Commodity Price Volatility and Migration: Evidence from Rural Ethiopia

Yu Na Lee*

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Abstract

In many developing countries rural-to-urban migration persists even when the expected income is lower in urban areas compared to rural areas, and a stream of literature has indicated that migration is a strategy to manage income risks. To better understand the mechanism of rural-to-urban migration in developing countries in which agriculture constitutes a substantial part of economic activities, it is important to understand not only the income risk, but also the price risk of staple commodities. This paper investigates whether commodity price volatility drives out-migration from rural areas. I adapt a standard agricultural household model and set up a simple model in which a rural household makes migration decisions facing uncertainties in both commodity prices and urban wage. Using the Ethiopian Rural Household Survey panel for the period 1994-97, I find that greater household-level willingness to pay for price stabilization is significantly related to higher incidence of migration, both in extensive and intensive margins. This significant relationship is more pronounced in the villages that lack daily markets, producer co-ops, and programs such as food aid, food-for-work, and cash-for-work. I also find that village-level price volatility of coffee−one of the most important cash crops in Ethiopia−is significantly related to out-migration. This study provides the first evidence that migration is a price risk management strategy of rural households and complements the theory of migration as an income risk management strategy.

JEL Classifications: D81, O12, O13, O15, Q12
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*Ph.D. Candidate, Department of Applied Economics, University of Minnesota, Saint Paul, MN, 55108. Email: leex5244@umn.edu. For the latest version, check my website: https://sites.google.com/site/ynlee0120/

1 Introduction

The proportion of urban population over the world has steadily increased over the past half-century. Internal migration from rural to urban areas has been recognized as the main driver for this urbanization process. Reallocation of labor from agriculture to industry due to migration contributes to the structural transformation that is key to economic development. Consequently, motivations for internal migration have been an important area of research. Todaro (1969) and Harris and Todaro (1970) developed models in which higher expected income in urban areas explains rural-to-urban migration. Katz and Stark (1986) later offered a theoretical explanation that income risk aversion can motivate rural-to-urban migration, even when the expected income is lower in urban areas. Migration is one strategy that rural households use to manage income risk (Stark and Levhari, 1982; Rosenzweig and Stark, 1989), and a body of recent empirical literature has examined the direct relationship between income risk aversion and migration (Heitmueller, 2005; Jaeger et al., 2010; Bonin et al., 2009; Constant et al. 2011; Hao et al., 2014).

To better understand the mechanism of rural-to-urban migration in developing countries, it is important to understand not only the income risk, but also the price risk[1] of agricultural commodities, for several reasons. First, agriculture constitutes a substantial part of economic activities in developing countries, in terms of both production and consumption. On the production side, shares of agriculture in GDP in developing countries are more than double the shares in developed countries (World Bank, 2014a). Especially in Africa, a higher share of population depends on agriculture for its living than in any other region (Minot, 2011). On the consumption side, the shares of food in households' budgets are much higher in developing countries than in developed countries.[2] Second, food price volatility has been considered harmful for both producers and consumers of agricultural commodities in developing countries. Given that production decisions must be made well before prices are realized, and that such decisions are hard to reverse once prices are realized, an income

[1] Hereafter I will use the terms "volatility," "fluctuation," "risk," and "uncertainty" interchangeably. I will use "price" to mean either producer, wholesale, or consumer price, and will focus on staple food prices.

[2] In countries such as Egypt, Malawi, Mozambique, Peru, and Nepal, shares of household expenditure on food in urban areas range from 37% to 69%. For all these countries the shares are even higher in rural areas (FAO, 2004). On the contrary, the share is only around 10% in the U.S. (USDA ERS, 2014), and ranges from 13% to 20% in OECD countries (OECD and FAO, 2008) for the same time period.

risk-averse producer is likely produce at a sub-optimal level (Sandmo, 1971). Proper insurance schemes to help producers manage price risks often do not exist in developing countries. High food price volatility can also create food security stress for consumers in developing countries (Barrett, 1996) where the budget shares of food are very high, and close substitutes for staples are often unavailable when food prices soar. Moreover, typical rural households in developing countries both produce and consume several agricultural commodities, resulting in exposure to price risks in terms of both production and consumption.

In this paper, I examine the role of agricultural price risk as a push factor on rural-to-urban migration by investigating two potential channels by which commodity price risk can affect rural out-migration. The main research questions are: (i) Do household risk attitudes towards commodity prices affect rural out-migration?, and (ii) Does a high degree of commodity price volatility increase rural out-migration? The former question focuses on the role of preferences, whereas the latter focuses on the direct impact of price volatility at a village level.

I model a household's decision to send one or more of its members to urban areas as a family labor allocation decision, adapting the standard agricultural household model (Singh, Squire, and Strauss, 1986) in which a rural household can produce an agricultural commodity and can consume some of it. Theoretical predictions are derived assuming that uncertainty lies in both the commodity prices in rural areas as well as the future wage that a potential migrant will receive in an urban area. For empirical analysis, I focus on rural households of Ethiopia by using several rounds of data from the Ethiopian Rural Household Survey (ERHS). Regarding the first research question, to measure households' risk attitudes towards prices I use the household-level willingness to pay (WTP) to stabilize the commodity prices in rural Ethiopia estimated by Bellemare, Barrett, and Just (2013, BBJ hereafter). This WTP measure has two advantages. First, it is derived from the agricultural household framework which allows a household to be both a producer and a consumer of the same crop. Second, it allows production and consumption of multiple crops. These features better reflect the situation of typical rural households in developing countries.

I find a significant relationship between higher WTP for price stabilization and higher incidence of migration, in terms of both extensive and intensive margins. In other words, a rural household

whose welfare is decreasing in price volatility is more likely to send members to urban areas and have a greater number of household members migrate than a household whose welfare is unaffected by price volatility. Due to the inherent challenges in attaining an exogenous measure of the WTP, this paper may not accomplish perfect identification of the causal impact of price risk attitudes on migration. A linear probability model with district-time fixed effects is used as a main specification, and a battery of careful robustness checks are conducted. The results are remarkably robust to the inclusion of various levels of fixed effects, an alternative definition of the WTP, various definitions of internal migration, linear and non-linear specifications, as well as falsification tests. Further analysis finds that this significant relationship between price risk attitudes and migration is more pronounced in the villages where daily markets, producer co-ops, and food aid, food-for-work, and cash-for-work programs are unavailable. These results suggest that negative welfare impacts of price volatility are a push factor on migration, especially in the villages that are systematically more vulnerable to price risk. I also find evidence that not only attitudes towards, but also exposure to, price volatility matter for migration decisions. Higher village-level price volatility of coffee and teff is each significantly related to out-migration of the households that produce and consume coffee and teff, respectively.

