)	(2)	(3)	(4)	(5)	(6)
	Male	Male	Male	Female	Female	Female
Dummy: Year2004	-0.0267	0.0247	0.0291	-0.0526	-0.0104	0.0443
	(0.130)	(0.128)	(0.140)	(0.108)	(0.103)	(0.115)
Refugee1 × Year2004	-0.195	-0.241	-0.196	-0.405**	-0.326	-0.268
	(0.221)	(0.260)	(0.258)	(0.198)	(0.221)	(0.236)
Year2004 × Bean seller	0.105	0.155	0.178	0.361***	0.361***	0.270**
	(0.184)	(0.169)	(0.174)	(0.0899)	(0.0741)	(0.106)
Year2004 × Coffee seller	0.558***	0.459***	0.586***	0.524***	0.490***	0.493***
	(0.107)	(0.0969)	(0.101)	(0.0808)	(0.0802)	(0.100)
Refugee1 × Year2004 × Bean seller	0.165	0.129	0.120	0.0126	-0.0631	0.0150
	(0.248)	(0.236)	(0.228)	(0.148)	(0.120)	(0.150)
Refugee1 × Year2004 × Coffee seller	-0.379*	-0.296*	-0.414*	-0.0889	-0.138	-0.293*
	(0.193)	(0.174)	(0.229)	(0.135)	(0.102)	(0.153)
Land area	0.204***	0.232***	0.246***	0.268***	0.296***	0.329***
	(0.0329)	(0.0331)	(0.0415)	(0.0335)	(0.0327)	(0.0491)
District fixed effects	Y	N	N	Y	N	N
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	950	950	950	1,203	1,203	1,203
R-squared	0.182	0.126	0.154	0.201	0.169	0.178

Notes: Robust standard errors clustered at the village level in parentheses. The procedure of the shadow wage estimation is described in Appendix B. Household demographic information (household size, number of adult household members; religion dummies; tribe dummies) is controlled in all the specifications presented here. *Refugee1* is a dummy which takes 1 if one of the refugee camps is located within 50km from center of the village where each household lives.
*** p<0.01, ** p<0.05, * p<0.1

Appendices

Appendix A. Additional Tables and Figures

Table 16: Food Aid Delivered to Tanzania (Tons)

Year	Maize	Maize share (%)	Beans	Beans share (%)	Rice	Rice share (%)	Total
1991	11938.5	55.71	1366.0	6.37	5446.3	25.41	21430.9
1992	14989.8	67.52	334.0	1.50	3985.0	17.95	22200.5
1993	19893.6	50.69	2122.8	5.41	14536.0	37.04	39245.5
1994	55089.4	66.11	13596.2	16.32	6436.1	7.72	83326.9
1995	71434.0	51.11	11519.8	8.24	15299.8	10.95	139767.2
1996	9852.2	34.77	5224.0	18.44	8858.0	31.26	28336.1
1997	11000.0	26.78	480.0	1.17	23236.0	56.56	41082.9
1998	46398.3	57.69	3086.9	3.84	1440.0	1.79	80428.5
1999	31640.5	98.09					32256.8
2000	9443.0	15.12	364.5	0.58	28597.2	45.79	62451.7
2001	49964.9	29.01	5699.8	3.31	38838.4	22.55	172259.1
2002	26607.9	30.48	6221.0	7.13			87289.8
2003	77153.0	59.56	5735.9	4.43	20097.0	15.51	129547.8
2004	89152.6	80.56	3306.2	2.99			110669.6
1994-2004	477735.8	49.38	55234.3	5.71	142802.5	14.76	967416.4

Note: Missing information in the blanc places.
Source: WFP *Food Aid Information System* (www.wfp.org/fais/)

Table 17: Refugee Inflow and Aggregate Crop Supply and Subsistence

	Dummy: Crop seller			**Value of crop sales (z-score)**			**Fraction of crops sold**		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dummy: Year2004	-0.247***	-0.254***	-0.256***	0.0702	0.0725	0.0755	-0.00859	-0.0110	-0.0150*
	(0.0273)	(0.0257)	(0.0237)	(0.101)	(0.0993)	(0.106)	(0.00929)	(0.00865)	(0.00822)
Dummy: *Refugee1*	0.0625*			-0.0349			-0.00466		
	(0.0331)			(0.0633)			(0.0130)		
Refugee1 × Year2004	-0.0545	-0.0574	-0.0706	0.0250	-0.00732	-0.0396	0.0169	0.0133	0.0117
	(0.0441)	(0.0453)	(0.0502)	(0.0790)	(0.0737)	(0.0909)	(0.0120)	(0.0114)	(0.0107)
Land area	0.0404***	0.0354***	0.0213	0.228***	0.223***	0.221***	0.0214***	0.0196***	0.0147***
	(0.0137)	(0.0120)	(0.0149)	(0.0607)	(0.0629)	(0.0748)	(0.00357)	(0.00333)	(0.00373)
Observations	1,386	1,386	1,386	1,386	1,386	1,386	1,386	1,386	1,386
R-squared	0.116	0.124	0.172	0.057	0.050	0.056	0.070	0.055	0.054
Dummy: Year2004	-0.245***	-0.254***	-0.256***	0.0719	0.0723	0.0753	-0.00843	-0.0110	-0.0150*
	(0.0273)	(0.0257)	(0.0236)	(0.101)	(0.0986)	(0.105)	(0.00928)	(0.00865)	(0.00821)
Dummy: *Refugee1*	-0.0631			-0.312***			-0.0240*		
	(0.112)			(0.0867)			(0.0124)		
Refugee1(Rwanda)	0.121			0.362***			0.0231		
	(0.107)			(0.0850)			(0.0163)		
Refugee1 × Year2004	-0.115	-0.126	-0.132	0.212**	0.185**	0.210**	0.0223**	0.0183*	0.0216*
	(0.0829)	(0.0811)	(0.0958)	(0.0923)	(0.0857)	(0.0983)	(0.0101)	(0.0101)	(0.0114)
Refugee1(Rwanda) × Year2004	0.103	0.108	0.0983	-0.288***	-0.304***	-0.396***	-0.00792	-0.00789	-0.0157
	(0.0821)	(0.0830)	(0.101)	(0.0764)	(0.0783)	(0.128)	(0.0156)	(0.0148)	(0.0128)
Land area	0.0412***	0.0353***	0.0212	0.230***	0.223***	0.221***	0.0215***	0.0196***	0.0148***
	(0.0135)	(0.0119)	(0.0146)	(0.0596)	(0.0618)	(0.0725)	(0.00354)	(0.00332)	(0.00370)
Observations	1,386	1,386	1,386	1,386	1,386	1,386	1,386	1,386	1,386
R-squared	0.119	0.125	0.173	0.058	0.051	0.059	0.070	0.055	0.055
Village fixed effects	N	Y	N	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y	N	N	Y