The contribution of this paper is threefold. First, this is the first to examine the relationship between price risk, as distinct from income risk, and migration, both in terms of preference and the volatility of market prices. The indirect utility function $V(p, y)$, which can be used as a measure of welfare, is defined over a vector of prices p and income y. Existing empirical studies on risk and migration have primarily focused on one's attitudes to *income* risk, that is, $-\frac{V_{yy}}{V_y}$,[3] (Heitmueller, 2005; Jaeger et al., 2010; Bonin et al., 2009; Constant et al., 2011, Hao et al., 2016) but we know nothing about how one's attitudes to *price* risk,$-\frac{V_{pp}}{V_y}$, affect migration decisions. A recent study by Bazzi (2016) finds a positive relationship between rainfall and rice price shocks and international migration in Indonesia. His study, however, focuses on the impact of price *levels*, whereas this study focuses on the impact of price volatility. This paper provides evidence that migration is a price risk management strategy of rural households, which could complement the theory of migration as an income risk management strategy. Research on migration is absent in the empirical literature

[3] V_x and V_{xx} denote the first-order and the second-order derivatives of V, respectively, with respect to argument x.

on price risk and welfare (Barrett, 1996; BBJ, 2013; Bellemare, 2015) as well. Finkelshtain and Chalfant (1991) theoretically predicted that peasant households' aversion to price risk can induce an exit from farming. To the best of my knowledge, no study has empirically tested this theory.[4]

This study is important for development policy. Ethiopia is one of the least urbanized countries worldwide, with only about 20% of the population living in urban areas in 2014 (World Bank, 2014b). Yet there has been a consistent increase in the proportion of the population living in urban areas in Ethiopia, and the level of urbanization is expected to increase further in the future. Given the low fertility rate in urban areas, migration has been a major factor in explaining urbanization in Ethiopia. Governments in Ethiopia and in other developing countries, however, have implemented conflicting policies, ranging from encouraging rural-to-urban migration to restricting them (Lall et al., 2006). This study sheds light on the important connection between food insecurity and urbanization. Less competition resulting from farmers exiting agriculture can lead to higher food price levels, which is bad for rural food consumers, and maybe even worse for urban food consumers. Moreover, villages that are systematically more prone to food insecurity will be disproportionately affected, losing more labor force that used to engage in farming. Knowing that price volatility is a source of rural distress, and a driver of migration, policies aimed at promoting market activities and enhancing agricultural value chain may improve the welfare of rural households.

Lastly, this study also informs food policy. Policies designed to decrease food price volatility have been an important policy instrument that have required large amounts of government spending in a number of developing countries, especially after the global food crisis of 2007-08 and the sharp increase in food prices in 2010.[5] These measures, however, are often implemented by governments just to appear to be doing something under political pressure (Poulton et al. 2006) and without

[4]Three features distinguish the Finkelshtain and Chalfant (1991) and the model used this study. First, I assume that there is uncertainty in both the commodity price and the urban wage, whereas the F&C addresses only the uncertainty in the commodity price and assumes away uncertainty in the urban wage. Second, the F&C discusses only the long-term exit from farming, whereas I allow two cases in my model: (i) an entire household quits farming; (ii) Some members migrate to urban areas, while the rest of the household members remain in the rural area. Third, the prediction by the F&C does not take into account the possibility that a peasant household is a net buyer, i.e., a household consumes more than what it produces. I consider the case of a net buyer as well.

[5]In South Asia, Bangladesh, India, Afghanistan, and Sri Lanka used economic measures such as price controls or trade policies to decrease food price volatility (World Bank, 2010). In Africa where food price fluctuations are more severe, Zambia and Malawi have taken the most aggressive measures to stabilize food prices (Chapoto and Jayne, 2009).

careful justification of high implementation costs (Gouel, 2013). If migration is an indication of negative welfare impacts of price volatility, policies designed to decrease food price volatility will reap higher welfare gains if focused on specific commodities that influence migration, such as coffee and teff.

The paper proceeds as follows: Section 2 discusses the theoretical framework and the WTP measure. Sections 3 and 4 describe the data and the empirical strategy, respectively. Empirical results are presented in Section 5. Policy implications, limitations, and future directions are discussed in Section 6.

2 Theoretical Framework

2.1 Modeling the Price Risk Attitudes and Migration Decision Making

2.1.1 The Model

In this section, I adapt the standard agricultural household model (Singh, Squire, and Strauss, 1986) and incorporate migration decision making.[6]

Suppose that a household maximizes a Von Neumann-Morgenstern utility function defined over leisure (L^L), consumption of a staple good (S) that is produced on the household's own farm, and consumption of a non-staple good (N) that is purchased in the market.[7] The utility function $U(\cdot)$ is twice continuously differentiable, strictly increasing in each argument L^L, N, and S, quasi-concave, concave in each argument, and satisfies the Inada conditions with respect to each argument x, i.e., $lim_{x\to 0}U(x) = +\infty$. This is a two-stage model in which the household makes its production and labor-leisure allocation decisions in stage one under uncertainty with regards to both the price of the staple crop (P^S) that it produces and consumes, and the urban wage (W^U). These prices are

[6]The basic setup of the model is heavily influenced by Barrett (1996) who, using a simple two-period agricultural household model, demonstrates the inverse farm size−productivity relationship commonly observed in agriculture.

[7]This is a unitary household model, in which a household maximizes a single utility function. Labor allocation, consumption, and production decisions are assumed to be made by one person. Thus, I abstract away from the issues of intra-household resource allocation, conflicts, and commitment to remit. The unitary household framework is also consistent with BBJ (2013) in which the WTP measure used in this study was estimated.

realized in stage two, when consumption decisions are made for the staple crop and the non-staple good. The price of the non-staple good (P^N) and the rural wage (W^R) are assumed to be known during the stage one. I assume that there are no labor market for farm labors and no credit market. The household's maximization problem is the following.

$$\begin{aligned} &\max_{L^L, L^F, L^R, L^U} E \max_{N,S} U(L^L, N, S) \\ &s.t. \quad P^S S + P^N N \leq Y \\ &Y \equiv P^S F(L^F, T) + W^R L^R + (W^U - C) L^U \\ &L^0 \geq L^L + L^F + L^R + L^U \end{aligned} \tag{1}$$

where E is an expectation operator, L^0 is the total endowment of the hours of household members, which can be allocated to leisure (L^L), working at the household's farm (L^F), working for rural off-farm employment opportunities (L^R), or working in an urban area (L^U). $F(\cdot)$ is a production function that is strictly increasing in the farm labor hours (L^F) and an endowment of land (T).[8] W^R and W^U are wages earned from working for rural off-farm labor and from migrant household members (if any) working in an urban area, respectively. $C \cdot L^U$, in which $C > 0$ is a constant parameter, is the cost of sending out migrant household members to an urban area, which includes any upfront costs of migration such as transportation and lodging costs, and costs associated with seeking employment opportunities. Thus, the expression $(W^U - C)L^U$ is a gain from migration, which is strictly increasing in W^U and strictly decreasing in $C > 0$.

Given that the household makes its labor-leisure allocation decision in stage one, subject to the expected maximized utility from the optimal consumption choices in stage two, using the concept of duality (Epstein, 1975), the indirect utility function can be used. The benefit of using the indirect utility function instead of the utility function is that it is homogeneous of degree zero in prices and income, i.e., (P^S, P^N, Y). Using P^N as a numéraire, let $p = P^S/P^N$, $y = Y/P^N$, $w^R = W^R/P^N$,

[8] In order to make the analysis tractable, I assume that production is riskless, and focus on the risks in P^S and W^U.