Notes: Robust standard errors clustered at the village level in parentheses. For the variables *Crop sales* and *Land area*, z-score are used. Household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee1* is a dummy which takes 1 if one of the refugee camps is located within 50km from center of the village where each household lives.
*** p<0.01, ** p<0.05, * p<0.1

Table 18: Refugee Inflow and Structure of Crop Production and Marketization

(A)	Dep. Var.: Harvest Share of Each Crop out of Total Crop Harvests											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Maize	Maize	Maize	Beans	Beans	Beans	Coffee	Coffee	Coffee	Staple	Staple	Staple
Dummy: Year2004	0.0208**	0.0157*	0.0183*	-0.0347***	-0.0353***	-0.0361***	-0.0461***	-0.0458***	-0.0471***	-0.0433**	-0.0329*	-0.0237
	(0.00992)	(0.00898)	(0.00912)	(0.00818)	(0.00836)	(0.00884)	(0.00784)	(0.00738)	(0.00708)	(0.0169)	(0.0166)	(0.0184)
Dummy: *Refugee1*	-0.0319**			0.0210			-0.0133			0.0565*		
	(0.0146)			(0.0190)			(0.0115)			(0.0304)		
Refugee1 × Year2004	0.0103	0.00543	0.00813	-0.0104	-0.00750	-0.000248	0.0259**	0.0261**	0.0267**	0.00161	0.00351	0.00477
	(0.0140)	(0.0140)	(0.0136)	(0.0161)	(0.0155)	(0.0159)	(0.0126)	(0.0115)	(0.01000)	(0.0326)	(0.0316)	(0.0318)
Land area	-0.00471	-0.00886***	-0.00431	-0.00754***	-0.00813***	-0.00635*	0.00926**	0.0102***	0.00840***	-0.00925**	-0.00123	0.00520
	(0.00302)	(0.00300)	(0.00369)	(0.00273)	(0.00269)	(0.00338)	(0.00367)	(0.00325)	(0.00298)	(0.00455)	(0.00445)	(0.00523)
Village fixed effects	N	Y	N	N	Y	N	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y	N	N	Y	N	N	Y
Observations	1,386	1,386	1,386	1,386	1,386	1,386	1,386	1,386	1,386	1,386	1,386	1,386
R-squared	0.077	0.025	0.033	0.092	0.051	0.075	0.171	0.158	0.200	0.074	0.017	0.027
(B)	Dep. Var.: Sales Share of Each Crop out of Total Crop Sales											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Maize	Maize	Maize	Beans	Beans	Beans	Coffee	Coffee	Coffee	Staple	Staple	Staple
Dummy: Year2004	0.0487***	0.0458***	0.0481**	0.00967	0.00468	0.00814	-0.0930**	-0.103***	-0.101***	0.0204	0.0269	0.0368
	(0.0167)	(0.0159)	(0.0186)	(0.0135)	(0.0127)	(0.0161)	(0.0375)	(0.0331)	(0.0358)	(0.0271)	(0.0292)	(0.0308)
Dummy: *Refugee1*	0.0121			0.123***			0.0102			-0.0470		
	(0.00966)			(0.0384)			(0.0656)			(0.0348)		
Refugee1 × Year2004	0.00924	2.53e-05	0.0202	0.0534	0.0591	0.0610*	-0.0519	-0.0453	-0.0350	0.00555	0.00677	0.00832
	(0.0245)	(0.0247)	(0.0239)	(0.0341)	(0.0358)	(0.0323)	(0.0866)	(0.0828)	(0.0813)	(0.0333)	(0.0331)	(0.0350)
Land area	0.00341	0.000647	0.00370	-0.00253	-0.0100	-0.00260	-0.0219*	-0.0144	-0.0156	0.00902	0.0183**	0.0191*
	(0.00389)	(0.00283)	(0.00616)	(0.00665)	(0.00691)	(0.0105)	(0.0128)	(0.00876)	(0.0112)	(0.00659)	(0.00764)	(0.0109)
Village fixed effects	N	Y	N	N	Y	N	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y	N	N	Y	N	N	Y
Observations	1,008	1,008	1,008	1,008	1,008	1,008	1,008	1,008	1,008	1,008	1,008	1,008
R-squared	0.070	0.033	0.054	0.149	0.023	0.036	0.092	0.044	0.071	0.028	0.021	0.022

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 19: Refugee Inflow and Off-Farm Employment Wages

Dep. Var.: log (market wage)	**Household-level**			**Male**		
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy: Year2004	0.765***	0.778***	0.750*	0.763***	0.872***	0.488
	(0.159)	(0.152)	(0.389)	(0.156)	(0.166)	(0.489)
Dummy: *Refugee1*	0.362			0.312		
	(0.257)			(0.292)		
Refugee1 × Year2004	-0.257	0.00404	-1.173**	-0.173	0.0207	-2.053***
	(0.314)	(0.249)	(0.450)	(0.378)	(0.345)	(0.751)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	304	304	304	224	224	224
R-squared	0.097	0.091	0.090	0.096	0.085	0.158

Notes: Robust standard errors clustered at the village level in parentheses. The sample consists of agricultural households which supply labor to off-farm. Size of land area and household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee1* is a dummy which takes 1 if one of the refugee camps is located within 50km from center of the village where each household lives.
*** p<0.01, ** p<0.05, * p<0.1

Table 20: Refugee Inflow and Labor Market Efficiency with Alternative Treatment 1

(A)	**Dep. Var.: log (shadow wage of own farm work)**					
	(1)	(2)	(3)	(4)	(5)	(6)
	Male	Male	Male	Female	Female	Female
Dummy: Year2004	0.238	-0.162	-2.489	0.151	0.434	0.572
	(0.515)	(0.629)	(1.583)	(0.406)	(0.412)	(0.783)
Dummy: *Refugee2*	-0.0494			0.444*		
	(0.289)			(0.228)		
log (wage of off-farm job)	0.113	0.0408	-0.582	0.0815	0.116	0.273
	(0.129)	(0.173)	(0.471)	(0.100)	(0.102)	(0.275)
log (wage) × Year2004	-0.0886	0.0606	0.779	-0.0164	-0.0317	-0.140
	(0.150)	(0.186)	(0.465)	(0.122)	(0.122)	(0.270)
Refugee2 × Year2004	0.000470	0.0373	0.00605	-0.550	-0.733**	-0.821*
	(0.328)	(0.369)	(0.616)	(0.345)	(0.357)	(0.408)
Refugee2 × log (wage) × Year2004	-0.0145	-0.155*	-0.511***	-0.0484	-0.116	-0.258**
	(0.0602)	(0.0813)	(0.131)	(0.0608)	(0.0699)	(0.108)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	262	262	262	297	297	297
R-squared	0.079	0.074	0.259	0.088	0.104	0.217
(B)	**Dep. Var.: Absolute value of wage gap (log)**					
	(1)	(2)	(3)	(4)	(5)	(6)
	Male	Male	Male	Female	Female	Female
Dummy: Year2004	0.378*	0.0895	-0.326	0.455**	0.335*	0.578
	(0.205)	(0.218)	(0.449)	(0.197)	(0.191)	(0.360)
Dummy: *Refugee2*	-0.0181			-0.320		
	(0.259)			(0.312)		
Refugee2 × Year2004	0.305	0.876**	2.608***	0.521	0.944**	1.504***
	(0.343)	(0.350)	(0.667)	(0.410)	(0.405)	(0.451)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	262	262	262	297	297	297
R-squared	0.100	0.084	0.263	0.073	0.101	0.191

Notes: Robust standard errors clustered at the village level in parentheses. Wages are referred to only adult labor (age≥15). Household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee2* is a dummy which takes 1 if one of the refugee camps is located within own ward or the neighborhood wards of the village where each household lives. The sample consists of households in 1993 (pre-shock) and 2004 (pre-shock) which have *both* own-farm family labor and a member engaging in an outside job.
*** p<0.01, ** p<0.05, * p<0.1

Table 21: Refugee Inflow and Labor Market Participation with Alternative Treatment 1

(A)	**Dummy: Off-Farm Employment**			**Dummy: Hired Farm Labor**		
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy: Year2004	0.184***	0.194***	0.191***	-0.125***	-0.125***	-0.160***
	(0.0325)	(0.0322)	(0.0363)	(0.0324)	(0.0327)	(0.0336)
Dummy: *Refugee2*	0.0435			0.00173		
	(0.0467)			(0.0776)		
Refugee2 × Year2004	-0.144**	-0.129**	-0.113*	0.0189	0.00584	-0.00703
	(0.0541)	(0.0536)	(0.0588)	(0.0935)	(0.0919)	(0.0880)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	1,411	1,411	1,411	1,411	1,411	1,411
R-squared	0.045	0.041	0.049	0.098	0.103	0.127
(B)	**Dummy: Gender-Specific Off-Farm Employment**					
	(1)	(2)	(3)	(4)	(5)	(6)
	Male	Male	Male	Female	Female	Female
Dummy: Year2004	0.146***	0.159***	0.167***	0.0663***	0.0658***	0.0557**
	(0.0284)	(0.0276)	(0.0299)	(0.0223)	(0.0227)	(0.0228)
Dummy: *Refugee2*	0.0187			0.0370		
	(0.0333)			(0.0364)		
Refugee2 × Year2004	-0.135***	-0.128***	-0.116***	-0.0350	-0.0255	-0.00860
	(0.0415)	(0.0376)	(0.0385)	(0.0359)	(0.0364)	(0.0395)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	1,411	1,411	1,411	1,411	1,411	1,411
R-squared	0.043	0.041	0.049	0.021	0.016	0.018

Notes: Robust standard errors clustered at the village level in parentheses. Size of land area and household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee2* is a dummy which takes 1 if one of the refugee camps is located within own ward or the neighborhood wards of the village where each household lives.
*** p<0.01, ** p<0.05, * p<0.1

Table 22: Refugee Inflow and Transition from Subsistence to Sellers with Alternative Treatment 1

(A)	Dep. Var.: Seller dummies					
Market oriented crops	(1)	(2)	(3)	(4)	(5)	(6)
	Maize	Maize	Maize	Beans	Beans	Beans
Dummy: Year2004	0.124***	0.122***	0.125***	0.132***	0.116***	0.0920***
	(0.0234)	(0.0234)	(0.0276)	(0.0265)	(0.0239)	(0.0244)
Dummy: *Refugee2*	-0.0281**			-0.0436*		
	(0.0118)			(0.0258)		
Refugee2 × Year2004	0.0968**	0.0844**	0.0585	0.152**	0.148**	0.145**
coefficient $\equiv \beta$	(0.0369)	(0.0384)	(0.0384)	(0.0639)	(0.0662)	(0.0679)
Coefficient equality test of β				=(1)	=(2)	=(3)
p-value				0.2407	0.1831	0.0841
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	1,253	1,253	1,253	1,189	1,189	1,189
R-squared	0.071	0.058	0.063	0.117	0.061	0.070
(B)	Dep. Var.: Seller dummies					
Staple crops	(1)	(2)	(3)	(4)	(5)	(6)
	Plantain	Plantain	Plantain	Cassava	Cassava	Cassava
Dummy: Year2004	0.225***	0.223***	0.223***	0.104***	0.100***	0.108***
	(0.0307)	(0.0291)	(0.0307)	(0.0158)	(0.0168)	(0.0198)
Dummy: *Refugee2*	-0.000367			-0.0114		
	(0.0175)			(0.0151)		
Refugee2 × Year2004	-0.0891***	-0.0890***	-0.0950***	0.0210	0.0174	0.0194
	(0.0331)	(0.0318)	(0.0352)	(0.0261)	(0.0241)	(0.0241)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	1,117	1,117	1,117	1,235	1,235	1,235
R-squared	0.075	0.065	0.074	0.041	0.040	0.045