$w^U = W^U/P^N$, and $c = C/P^N$. The household's maximization problem can then be expressed as

$$\begin{aligned} &\max_{L^L, L^F, L^R, L^U} EV(L^L, p, y) \\ s.t. \quad &y = pF(L^F, T) + w^R(L^0 - L^L - L^F - L^U) + (w^U - c)L^U \\ &where \quad V(L^L, p, y) \equiv \max_{N,S} U(L^L, N, S) \\ &s.t. \quad p\{S - F(L^F, T)\} + N = y \end{aligned} \tag{2}$$

The first-order necessary conditions are[9]

$$\begin{aligned} w.r.t. \;\; L^L &: E\left[V_{L^L} - V_y w^R\right] \leq 0 \;\; (= 0 \;\; if \;\; L^L > 0) \\ w.r.t. \;\; L^F &: E\left[V_y(pF_{L^F} - w^R)\right] \leq 0 \;\; (= 0 \;\; if \;\; L^F > 0) \\ w.r.t. \;\; L^U &: E\left[V_y(w^U - c - w^R)\right] \leq 0 \;\; (= 0 \;\; if \;\; L^U > 0) \end{aligned} \tag{3}$$

By the Inada condition, $L^L > 0$ at an optimum. Therefore, $E\left[V_{L^L}\right] = E\left[V_y w^R\right]$. But interior solutions are not guaranteed for L^F and L^U. From the first-order necessary conditions above and the complementary slackness condition, the following condition which must hold if the household has one or more of its members migrate to urban areas (For derivation, see A.1. in appendix).

$$E[\underbrace{w^U - c}_{\text{Gains from Migration}} - \underbrace{pF_{L^F}}_{\text{Gains from Agriculture}}] \geq \frac{F_{L^F} \cdot \overbrace{Cov[V_y, p]}^{\text{Price Risk Attitude}} - \overbrace{Cov[V_y, w^U - c]}^{\text{Income Risk Attitude}}}{E[V_y]} \tag{4}$$

The left-hand-side (LHS) is the expected gap between the gains from migration and the gains from agriculture, the latter of which is the marginal value product of farm labor. The right-hand-side (RHS) is determined by signs and relative magnitudes of two covariances, i.e., $Cov[V_y, p]$ and

[9] The Langrangian for this optimization problem is $\mathscr{L} = EV(L^L, p, y) + \lambda[pF(L^F, T) + w^R(L^0 - L^L - L^F - L^U) + (w^U - c)L^U - pS - N]$ where λ is a the Lagrange multiplier.

$Cov[V_y, w^U]$, which in turn depend on the household attitudes towards price risk and income risk, respectively.[10] Thus, a household's migration decision is made by comparing the difference between the expected gains from migration, the expected gains from agriculture, and the relative magnitude of income risk and price risk that the household must take by making the decision.

2.1.2 The Coefficient of Absolute Price Risk Aversion

In the standard theory of income risk and uncertainty, $-\frac{V_{yy}}{V_y}$ is Pratt's (1964) coefficient of absolute income risk aversion. This is widely used as a measure of the welfare impact of income risk, or of risk attitudes with respect to income. Likewise, $-\frac{V_{pp}}{V_y}$ can serve as a measure of the welfare impact of price risk. This is the coefficient of price risk aversion developed by Schmitz et al. (1981) for producers, and Turnovsky et al. (1980) for consumers. The concept was later extended to the case of agricultural households by Barrett (1996), and the estimable coefficient of absolute price risk aversion A is defined as:[11]

$$A \equiv -\frac{V_{pp}}{V_y} = -\frac{M}{p} \cdot \{\beta(\eta - R) + \epsilon\} \tag{5}$$

where M is the marketable surplus (production (F) - consumption (S)), β is a budget share of the marketable surplus of the commodity ($\frac{pM}{y}$), η is the income elasticity of the marketable surplus ($\frac{\partial M}{\partial y}\frac{y}{M}$), R is the Arrow-Pratt coefficient of relative risk aversion of households, and ϵ is the own-price elasticity of the marketable surplus ($\frac{\partial M}{\partial p}\frac{p}{M}$). $A > (=, or <)\, 0$ if and only if $V_{pp} < (=, or >)\, 0$, which indicates that a household is price risk averse (neutral, or loving).

An intuition behind $A > 0$ is the following. For both net sellers and net buyers, $A > 0$ if and only if $R > \eta + \frac{\epsilon}{\beta}$.[12] For both net sellers and net buyers, ceteris paribus, each of the following characteristics contributes to the aversion to price risk: (i) higher income risk aversion (R), (ii) lower income elasticity of marketable surplus (η), (iii) lower price elasticity of marketable surplus (ϵ), and (iv) higher budget share of marketable surplus (β). These characteristics indicate that, being averse

[10] To see why, refer to A.2. in appendix.
[11] For derivation, refer to A.3. in appendix.
[12] For proof, see A.4. in appendix.

to price risk is associated with being averse to income risk, lacking flexibility in adjusting one's production and consumption according to fluctuations in income and price, and having a lot to lose from unfavorable price shocks.

2.1.3 Testable Hypotheses

In this subsection, testable hypotheses (Propositions I and II) on price risk attitudes and migration are derived based on the discussions so far. Claims I and II below are some necessary intermediate steps for which proofs are shown in appendices.

Claim I. *If a household is a net seller of a normal good S, aversion to price risk ($A > 0 \Leftrightarrow V_{pp} < 0$) is a sufficient condition for $Cov[V_y, p] < 0$.*
For proof, see A.5. in appendix.

Claim II. *If a household is a net buyer of a normal good S, aversion to price risk ($A > 0 \Leftrightarrow V_{pp} < 0$) is a sufficient condition for $Cov[V_y, p] > 0$.*
For proof, see A.6. in appendix.

Proposition I. *Suppose that a household is a price risk-averse net seller of a normal good S. If the household's welfare effect of price risk (associated with farming) dominates that of income risk (associated with migration), then, compared to the converse, the household is more likely to send its members to an urban area.*
Proof. Consider two price risk-averse net seller households A and B. The following condition must be satisfied in order for a household to be indifferent between having a member migrate to an urban area or having the member work at a family farm.

$$E[w^U - c - pF_{L^F}] = \frac{\overbrace{F_{L^F}}^{(+)} \cdot \overbrace{Cov[V_y, p]}^{(-)} - \overbrace{Cov[V_y, w^U - c]}^{(-)}}{\underbrace{E[V_y]}_{(+)}} \tag{6}$$

For both A and B, due to price risk aversion, $Cov[V_y, p] < 0$ by Claim I. Due to income risk aversion, $Cov[V_y, w^U - c] < 0$. Therefore, the sign of the RHS of expression (6) is ambiguous.

Suppose that, for the household A, the welfare effect of price risk associated with farming dominates that of income risk associated with migrating, i.e., $\left|F_{L^F} \cdot Cov[V_y, p]\right| > \left|Cov[V_y, w^U - c]\right|$. Suppose the opposite for the household B, that is, $\left|F_{L^F} \cdot Cov[V_y, p]\right| < \left|Cov[V_y, w^U - c]\right|$. Thus, at an optimum, the RHS of expression (6) < 0 for the household A, and the $RHS > 0$ for the household B. Therefore, the following condition must hold at the optimum.

$$E[w^U - c - pF_{L^F}]^{A*} < 0 < E[w^U - c - pF_{L^F}]^{B*} \tag{7}$$

where $E[w^U - c - pF_{L^F}]^{A*}$ and $E[w^U - c - pF_{L^F}]^{B*}$ are the expected differences in the gains from migration and the gains from agriculture that makes the households A and B, respectively, indifferent from farming in rural area and migrating to urban area. In order for the household B to have its members migrate to urban areas, it must be that $E[w^U - c] > E[pF_{L^F}]$. The household A, however, can have its members migrate to urban areas even though $E[w^U - c] < E[pF_{L^F}]$. If the term $E[pF_{L^F}]$ is identical for the households A and B, the household B will require higher gains from migration in order to have $L^U > 0$, than the household A. Thus, household A is more likely to have migrant members than household B. ■

According to Proposition I, a rural household can have its members migrate to urban areas even though the expected gains from migration is lower than the expected gains from agriculture, due to the aversion to price risk. This is consistent with Sandmo (1971), who stated that price uncertainty induces income risk-averse producers to produce at a sub-optimal level. This is also consistent with the result of Barrett (1996), who showed that price risk aversion of net sellers results in an underemployment in farm labor, i.e., employment of farm labor under its shadow value. Lastly, this is consistent with the result of Finkelshtain and Chalfant (1991) who predicted that a peasant household's aversion to price risk can induce a long-run exit from farming.

Intuitively, there is a trade-off between lower price risk and higher income risk when a net seller household sends a member to an urban area. This trade-off can also be seen by rearranging the

terms in expression (4) above, which is a condition for having $L^U > 0$.

$$E[\underbrace{w^U - c}_{\text{Gains from Migration}}] + \frac{\overbrace{Cov[V_y, w^U - c]}^{\text{Income Risk Attitude (-)}}}{E[V_y]} \geq E[\underbrace{pF_{L^F}}_{\text{Gains from Agriculture}}] + \frac{F_{L^F} \cdot \overbrace{Cov[V_y, p]}^{\text{Price Risk Attitude (-)}}}{E[V_y]} \quad (8)$$

On the LHS, the expected gains from migration are weighed against the income risk associated with migration, and on the RHS, the expected gains from agriculture are weighed against the price risk associated with farming. Only if LHS $\geq$ RHS, a household will have members migrate to the urban area. This suggests that, ceteris paribus, a net seller household that is more price risk-averse is more likely have migrant members.

Proposition II. *If a household is a price risk-averse net buyer of a normal good, it will have a member migrate to an urban area only if the expected gains from migration are strictly greater than those from farming.*

Proof. The following condition must be satisfied in order for a household to have $L^U > 0$.

$$E[w^U - c - pF_{L^F}] \geq \frac{\overbrace{F_{L^F}}^{(+)} \cdot \overbrace{Cov[V_y, p]}^{(+)} - \overbrace{Cov[V_y, w^U - c]}^{(-)}}{\underbrace{E[V_y]}_{(+)}} \quad (9)$$

For a price risk averse net buyer household, $Cov[V_y, p] > 0$ by Claim II. $Cov[V_y, w^U - c] < 0$ due to income risk-aversion. Therefore, $RHS > 0$, and accordingly, $LHS > 0$ in order for the household to allocate nonzero L^U. ■

Proposition II is consistent with the result of Barrett (1996), who showed that price risk aversion induces overemployment of farm labor by net buyer households. Comparing the migration decision making of price risk-averse net sellers and net buyers predicted in Propositions I and II, we can expect that the positive impact of price risk aversion on migration to be more pronounced for net sellers than for net buyers. This is because net sellers can send out migrants even when the expected

gains from migration are lower than the expected gains from agriculture, if the effect of price risk aversion dominates the effect of income risk aversion. For net buyers to have members migrate to urban areas, however, the expected gains from migration must be strictly greater than the expected gains from agriculture.[13]

2.2 Willingness to Pay Measure of Price Risk Preferences

This section connects the theory discussed so far and the measure of household-level price risk attitudes. The coefficient of absolute price risk aversion for a single commodity is given in expression (5) above. Note that $M, p, \beta, \eta, \epsilon$ and R on the RHS are all measurable or estimable using observational data. BBJ (2013) extended this into multiple commodities by considering the covariances between prices. Instead of facing an uncertain price for a single commodity, an agricultural household now faces a vector of k uncertain prices with respect to k agricultural commodities. Extending this concept of the coefficient of absolute price risk aversion into k commodities yields a matrix A of price risk aversion coefficients, defined as the following.

$$A \equiv -\frac{V_{pp}}{V_y} = -\frac{1}{V_y} \cdot \begin{bmatrix} V_{p_1p_1} & \dots & V_{p_1p_k} \\ \cdot & & \cdot \\ \cdot & & \cdot \\ V_{p_kp_1} & \dots & V_{p_kp_k} \end{bmatrix} \equiv \begin{bmatrix} A_{11} & \dots & A_{1k} \\ \cdot & & \cdot \\ \cdot & & \cdot \\ A_{k1} & \dots & A_{kk} \end{bmatrix} \tag{10}$$

And, each $ij-$element of this matrix can be estimated based on the following form.

$$A_{ij} = -\frac{M_i}{p_j} \cdot \{\beta_j(\eta_j - R) + \epsilon_{ij}\} \tag{11}$$

M_i is the marketable surplus of commodity i, which is equal to the difference in the amounts

[13] Considering migration as a coping strategy for negative welfare impacts of food price volatility, this is consistent with Bellemare (2015): "Indeed, as Sandmo (1971) has demonstrated, the negative effects of food price volatility are largely felt by food producers who, by virtue of having to dedicate resources to food production long before the resolution of price uncertainty, cannot make profit-maximizing production decisions in the presence of food price volatility. Food consumers, however, can always adjust their food consumption bundle after the resolution of price uncertainty, and so for them, greater food price volatility means an increased likelihood of enjoying price discounts on food."

of commodity i sold and i consumed. p_j is the price of commodity j. β_j is the budget share of the marketable surplus of commodity j, which is equal to $\frac{p_j M_j}{y}$. η_j is the income elasticity of marketable surplus of commodity j, and R is the Arrow-Pratt coefficient of relative risk aversion of households. ϵ_{ij} is the cross-price elasticity of the marketable surplus of commodity i with respect to the price of commodity j. The diagonal elements $A_{ii} > (=, or <) 0$ means that the household's welfare is decreasing (unaffected by, or increasing) in the volatility of the price of i. BBJ (2013) estimated this matrix A for the seven major commodities in rural Ethiopia−coffee, maize, beans, barley, wheat, teff, and sorghum. In order to make the estimation feasible in an absence of an experimental measure of R, it is assumed that R is equal to one for all households.[14]

In order to conveniently measure the welfare impacts of stabilizing the prices of several commodities, BBJ (2013) estimated the willingness-to-pay (WTP) for price stabilization. Conceptually, WTP can be expressed in the following way.

$$E\{V(E(p), y - WTP)\} = E\{V(p, y)\} \tag{12}$$

Thus, WTP is defined as the amount that a household is willing to pay in order to eliminate all price risks such that the prices of the seven major commodities are set to be equal to the expected values.[15] Using a second-order Taylor series expansions, they then show that the WTP can be estimated by summing up the coefficients of price stabilization across the commodities.[16]

$$WTP = \frac{1}{2} \cdot \{ \sum_{j=1}^{k} \sum_{i=1}^{k} \sigma_{ij} A_{ij} \} \tag{13}$$

where σ_{ij} denotes the covariance of the prices of commodities i and j. This measure was then divided by income in order to make it comparable across households. I call it as the willingness-to-pay (WTP) from now on. Thus, WTP is the amount of household income that the households

[14] Thus, there is no variation of R across households, or within households, which is a shortcoming of the WTP currently being used.