Notes: Robust standard errors clustered at the village level in parentheses. For each crop-level estimation, we use the subsamples of the that crop's subsistence households in 1993 (pre-shock) and their related households in 2004 (post-shock). Size of land area and household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee2* is a dummy which takes 1 if one of the refugee camps is located within own ward or the neighborhood wards of the village where each household lives.
*** p<0.01, ** p<0.05, * p<0.1

Table 23: Refugee Inflow and Food Crop Supplies to Markets with Alternative Treatment 1

(A)	Value of crop sales (z-score)						Fraction of a crop sold					
Market oriented crops	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Maize	Maize	Maize	Beans	Beans	Beans	Maize	Maize	Maize	Beans	Beans	Beans
Dummy: Year2004	0.337**	0.311***	0.301**	0.155***	0.145***	0.0907***	0.0296***	0.0280***	0.0274***	0.0257***	0.0222***	0.0193***
	(0.130)	(0.107)	(0.116)	(0.0416)	(0.0401)	(0.0335)	(0.00783)	(0.00731)	(0.00756)	(0.00693)	(0.00583)	(0.00571)
Dummy: *Refugee2*	-0.102			-0.116			-0.00884*			-0.0178		
	(0.0651)			(0.0813)			(0.00477)			(0.0118)		
Refugee2 × Year2004	0.207**	0.177*	0.123	0.279*	0.245*	0.241*	0.0118	0.00979	0.00356	0.0471**	0.0435*	0.0441*
coefficient $\equiv \beta$	(0.0936)	(0.0886)	(0.0971)	(0.146)	(0.138)	(0.143)	(0.00859)	(0.00831)	(0.00832)	(0.0218)	(0.0218)	(0.0229)
Coefficient equality test of β				=(1)	=(2)	=(3)				=(7)	=(8)	=(9)
p-value				0.6127	0.6120	0.3960				0.0495	0.0599	0.0469
Village fixed effects	N	Y	N	N	Y	N	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y	N	N	Y	N	N	Y
Observations	1,251	1,251	1,251	1,187	1,187	1,187	1,191	1,191	1,191	1,146	1,146	1,146
R-squared	0.050	0.047	0.056	0.083	0.021	0.018	0.036	0.035	0.042	0.117	0.036	0.050
(B)	Value of crop sales (z-score)						Fraction of a crop sold					
Staple crops	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Plantain	Plantain	Plantain	Cassava	Cassava	Cassava	Plantain	Plantain	Plantain	Cassava	Cassava	Cassava
Dummy: Year2004	0.198***	0.189***	0.159***	0.154**	0.137**	0.143***	0.0466***	0.0420***	0.0363***	0.0273***	0.0243***	0.0242***
	(0.0617)	(0.0569)	(0.0422)	(0.0641)	(0.0533)	(0.0531)	(0.0119)	(0.00962)	(0.00819)	(0.00859)	(0.00709)	(0.00708)
Dummy: *Refugee2*	0.0306			-0.00734			0.00243			0.00139		
	(0.0256)			(0.0315)			(0.00396)			(0.00639)		
Refugee2 × Year2004	-0.132**	-0.138**	-0.0898**	0.0546	0.0232	-0.00859	-0.0222***	-0.0249***	-0.0256***	0.0177	0.00868	0.000852
	(0.0596)	(0.0574)	(0.0346)	(0.0645)	(0.0561)	(0.0403)	(0.00802)	(0.00778)	(0.00814)	(0.0143)	(0.0130)	(0.00927)
Village fixed effects	N	Y	N	N	Y	N	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y	N	N	Y	N	N	Y
Observations	1,116	1,116	1,116	1,234	1,234	1,234	1,029	1,029	1,029	1,081	1,081	1,081
R-squared	0.015	0.014	0.024	0.038	0.032	0.048	0.039	0.034	0.044	0.038	0.031	0.046

Notes: Robust standard errors clustered at the village level in parentheses. For each crop-level estimation, we use the subsamples of the that crop's subsistence households in 1993 (pre-shock) and their related households in 2004 (post-shock). Size of land area and household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee2* is a dummy which takes 1 if one of the refugee camps is located within own ward or the neighborhood wards of the village where each household lives.
*** p<0.01, ** p<0.05, * p<0.1

Table 24: Refugee Inflow and Labor Market Efficiency with Alternative Treatment 2

(A)	**Dep. Var.: log (shadow wage of own farm work)**					
	(1)	(2)	(3)	(4)	(5)	(6)
	Male	Male	Male	Female	Female	Female
Dummy: Year2004	0.285	-0.495	10.35	2.721**	0.711	4.359
	(2.291)	(2.708)	(6.961)	(1.175)	(1.593)	(3.754)
Refugee3	0.418			-0.307		
	(0.299)			(0.278)		
log (wage of off-farm job)	0.0893	0.0438	-0.953***	0.0886	0.0968	0.103
	(0.132)	(0.174)	(0.340)	(0.101)	(0.105)	(0.312)
log (wage) × Year2004	-0.0669	0.0492	1.311***	0.0443	0.0337	0.160
	(0.156)	(0.193)	(0.378)	(0.124)	(0.124)	(0.351)
Refugee3 × Year2004	-0.0381	0.0916	-3.421*	-0.691**	-0.159	-1.210
	(0.566)	(0.673)	(1.777)	(0.275)	(0.391)	(1.028)
Refugee3 × log (wage) × Year2004	0.00645	-0.136	-0.689***	-0.193***	-0.216***	-0.414***
	(0.0754)	(0.0928)	(0.156)	(0.0615)	(0.0687)	(0.0851)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	262	262	262	297	297	297
R-squared	0.089	0.074	0.321	0.122	0.085	0.205
(B)	**Dep. Var.: Absolute value of wage gap (log)**					
	(1)	(2)	(3)	(4)	(5)	(6)
	Male	Male	Male	Female	Female	Female
Dummy: Year2004	0.820	2.456	8.456	0.0380	3.054*	-1.949
	(1.365)	(1.487)	(10.14)	(1.413)	(1.780)	(4.283)
Refugee3	-0.145			0.453		
	(0.289)			(0.369)		
Refugee3 × Year2004	-0.0885	-0.516	-1.883	0.119	-0.608	0.699
	(0.342)	(0.368)	(2.350)	(0.348)	(0.431)	(0.992)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	262	262	262	297	297	297
R-squared	0.091	0.069	0.132	0.076	0.079	0.184