[15] When $WTP > 0$, household welfare is decreasing in price volatility. Therefore, they are willing to pay a positive amount of money in exchange for price stabilization. When $WTP < 0$, household welfare is increasing in price volatility. Therefore, they would like to be compensated for price stabilization.

[16] For the details on the mathematical derivation, refer to BBJ (2013) and its online appendix.

are willing to sacrifice in order to eliminate all price risks, expressed in terms of the proportion of income. A positive (negative) value of WTP of a household indicates that the household is price risk-averse (risk-loving). A higher (lower) value of WTP means that the household is relatively more (less) price risk-averse.

3 Data

3.1 The Ethiopian Rural Household Survey

The Ethiopian Rural Household Survey (ERHS) is a unique household panel data set that covers villages in rural Ethiopia. The survey started from 1989 collecting data from six villages (or peasant associations, called *kebele* in Ethiopia). In 1994, the project was extended to cover 18 villages in 15 districts (called *woreda*) in 5 regions.[17] Additional rounds of surveys were then collected in late 1994, 1995, 1997, 1999, 2004, and 2009.

This study uses the 1994a, 1994b, 1995, and 1997 rounds of the ERHS based on the following reasons: First, the data set contains information on household consumption and production of agricultural commodities, prices of agricultural commodities, and household migration behavior that are essential for investigating the two research questions of this paper. These rounds of the surveys also contain other household and individual-level variables related to education, health, credit, asset, etc. Also, the WTP measure estimated by BBJ (2013) are available for these rounds of the survey. Second, during the period, the questionnaires were not changed much, which makes the surveys highly comparable across time. Lastly, household-level attrition is particularly low during this period, and is just under 2 percent across the four rounds of the surveys (Dercon and Krishnan 1998). According to the tracing rule used in this survey, "a household was kept in the sample even if the head of the household had left or died. [...] Also, the fact that households cannot obtain land when moving to other areas is clearly a part of the explanation of the low attrition rate"

[17] Districts, the third-level administrative unit in Ethiopia, form distinct socio-cultural regions with different local history and rural economy (Rahmato, 1984). A peasant association (village) is the smallest administrative unit and is part of a district. It is a network of local organizations, and very few peasants remain outside the village network (Rahmato, 1984).

(Dercon and Hoddinott, 2011). Moreover, it is difficult to distinguish attrition from the migration of the whole households in the data. Given these circumstances, this paper focuses on migration in the form of sending household members to urban areas while other members remain in rural areas, rather than entire households exiting rural areas. This is consistent with the form of migration considered in the theoretical framework as well.

3.2 Migration Statistics

The sample contains 1,425 households in 18 villages in 15 districts within 6 regions observed over the four rounds, with an attrition rate of about 2 percent. Table 1 summarizes the variables used in this study.[18] Panel a summarizes the variables related to migration. The main dependent variable of interest is *Migrate*, which is 1 when there is a household member who left the household since the previous round of the survey, and 0 otherwise.[19] About 18 percent of the households in the sample have members migrated since the previous round of the survey. Marriage migration (10.6 percent) is much more common than migration for work purposes (6.6 percent), which includes leaving households to look for work, to take up jobs, to be near to the place of work, and to run own farm or enterprise. 4.5 percent and 14 percent of the sample have migrants to urban and rural areas, respectively, which indicates that rural-to-rural migration is more commonly observed than rural-to-urban migration. Low migration rates to urban areas and low rates of labor migration both seem to suggest some liquidity or credit constraints that hinder migration, given the high gains from migration observed from the ERHS households in terms of consumption (de Brauw, 2015). See tables A.8. and A.9. in Appendix for more information on the reasons and destinations of migration, respectively.

[18] For the full definitions of the variables, see A.7. in appendix.

[19] The lengths of time considered to count the events of leaving households are not identical for different rounds because time periods between consecutive rounds of the surveys are not identical from a round to the next. In the survey, there is also a question about household members who are currently absent, but "absence" includes temporary absence due to seasonal migration, short-term visits, and many other reasons besides long-term migration. Therefore, I opt for using the variable on household members who "left" their households instead of those who are "absent." The cases of leaving households due to deaths are excluded.

3.3 Key Explanatory Variables

Panel b of Table 1 presents summary statistics for three sets of selected explanatory variables: price risk attitudes, time-varying household characteristics, and access to credit. The table also displays results from the t-tests for differences in mean values for two sub-samples: households without and with migrant members.

The mean value of the WTP indicates that, on average, a household is willing to give up about 9 percent of its income in exchange for stabilizing the prices of the seven major crops at their mean values. This positive number indicates that households are, on average, averse to price risk. Comparing the households with and without migrants, the households with migrants tend to be more averse to price risk than the households without migrants, and this difference is highly significant.

Households with migrants tend to have significantly greater income, greater income from farming, and larger plot area than households without migrants. Also, households with migrants have significantly greater incidences of taking loans (from both formal and informal sources, for any purpose, either cash or in-kind), taking loans for food purchases and travels than households with no migrants. These results are indicative of liquidity, credit, and resource constraints that hinder migration.

Panel c of Table 1 summarizes the prices of the seven major crops that vary according to each village and each round. Mean, standard deviation, and coefficient of variation are the highest for coffee prices. Given that coffee is the most important cash crop for Ethiopian farmers, high volatility of coffee prices may pose a threat to the welfare of coffee producing farmers.

3.4 Household Production and Consumption of Staple Crops

Table 2 displays household marketable surpluses (production minus consumption) of the seven major crops. A household is a net seller (net buyer) of commodity k if the marketable surplus is positive (negative). Panel a shows marketable surpluses of all households. On average, households are net buyers of all seven commodities. Panel b shows the marketable surpluses of net sellers and net buyers of each commodity. For all commodities, there are more net buyers than net sellers. For each commodity, there are a number of households that do not produce or consume the commodity

(households in autarky). However, there are only 138 in the total of 5,621 households in the sample (about 2.4 percent) that do not produce or consume any of these seven commodities. The average amount of net sales is largest for wheat, teff, and sorghum. The average amount of net purchase is largest for barley, teff, and maize.

4 Empirical Framework

4.1 Price Risk Attitude and Migration: Extensive Margin

The first research question concerns the impact of household-level price risk attitudes on migration. The main equation to be estimated is the following linear probability model (LPM) with fixed effects.

$$Migrate_{ijt} = \beta_0 + \beta_1 WTP_{ijt} + \beta_2 X_{ijt} + \nu_{jt} + \epsilon_{ijt} \tag{14}$$

$Migrate_{ijt}$ is equal to 1 if household i in district j in round t reported that there was a member who left the household since the previous round of the survey and 0 otherwise, and WTP_{ijt} is the household i's WTP to stabilize the prices of the seven major commodities (coffee, maize, barley, beans, wheat, teff, and sorghum) expressed as a fraction of income in round t.[20] X_{ijt} is a vector of time-varying household-level control variables including access to credit according to different sources and uses, income measured by sources, plot area, and household size. ν_{jt} is a district-round fixed effect for a district-round pair jt. Districts in Ethiopia form distinct socio-cultural regions with separate local history and rural economy (Rahmato, 1984). These two-way fixed effects are included to account for unobserved heterogeneity embedded in each district in each round such as weather events, socio-cultural events, and political conditions. Accordingly, error terms (ϵ_{ijt}) are clustered at the district level given that they might be correlated in the district level. Given that the WTP measure is a structurally estimated measure, the error terms are bootstrapped as well.

[20] Due to a possible lag in migration decision, lagged WTP will also be considered in robustness checks.

This equation will be estimated for all households and separately for households that are net sellers and net buyers.

The coefficient estimate β_1 is the parameter of interest that is expected to be positive and significant for the households that are net sellers according to the Proposition I. According to the Propositions I and II, we expect to see a stronger impact of β_1 for net sellers than for net buyers.

For a clean identification of β_1, an ideal data set would contain a direct measure of the WTP for price stabilization that is measured for each household in each round using an experimental method. Such data is not currently available. Alternatively, one would construct the WTP measure by exogenously varying the components such as budget share, marketable surplus, price, and elasticities. Ideally, one could randomly assign the prices of the crops that households produce and consume. It would be nearly impossible, however, to randomly assign other components of the WTP. For example, marketable surpluses are determined by production and consumption of crops which cannot be easily manipulated by researchers. Similar issues persist in manipulating the budget share that depends on income and marketable surplus. Moreover, there are multiple commodities that households produce and consume. Given these inherent difficulties in pursuing a truly exogenous measure of the WTP, we rely on the WTP measure structurally estimated by BBJ (2013) using observational data. The following paragraphs address potential issues that can lead to a biased estimate of β_1 and what identification strategies are used in order to alleviate these concerns.

Reverse Causality

If migration of a household member causes any component of the WTP−such as price, marketable surplus, income, and attitudes to income risk−to be affected, there might be a concern of reverse causality. First, price is less of a concern, because households are price takers. In the data, prices vary by communities and not by individual households. Because each community consists of at least 500 households, it is unlikely that a migration decision of a single household affects prices. Second, attitudes to income risk is associated with household preferences, which is unlikely to change over the short period of time (1994-97) that the data set covers. Lastly, migration can affect the marketable surplus and income of a household, and accordingly the WTP. To address this issue, a

test for Granger causality (Angrist and Pischke, 2009) is conducted. For there to be no Granger causation, WTP in round $t+1$ should not be significantly related to migration in round t. I find no evidence of such a relationship.

Unobserved Heterogeneity

Failing to control for unobserved heterogeneity that might affect migration and is correlated with the WTP can result in a biased parameter estimate. Because commodity prices, production, consumption, and income of a household all comprise the WTP measure, unobserved factors that may affect any of these components and migration can cause an omitted variable bias. Districts, called "woreda" in Ethiopia, form distinct socio-cultural units with separate local history and rural economy (Rahmato, 1984). Thus, district-round fixed effects used in the baseline model are expected to capture time-varying, unobserved economic conditions, political events, and weather conditions common across households in a district that can affect the WTP measure and migration. In addition to the baseline model, specifications with various fixed effects pertaining to different geographic units are considered. District fixed effects are expected to capture time-invariant factors common to households in each district such as socio-cultural, historical, and political backgrounds, distance to the nearest town, and soil quality. Village-round fixed effects are expected to capture shocks in commodity prices because commodity prices vary across villages and over time. Village-round fixed effects and village fixed effects are expected to capture time-varying and time-invariant village-specific characteristics such as local off-farm labor opportunities, access to markets, access to electricity, road conditions, availability of food aid and related programs. Moreover, time-varying household-level controls include factors that can facilitate households' risk management, i.e., plot area, income from businesses, income from non-farm activities, access to credit, loans from various sources, and loans for various purposes including farming and travel.

Measurement Error

Commodity prices are reported in a community level. As was documented in BBJ (2013), it is unlikely that there are any systematic errors in the measurement of the commodity prices. Also, it

is hard to think of motivations to misreport the commodity prices in a systematic manner. If there was any systematic under- or over-reporting of the commodity prices in a specific community, such tendency must be captured by village fixed effects. Given that household income is zero in 1,082 out of the 5,621 total observations, there is a possibility that there was a systematic under-reporting of income. Regarding the issue of treating the zero-income households, an alternative measure of WTP was estimated following the suggestion of McBride (2016) on the treatment of zero-valued household incomes. To take into account any possibility that migration statuses of household members may be misreported, several alternative definitions of migration in terms of purposes and destinations are considered as the dependent variables. One possible form of misreporting is the following—when asked to recall the events of migration, respondents may be confused and misreport migration in the previous round as migration in the current round of the survey. For this possibility, I report results with lagged values of migration as regressors as well. Lastly, there is a possibility of random measurement error that may induce an attenuation bias and can bias the coefficient estimate towards zero. If this is the case, a positive and significant coefficient on the WTP would be a lower bound of the true coefficient estimate.

The LPM with fixed effects is the main specification, but given the binary dependent variable, results from the logit model with and without fixed effects are also presented.

4.2 Price Risk Attitude and Migration: Intensive Margin

The following linear regression with district-round fixed effects is estimated to figure out the relationship between the price risk attitudes and the number of migrants within households with migrants.

$$NumberMigrants_{ijt} = \gamma_0 + \gamma_1 WTP_{ijt} + \gamma_2 X_{ijt} + \nu_{jt} + \theta_{ijt} \tag{15}$$

$NumberMigrants_{ijt}$ is the number of household members who had left household i in district j

since the previous round of survey. WTP_{ijt}, X_{ijt}, and ν_{jt} are already defined. θ_{ijt} is an error term with mean zero that are clustered at the district level and bootstrapped. Given that the dependent variable is a count data, Poisson and negative binomial regressions with district-round fixed effects will be estimated as well using these variables.

4.3 Volatility of Prices and Migration

The second research question concerns the relationship between the community-level commodity price volatility and migration. The purpose is to examine the direct relationship between the price volatility and migration without having to make assumptions regarding utility function and preferences. The following equation will be estimated separately for net sellers and net buyers of each of the seven major crops:

$$Migrate_{ijt} = \delta_0 + \sum_{k=1}^{7} \delta_1 CV_{kj} + \delta_2 X_{ijt} + \psi_{ijt} \tag{16}$$

$Migrate_{ijt}$ and X_{ijt} are already defined, and CV_{kj} is the coefficient of variation, which is a standard measure of volatility (calculated as the standard deviation divided by the mean), of the price of crop k for each village j.[21] Lastly, ψ_{ijt} is an error term with mean zero clustered at the village level.