Notes: Robust standard errors clustered at the village level in parentheses. Wages are referred to only adult labor (age≥15). Household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee3* is log of the distance between the center of the village each household lives and its nearest refugee camp. The sample consists of households in 1993 (pre-shock) and 2004 (pre-shock) which have *both* own-farm family labor and a member engaging in an outside job.
*** p<0.01, ** p<0.05, * p<0.1

Table 25: Refugee Inflow and Labor Market Participation with Alternative Treatment 2

(A)	**Dummy: Off-Farm Employment**			**Dummy: Hired Farm Labor**		
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy: Year2004	-0.303*	-0.217	-0.160	0.115	0.0355	0.000530
	(0.151)	(0.131)	(0.131)	(0.183)	(0.169)	(0.173)
Refugee3	0.0136			-0.0123		
	(0.0541)			(0.0577)		
Refugee3 × Year2004	0.114***	0.0957***	0.0829**	-0.0597	-0.0403	-0.0412
	(0.0382)	(0.0338)	(0.0340)	(0.0429)	(0.0393)	(0.0383)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	1,386	1,386	1,386	1,386	1,386	1,386
R-squared	0.049	0.041	0.050	0.102	0.104	0.129
(B)	**Dummy: Gender-Specific Off-Farm Employment**					
	(1)	(2)	(3)	(4)	(5)	(6)
	Male	Male	Male	Female	Female	Female
Dummy: Year2004	-0.397***	-0.313**	-0.269**	0.0572	0.0581	0.0951
	(0.139)	(0.123)	(0.124)	(0.0641)	(0.0640)	(0.0745)
Refugee3	-0.0379			0.0273		
	(0.0471)			(0.0188)		
Refugee3 × Year2004	0.128***	0.110***	0.103***	0.00120	0.00115	-0.00906
	(0.0351)	(0.0315)	(0.0316)	(0.0171)	(0.0172)	(0.0193)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	1,386	1,386	1,386	1,386	1,386	1,386
R-squared	0.043	0.040	0.048	0.022	0.017	0.022

Notes: Robust standard errors clustered at the village level in parentheses. Size of land area and household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee3* is log of the distance between the center of the village each household lives and its nearest refugee camp.
*** p<0.01, ** p<0.05, * p<0.1

Table 26: Refugee Inflow and Transition from Subsistence to Sellers with Alternative Treatment 2

(A)	Dep. Var.: Seller dummies					
Market oriented crops	(1)	(2)	(3)	(4)	(5)	(6)
	Maize	Maize	Maize	Beans	Beans	Beans
Dummy: Year2004	0.310**	0.256*	0.228*	0.640***	0.630***	0.535**
	(0.120)	(0.128)	(0.125)	(0.205)	(0.211)	(0.201)
Refugee3	0.0436*			-0.0298		
	(0.0231)			(0.0368)		
Refugee3 × Year2004	-0.0405	-0.0287	-0.0235	-0.118**	-0.119**	-0.102**
	(0.0305)	(0.0324)	(0.0309)	(0.0495)	(0.0509)	(0.0490)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	1,235	1,235	1,235	1,169	1,169	1,169
R-squared	0.066	0.056	0.061	0.122	0.061	0.068
(B)	Dep. Var.: Seller dummies					
Staple crops	(1)	(2)	(3)	(4)	(5)	(6)
	Plantain	Plantain	Plantain	Cassava	Cassava	Cassava
Dummy: Year2004	0.0913	0.102	0.102	0.162**	0.185***	0.254***
	(0.0851)	(0.0963)	(0.111)	(0.0693)	(0.0635)	(0.0715)
Refugee3	0.000995			0.0306		
	(0.0323)			(0.0251)		
Refugee3 × Year2004	0.0275	0.0249	0.0243	-0.0141	-0.0210	-0.0367**
	(0.0240)	(0.0265)	(0.0295)	(0.0174)	(0.0160)	(0.0175)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	1,100	1,100	1,100	1,213	1,213	1,213
R-squared	0.068	0.064	0.067	0.042	0.040	0.046

Notes: Robust standard errors clustered at the village level in parentheses. For each crop-level estimation, we use the subsamples of the that crop's subsistence households in 1993 (pre-shock) and their related households in 2004 (post-shock). Size of land area and household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *.Refugee3* is log of the distance between the center of the village each household lives and its nearest refugee camp.

*** p<0.01, ** p<0.05, * p<0.1

Table 27: Refugee Inflow and Food Crop Supplies to Markets with Alternative Treatment 2