The coefficient of interest, δ_1, is expected to be positive and significant.

5 Results

5.1 Price Risk Attitudes and Migration

This subsection provides evidence that risk attitudes towards commodity prices matter for migration. Both nonparametric and parametric results suggest that there is a positive and significant

[21] Prices vary over crops, survey rounds, and villages. Therefore, the coefficients of variation are calculated over time for each village and each crop. In the empirical framework for the first research question, the effect of time-varying price level is captured by village-round fixed effects, and the effect of price volatility measured by coefficient of variation is captured by village fixed effects.

relationship between the WTP to stabilize the prices of the seven commodities in Ethiopia and migration.

5.1.1 Nonparametric Results

Figure 1 shows the kernel density plots of the WTPs for the households with and without migrants. Several aspects of these plots are noteworthy. First, the high density around zero WTP is mainly due to the large proportion of households doing subsistence farming. The two distributions look almost identical in the region of negative WTPs, or the households that are price risk-loving. However, households with migrants seem to have a lower density around zero, and a slightly fatter right-tail. Figure 2 shows the kernel density plots of the WTP for the households with and without migrants to cities. The distribution of the WTPs for households with migrants to urban areas seems to have a lower density around zero and also seems to show a larger variance.

Figure 3 and Figure 4 show the cumulative distribution functions (CDFs) of the WTP for households with and without migrants, for all destinations and urban destinations, respectively. Looking at both figures, it is more evident that the WTPs tend to be higher, especially in the cases of positive WTPs, for households with migrants.

5.1.2 Main Results (1): Extensive Margin

Table 3 presents the main results. Columns (1) through (4) show the results for all households. The coefficient estimates on the WTP are positive and significant at 1 percent level of significance in all four specifications. Columns (1) presents the results from a simple linear regression without fixed effects and control variables. Columns (2) through (4) show the results including district-round fixed effects, with different numbers of control variables included. Highlighted results in columns (1)-(4) indicate that households that prefer more stable prices of the seven major crops tend to have higher likelihoods of sending family members out of the households. Specifically, a 10% point increase in the WTP[22] is associated with about 1.1-1.2% point increase in the probability of having

[22]In the data, an average household is averse to price risk, having a willingness to give up about 9% of its income for price stabilization.

at least one household member who migrated.[23] This looks like a modest impact, but recalling that an average household has only about 18% likelihood of having members who migrated, a 1.1-1.2% point increase corresponds to about 6-7% increase in the likelihood of migration.

Column (5) of Table 3 provides the results on the sub-sample of households that are net sellers of at least one of the seven commodities.[24] The WTP has a positive coefficient estimate, and it is significant at 10% level. Proposition I states that, in the case of price risk-averse net sellers, having the effect of price risk aversion dominate the effect of income risk aversion increases the probability of migration. Thus, the proposition predicts that, ceteris paribus, a more price risk-averse net seller household is more likely have migrant members. The result in column (5) supports Proposition I.

Column (6) of Table 3 displays the results on the sub-sample of households that are net buyers of all the seven commodities. The WTP has a positive coefficient estimate that is significant at 5% level.

5.1.3 Main Results (2): Intensive Margin

Table 4 shows the results on the number of migrants as a dependent variable. Columns (1) and (2) present results from simple OLS regressions without fixed effects, and columns (3) and (4) show the results from district-round fixed effects regressions. Having a higher WTP for price stabilization of the seven commodities is significantly related to having a greater number of migrants in all four specifications.[25] Interestingly, WTP is significant only for the cases of the households that are net sellers of at least one of the seven commodities (column (5)), and is not significant for the cases of net buyers of all the seven commodities (column (6)). Given that the dependent variable (number of migrants) is count data, columns (5) and (6) present the results from Poisson and negative binomial regressions with district-round fixed effects, respectively. The key finding is robust to these alternative specifications.

[23] In LPM, the magnitude of the marginal effect is assumed to be constant across the level of WTP (Wooldridge, 2002).

[24] Because households produce and consume multiple commodities, and accordingly, assume different market positions for different commodities, it is tricky to define net sellers and net buyers. There is no observation in the sample that produces all seven commodities.

[25] Due to the concern on the selection issue, the sample is not restricted to the households with migrant members. When the sample is restricted to only the households with migrants, the WTP still has a positive and significant coefficient.

Proposition II predicts that a price risk-averse net buyer household will have a member migrate to an urban area only if the expected gains from migration are strictly greater than the expected gains from agriculture. This is unlike the case of a price risk-averse net seller household that can send out a migrant even when the expected gains from migration are lower than the expected gains from agriculture (shown in Proposition I). Thus, the positive impact of WTP on migration is expected to be more pronounced for net sellers than for net buyers. Comparing the results in the columns (5) and (6) of Table 3, we can see that a greater WTP increases the likelihood of having migrant members in the cases of both net sellers and net buyers, and such effect is slightly more pronounced for the net buyers than the net sellers. Comparing the columns (5) and (6) of Table 4, however, we can see that a greater WTP increases the *number* of migrant household members only in the case of net sellers. Thus, empirical results suggest mixed evidence in regards to Proposition II.

5.1.4 Falsification Tests

Table 5 displays the results from some falsification tests. Column (1) shows the main results (identical to column (4) in Table 3) with district-round fixed effects. To take into account the possibility that there may be lags in the WTP in affecting migration decisions, lagged WTPs are considered. Specifications in columns (2) and (3) include one-period and two-period lags of the WTP, respectively. One-period lag is positive and significant suggesting that there may be some lag in migration decision making, but the significance of the WTP does not disappear by including the lagged values.

One concern on identification is the possibility of reverse causality, i.e., the possibility that migration in a given round affects the WTP in the next round (Granger causality). Columns (4) and (5) display the results from testing whether migration Granger-causes WTP by including one-period WTP lead, following the suggestion of Angrist and Pischke (2009). Column (4) shows that WTP in round $t+1$ is not significantly related to migration in round t. Column (5) indicates that WTP is still significant when one-period lead WTP is included. These results imply that there is not enough evidence to reject the null hypothesis of no Granger causation.

It is possible that migration in one period is significantly related to migration in the next period, i.e., autocorrelation may be present in the dependent variable. Columns (6) and (7) present the results from including the lagged dependent variables as regressors. Lagged values of migration are indeed a strong predictor of migration, but including lagged values of migration does not wash out the significance of the WTP, the main treatment variable of interest. This result partially alleviates the concern of measurement errors in migration—especially in the form of misreporting past migration as current migration—as well.

5.1.5 Community Characteristics

The community module of the ERHS provides some interesting information on the characteristics of the sample communities. Table 6 and Table 7 exhibit the results from the the analysis of some community characteristics, all of which indicate that migration is a strategy to cope with unfavorable welfare impacts of price volatility especially in the communities with insufficient alternatives to mitigate the negative welfare impacts of price volatility.