(A)	Value of crop sales (z-score)						Fraction of a crop sold					
Market oriented crops	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Maize	Maize	Maize	Beans	Beans	Beans	Maize	Maize	Maize	Beans	Beans	Beans
Dummy: Year2004	0.686***	0.589**	0.359	0.959**	0.883**	0.784**	0.0652**	0.0574**	0.0340	0.161***	0.149***	0.156***
	(0.244)	(0.230)	(0.215)	(0.417)	(0.383)	(0.380)	(0.0250)	(0.0242)	(0.0238)	(0.0588)	(0.0550)	(0.0531)
Refugee3	0.102			-0.0307			0.00463			-0.00132		
	(0.0906)			(0.0590)			(0.00655)		(0.0115)			
Refugee3 × Year2004	-0.0738	-0.0589	-0.00798	-0.184*	-0.169*	-0.159*	-0.00820	-0.00676	-0.00150	-0.0311**	-0.0291**	-0.0317**
	(0.0521)	(0.0505)	(0.0526)	(0.0948)	(0.0863)	(0.0884)	(0.00572)	(0.00557)	(0.00594)	(0.0139)	(0.0129)	(0.0123)
Village fixed effects	N	Y	N	N	Y	N	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y	N	N	Y	N	N	Y
Observations Observations	1,234	1,234	1,234	1,168	1,168	1,168	1,175	1,175	1,175	1,128	1,128	1,128
R-squared	0.049	0.046	0.055	0.084	0.020	0.017	0.036	0.035	0.042	0.116	0.034	0.048
(B)	Value of crop sales (z-score)						Fraction of a crop sold					
Staple crops	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Plantain	Plantain	Plantain	Cassava	Cassava	Cassava	Plantain	Plantain	Plantain	Cassava	Cassava	Cassava
Dummy: Year2004	0.165	0.177	0.193	0.198	0.219	0.224	0.00931	0.0125	0.0148	0.0480	0.0517	0.0535
	(0.127)	(0.155)	(0.144)	(0.150)	(0.151)	(0.149)	(0.0284)	(0.0318)	(0.0299)	(0.0310)	(0.0363)	(0.0344)
Refugee3	-0.141*			0.00527			-0.0122			-0.00562		
	(0.0703)			(0.0729)			(0.0138)			(0.0140)		
Refugee3 × Year2004	-0.00303	-0.00639	-0.0129	-0.00724	-0.0190	-0.0206	0.00771	0.00614	0.00413	-0.00419	-0.00638	-0.00731
	(0.0329)	(0.0400)	(0.0358)	(0.0338)	(0.0354)	(0.0364)	(0.00788)	(0.00852)	(0.00791)	(0.00751)	(0.00909)	(0.00865)
Village fixed effects	N	Y	N	N	Y	N	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y	N	N	Y	N	N	Y
Observations	1,116	1,116	1,116	1,234	1,234	1,234	1,029	1,029	1,029	1,081	1,081	1,081
R-squared	0.015	0.014	0.024	0.038	0.032	0.048	0.039	0.034	0.044	0.038	0.031	0.046

Notes: Robust standard errors clustered at the village level in parentheses. For each crop-level estimation, we use the subsamples of the that crop's subsistence households in 1993 (pre-shock) and their related households in 2004 (post-shock). Size of land area and household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here.*Refugee3* is log of the distance between the center of the village each household lives and its nearest refugee camp.
*** p<0.01, ** p<0.05, * p<0.1

Table 28: Placebo Test of Labor Market Participation and Efficiency

(A)	**Dummy: Off-Farm Employment**			**Dummy: Hired Farm Labor**		
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy: Year1993	0.0278	0.0275	0.0281	0.208***	0.208***	0.213***
	(0.0203)	(0.0202)	(0.0200)	(0.0266)	(0.0267)	(0.0267)
Dummy: *Refugee1*	-0.0271			0.0205		
	(0.0290)			(0.0544)		
Refugee1 × Year1993	0.0254	0.0251	0.0266	-0.0376	-0.0347	-0.0386
	(0.0353)	(0.0348)	(0.0341)	(0.0583)	(0.0584)	(0.0574)
Observations	1,468	1,468	1,468	1,468	1,468	1,468
R-squared	0.018	0.020	0.016	0.084	0.060	0.139
(B)	**Dummy: Gender-Specific Off-Farm Employment**					
	(1)	(2)	(3)	(4)	(5)	(6)
	Male	Male	Male	Female	Female	Female
Dummy: Year1993	0.0110	0.0109	0.0113	0.0167	0.0164	0.0165
	(0.0154)	(0.0152)	(0.0151)	(0.0143)	(0.0143)	(0.0145)
Dummy: *Refugee1*	-0.0167			-0.0159		
	(0.0229)			(0.0155)		
Refugee1 × Year1993	0.0470*	0.0467*	0.0484*	-0.0166	-0.0167	-0.0163
	(0.0277)	(0.0270)	(0.0266)	(0.0172)	(0.0174)	(0.0178)
Observations	1,468	1,468	1,468	1,468	1,468	1,468
R-squared	0.014	0.014	0.019	0.014	0.013	0.005
(C)	**Absolute value of wage gap (log)**					
	(1)	(2)	(3)	(4)	(5)	(6)
	Male	Male	Male	Female	Female	Female
Dummy: Year1993	0.136	0.203	0.258	-0.482*	-0.403	0.114
	(0.261)	(0.345)	(0.626)	(0.287)	(0.424)	(0.534)
Dummy: *Refugee1*	-0.101			0.0193		
	(0.447)			(0.296)		
Refugee1 × Year1993	0.287	0.141	0.0162	-0.149	-0.262	-0.875
	(0.345)	(0.388)	(0.692)	(0.385)	(0.491)	(0.572)
Observations	142	142	142	157	157	157
R-squared	0.088	0.077	0.099	0.102	0.074	0.299
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y

Notes: Robust standard errors clustered at the village level in parentheses. The sample consists of households from 1991 and 1993, both of which are before the refugee inflow. Size of land area and household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee1* is a dummy which takes 1 if one of the refugee camps is located within 50km from center of the village where each household lives.

*** p<0.01, ** p<0.05, * p<0.1

Table 29: Placebo Test of Crop Market Participation

(A)	Dep. Var.: Seller dummies					
Market oriented crops	(1)	(2)	(3)	(4)	(5)	(6)
	Maize	Maize	Maize	Beans	Beans	Beans
Dummy: Year1993	0.0769***	0.0747***	0.0747***	0.0788***	0.0827***	0.0713***
	(0.0174)	(0.0171)	(0.0198)	(0.0206)	(0.0211)	(0.0225)
Dummy: *Refugee1*	-0.0168			-0.0299		
	(0.0170)			(0.0545)		
Refugee1 × Year1993	0.0230	0.0241	0.0356	0.266***	0.272***	0.271***
	(0.0341)	(0.0346)	(0.0376)	(0.0815)	(0.0828)	(0.0814)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	827	827	827	904	904	904
R-squared	0.055	0.052	0.097	0.205	0.169	0.258
(B)	Dep. Var.: Seller dummies					
Staple crops	(1)	(2)	(3)	(4)	(5)	(6)
	Plantain	Plantain	Plantain	Cassava	Cassava	Cassava
Dummy: Year1993	0.195***	0.190***	0.185***	0.151***	0.149***	0.135***
	(0.0317)	(0.0316)	(0.0342)	(0.0222)	(0.0233)	(0.0258)
Dummy: *Refugee1*	-0.00454			-0.00820		
	(0.0358)			(0.0189)		
Refugee1 × Year1993	0.00926	2.02e-05	-0.0182	-0.0464	-0.0478	-0.0360
	(0.0417)	(0.0430)	(0.0456)	(0.0360)	(0.0346)	(0.0401)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	781	781	781	1,009	1,009	1,009
R-squared	0.145	0.160	0.262	0.086	0.094	0.169

Notes: Robust standard errors clustered at the village level in parentheses. For each crop-level estimation, we use the subsamples of the that crop's subsistence households in 1991 and their related households in 1993, both of which are before the refugee inflow. Size of land area and household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee1* is a dummy which takes 1 if one of the refugee camps is located within 50km from center of the village where each household lives.
*** p<0.01, ** p<0.05, * p<0.1

Table 30: Refugee Inflow and Crop Supply among Initial Sellers

(A)	**Dep. Var.: Value of crop sales (z-score)**					
	(1)	(2)	(3)	(4)	(5)	(6)
	Maize	Maize	Maize	Beans	Beans	Beans
Dummy: Year2004	-0.711*	-0.733*	-0.510	-0.645***	-0.564***	-0.529**
	(0.372)	(0.379)	(0.505)	(0.202)	(0.206)	(0.249)
Dummy: *Refugee1*	-0.372			0.219		
	(0.651)			(0.346)		
Refugee1 × Year2004	0.712	0.557	0.455	0.0987	0.0132	-0.185
	(0.586)	(0.592)	(0.641)	(0.406)	(0.393)	(0.473)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	772	772	772	846	846	846
R-squared	0.136	0.111	0.112	0.173	0.092	0.118
(B)	**Dep. Var.: Fraction of a crop sold**					
	(1)	(2)	(3)	(4)	(5)	(6)
	Maize	Maize	Maize	Beans	Beans	Beans
Dummy: Year2004	-0.156***	-0.147***	-0.138***	-0.103***	-0.0780***	-0.0544**
	(0.0420)	(0.0415)	(0.0505)	(0.0220)	(0.0197)	(0.0204)
Dummy: *Refugee1*	0.0594			0.0112		
	(0.0960)			(0.0307)		
Refugee1 × Year2004	-0.0188	-0.0413	-0.0499	0.0772**	0.0509	0.00711
	(0.0819)	(0.0792)	(0.0744)	(0.0313)	(0.0335)	(0.0325)
Village fixed effects	N	Y	N	N	Y	N
Initial household fixed effects	N	N	Y	N	N	Y
Observations	718	718	718	812	812	812
R-squared	0.153	0.133	0.147	0.173	0.046	0.068

Notes: Robust standard errors clustered at the village level in parentheses.For each crop-level estimation, we use the subsamples of the that crop's *seller* households in 1993 (pre-shock) and their related households in 2004 (post-shock). Size of land area and household demographic information (household size, number of adult household members; religion dummies; tribe dummies) are controlled in all the specifications presented here. *Refugee1* is a dummy which takes 1 if one of the refugee camps is located within 50km from center of the village where each household lives.
*** p<0.01, ** p<0.05, * p<0.1

Appendix B. Procedure of Estimating Shadow Wages

This appendix section describes the detail procedure of estimating shadow wages, in which I follow Jacoby (1993) and Skoufias (1994). We use annual data for getting information regarding agricultural production. In wave5 (2004), we have annual production data while in Wave2 (1992) and Wave3 (1993) we have only retrospective data for 6 months. Thus for the period before refugee inflow, we use the annual data of 1992-1993 which is a combined data between Wave2 (1992) and Wave3 (1993), since wave3 interview for data collecting was taken after 6 months from the wave2 interview[16]. For the period after refugee inflow, we use the annual data from 2004 (Wave5). As a benchmark reference, the annual data from Wave1 (1991) is also used to estimate shadow wages in 1991.

B.1. Construct the Subsample in 1993

The original sample size of Wave2 (1992) households is 876. Out of the 876 households, we have 863 households which have at least one individual who has owned or worked on a shamba/garden, and 643 households which have at least one individual who has raised or owned livestock or animals. Out of the 876 households, we finally got 865 households by dropping 11 households which have no members who either owned or worked on a shamba/garden, or who raised or owned livestock/animals.

The original sample size of Wave3 (1993) households is 829. Out of the 829 households, we have 820 households which have at least one individual who has owned or worked on a shamba/garden, and 611 households which have at least one individual who has raised or owned livestock or animals. Out of the 829 households, we finally got 820 households by dropping 9 households which have no members who either owned or worked on a shamba/garden, or who raised or owned livestock/animals.

Finally, we combine these two production data sets. After dropping attrition households, we got 817 households,

B.2. Construct the Subsample in 2004

The number of households interviewed in 2004 is 2774. The increase from the sample size in the early 90's is because we have splitting households in 2004 from the original 919 households in 1991. Out of

[16]Ikegami (2008) adopted the same way to construct annual data sets.

this overall sample, we make a subsample for agricultural production function estimation by the following procedure.

1. Detail questions in the section of agricultural production such as farm inputs and sales of crop products are dropped for tracked households. In order to keep the consistency in the estimation of agricultural production function, we drop such households. We have 1659 untracked households.
2. Out of the 2774 households, 266 households migrated to elsewhere in Tanzania and 52 households migrated to neighboring countries. Since our focus is within Kagera region, we drop such households for the shadow wage estimation. We have 1361 household in the same cluster as 10 years ago, 536 households in nearby villages, and 559 households which moved to elsewhere in Kagera. We first start our analysis using the sum of these three types of households, the total is 2456 households.
3. Out of the 2774 households, we have 2280 households which have at least one individual who has owned or worked on a shamba/garden, and 1514 households which have at least one individual who has raised or owned livestock or animals. We choose the households so that each household has at least one individual who owned or worked on a shamba/garden, or who raised or owned livestock/animals.

By restricting our sample following these three procedures, we got 1265 households. Finally, by dropping 35 households which have outliers in output values, we got 1230 households for production function estimation.

B.3. Outputs and Inputs Variables for the Estimation of Shadow Wages

Following the similar way as Jacoby (1993) and Skoufias (1994), the total value of agricultural outputs is defined as the sum of the followings:

{Value of harvest of crops sold; Value of crops lost; Value of crops kept for seed or given to laborers or landowner, or as gifts in ceremonies; Value of crops in stock; Value of crop products sold; Value of food consumption of home products; $0.2\times$Value of Livestock owned; Value of (animal) meat consumed; Value of animal products sold}

The value of harvest crops sold, crop products sold, and animal products sold are actual monetary revenue of these products sales. Other variables are monetary values evaluated by each household. For example, the value of crops lost (due to insects, rodents, fire, rotting, etc) is asked by a following question: If you had sold the lost quantity at the time you lost it, what is the most monetary amount you have gotten (TSHS)? Similar questions are asked for other variables as well.

B.4. Estimation of Cobb-Douglas Production Function and Shadow Wages

This subsection briefly reports the estimation of the Cobb-Douglas production function of the composite agricultural product[17] and the shadow wages of agricultural households in Kagera region. Assume that the production function $F()$ in (1) has the cobb-douglas form. We follow the same procedure as Jacoby (1993) and Skoufias (1994) for the shadow wage estimation. The definition of the shadow wage is in (2). The estimated shadow wage for each sex j is defined as

$$w_j^* \equiv MPL_j = \hat{\beta}\frac{p_f^* \hat{q_f}}{L_j} \tag{11}$$

where $\hat{\beta}$ is the estimated coefficient of labor time by each sex in the estimation of Cobb-Douglas production function (taking logs in all the variables) and $p^*\hat{q_f}$ is the predicted output value of the composite agricultural product from the estimated coefficients. Note that we have the data of the agricultural product represented by the value of products, regarding it as the proxy for $p_f^* q_f$. Table 31 presents the OLS estimation results of the Cobb-Douglas agricultural production function. Table 7 shows the estimated shadow wages and the market wages of agricultural households members adopting the specifications with the village fixed effects.

[17] Although we have the agricultural product data by crops as shown in the last subsection, we aggregate the agricultural products for the production function estimation, since we could not distinguish the inputs data for each crop production.

Table 31: Cobb-Douglas Agricultural Production Function Estimation

	Dependent variable.: Total output of agricultural products					
	(1)	(2)	(3)	(4)	(5)	(6)
	1991	1991	1993	1993	2004	2004
Land area (acres)	0.333***	0.350***	0.306***	0.306***	0.633***	0.629***
	(0.0662)	(0.0659)	(0.0440)	(0.0474)	(0.0744)	(0.0792)
Adult male labor (hours)	0.0469***	0.0357***	0.0313***	0.0331***	0.0532***	0.0512***
	(0.0141)	(0.0122)	(0.00689)	(0.00721)	(0.0157)	(0.0166)
Adult female labor (hours)	0.0558**	0.0455**	0.0813***	0.0756***	0.116***	0.113***
	(0.0227)	(0.0198)	(0.0101)	(0.0112)	(0.0201)	(0.0205)
Child male labor (hours)	0.0188**	0.0155*	0.0310***	0.0308***	0.0451***	0.0474***
	(0.00813)	(0.00914)	(0.00459)	(0.00482)	(0.0157)	(0.0171)
Child female labor (hours)	0.0424***	0.0398***	0.0190***	0.0171***	-0.00779	-0.0129
	(0.00884)	(0.00942)	(0.00560)	(0.00521)	(0.0248)	(0.0251)
Hired labor	0.0150	0.0113	0.0135***	0.0140***	0.0379***	0.0426***
	(0.0113)	(0.0115)	(0.00441)	(0.00444)	(0.0108)	(0.0109)
Manure	0.0131	0.0276*	0.0116	0.0101	0.00708	0.00689
	(0.0139)	(0.0153)	(0.00764)	(0.00777)	(0.0107)	(0.0120)
Fertilizer	0.0121	0.0226	0.00264	0.000434	-0.0545***	-0.0470*
	(0.0237)	(0.0211)	(0.0115)	(0.0138)	(0.0190)	(0.0254)
Pesticide	0.0122	0.0187	0.0212*	0.0280**	0.0303	0.0424**
	(0.0139)	(0.0145)	(0.0117)	(0.0122)	(0.0184)	(0.0198)
Transportation costs	0.0469***	0.0507***	0.0202**	0.0284***	0.00902	0.0145
	(0.0136)	(0.0126)	(0.00857)	(0.00780)	(0.0271)	(0.0286)
Other inputs	0.0212*	0.0183	0.0242***	0.0172***	0.0219	0.00711
	(0.0115)	(0.0112)	(0.00643)	(0.00619)	(0.0150)	(0.0175)
Livestock inputs	0.0308***	0.0253**	0.0269***	0.0261***	0.0307***	0.0247*
	(0.0110)	(0.0102)	(0.00421)	(0.00516)	(0.0114)	(0.0132)
Kiangaza dummy	-0.305**	0.0881	-0.153	-0.0765	-0.639***	-0.837***
	(0.119)	(0.113)	(0.141)	(0.162)	(0.217)	(0.304)
Masika dummy	0.101	-0.0231	-0.0680	-0.360***	-0.218	-0.452
	(0.153)	(0.269)	(0.0502)	(0.131)	(0.131)	(0.380)
Constant	10.75***	10.80***	10.39***	10.43***	9.229***	10.65***
	(0.255)	(0.149)	(0.110)	(0.0819)	(0.598)	(0.181)
Observations	888	891	817	817	1,222	1,222
R-squared	0.239	0.361	0.569	0.627	0.233	0.270
District fixed effect	Y	N	Y	N	Y	N
Village fixed effect	N	Y	N	Y	N	Y

Notes: Robust standard errors clustered at the village level in parentheses. We are taking log of all the variables. Input variables other than land and family labor (hired labor, manure, fertilizer, pesticide, transportation costs, livestock inputs, and other inputs) are expenditures spent in last 12 months. *Kiangaza* dummy and *Masika* dummy are the dummies which take one if the survey interview was taken during a dry season and a rainy season, respectively. *** p<0.01, ** p<0.05, * p<0.1.