Access to Daily Markets

When there are shocks in the commodity prices that are unfavorable to consumers, daily markets can facilitate purchases of cheaper substitutes. Having an access to daily markets in the community can help producers mitigate the impact of unfavorable price shocks as well, by making marketing activities more flexible. Columns (1) and (2) of Table 6 display the results from the sub-samples of communities where daily markets are unavailable and available, respectively. In both cases, the coefficient estimates on the WTP are positive and significant, but the magnitude of the coefficient is about fourfold for the communities without daily markets (column (1)).

Availability of Producer Cooperatives

Producer cooperatives (co-ops) are organizations owned and controlled by producers. Members in producer co-ops pool resources for marketing and production. Producer co-ops, therefore, facilitate access to capital and new technology, and help lower costs associated with production and market-

ing (Zheng et al. 2011). In Ethiopia where farming is dominated by smallholders, producer co-ops represent "modernization and commercialization of smallholder agriculture" (Bernard and Spielman, 2009). The results in the columns (3) and (4) of Table 6 indicate that the coefficient on the WTP is only significant in the communities where producer co-ops are unavailable.

Seasonal Migration

Seasonal migration is short-term, mostly rural-to-rural migration seeking off-farm employment opportunities during agricultural slack seasons at home.[26] Seasonal migrants in Ethiopia are predominantly young, single, landless, male farmers from the poorest households, motivated by the shortage of farmland and insufficient local non-farm activities during off-seasons (Asfaw et al., 2010). Columns (5) and (6) of Table 6 show the results from the sub-samples of communities without and with seasonal out-migration, respectively. WTP is significantly related to migration only in the communities where there is seasonal out-migration (Column (6)). This indicates that longer-term migration is a coping strategy for unfavorable welfare impacts of price risk, especially in the communities with insufficient viable off-farm employment opportunities during off-seasons.

Food Aid, Cash-for-Work, Food-for-Work

Ethiopia has been suffering from droughts and famines for over a century, and food aid has been an important mechanism that poor and food-insecure households in Ethiopia have depended on for many decades. Cash-for-work and food-for-work programs operated by humanitarian organizations offer short-term off-farm employment opportunities that pay wage in cash and in-kind, respectively. Table 7 presents the results from the sub-samples of communities without and with food-aid (columns (1) and (2)), cash-for-work (columns (3) and (4)), and food-for-work (columns (5) and (6)). The WTP has positive and significant coefficient only in the sub-samples of communities where food aid and cash-for-work programs are unavailable (shown in columns (1), and (3). Also, the coefficient estimate on the WTP is greater in its magnitude and is more significant in the communities where food-for-work is unavailable. These results suggest that migration is a coping

[26]The main dependent variable of this study is long-term migration, not short-term seasonal migration.

strategy for negative welfare impacts of food price volatility in the communities lacking mechanisms that help alleviate food insecurity.

5.1.6 Robustness Checks

The following set of results show that the positive and significant relationship between the WTP and migration is robust to alternative definitions of the dependent and the independent variables, inclusion of the fixed effects pertaining to different levels of geographic units, and non-linear specifications.

Alternative Definitions of Migration

Table A.10. in appendix shows the results from using alternative dependent variables in terms destinations and purposes. Columns (1), (2), and (3) show that the key result is robust for migration to urban areas (both within and outside of districts), migration outside of districts, and migration within districts, respectively. Column (4) shows that the WTP is not significant for migration for work purposes such as leaving in order to look for work, to take up jobs, to be near the place of work, and to run own farm or enterprise. There are two possible explanations for this: fear of losing land and liquidity and credit constraints. In Ethiopia, the land use law indicates that the land of the farmers who stay outside of the village for a long period of time or the land of those who have not cultivated their land for two consecutive years will be redistributed (Bezu and Holden, 2014). This policy may create disincentives for labor movement. Secondly, for young landless farmers, start-up costs of migration can be too high even if the potential gains from migration are substantial.

Column (5) shows that the WTP is significant for migration for marriage. According to the paper on assets at marriage in rural Ethiopia, Fafchamps and Quisumbing (2005) noted that, "[I]n agrarian societies,[...] [marriage] typically marks the onset not only of a new household but also of a new production unit, e.g., a family farm. Assets brought to marriage determine the start-up capital of this new enterprise.[...] Farm formation cannot be dissociated from marriage market considerations." For poor households lacking cash and in-kind assets, sending members to cities to look for work may involve high start-up costs and risk of failing to find work opportunities. Instead,

poor households can manage price risk by sending daughters to other villages for marriages, given the following: First, marriage migration in Ethiopia typically occur in the form of the wife moving to live in the husband's community (Fransen and Kuschminder, 2009). Second, land rights have been bestowed on men in Ethiopia (Norton et al., 2014). Third, grooms bring much more assets than brides to the new household unit (Fafchamps and Quisumbing, 2005),[27] Indeed, marriage has been an adaptation strategy of poor agricultural households in Ethiopia (Fransen and Kuschminder, 2009). This is also consistent with the finding of Rosenzweig and Stark (1989)—marriage migration significantly decreases the volatility of household food consumption in India.

Alternative Definition of the WTP

Figure 5 is a reproduction of the fractional polynomial regression of the WTP measure estimated by BBJ (2013). This shows that the WTP for commodity price stabilization increases with income, suggesting that "welfare gains from eliminating price volatility are increasing in household income" (BBJ, 2013). McBride (2016), in her comment, challenged the method used by BBJ (2013). In order to deal with the issue of zero-valued income households, BBJ (2013) used the mean income of all households when calculating the budget share of each household's marketable surplus. Alternatively, McBride (2016) used observed, as opposed to mean, income when available and assigned the minimum income to the households with zero-valued income. Figure 6 is a replication of the fractional polynomial regression of this alternative WTP measure that suggests a distributionally progressive benefit of food price stabilization. Table A.11. shows that the WTP still has positive and significant coefficient estimates when this alternative procedure was used in its calculation, in most of the specifications.

Heterogeneity Among Geographic Units

[27] Fafchamps and Quisumbing (2005) uses the ERHS data set in their study as well and find that "[G]rooms bring nearly 10 times more assets than brides to the newly formed family unit, an average of 4270 birr (in 1997 prices), compared to 430 birr for brides. For grooms, land is the asset with the highest average value. The next most valuable asset is livestock, followed by grain stocks and other minor assets. In contrast, brides bring very little land to the marriage. They bring some livestock but less than grooms. Two-thirds of the brides report bringing no asset to marriage. [...] The survey area can thus be described as a system where grooms bring most of the start-up capital of the newly formed household."

The results from including the fixed effects associated with different levels of geographic units are presented in Table A.12. The WTP is positive and significant for a variety of specifications: the main specification with district-round fixed effects (column (1)), district fixed effects with a time trend (column (2)), village-round fixed effects (column (3)), village fixed effects with a time trend (column (4)), region-round fixed effects (column (5)), and region fixed effects with a time trend (column (6)).

Non-linear Specification

Considering that the dependent variable of interest ($Migrate$) is a binary variable, logistic regression with fixed effects is used for a robustness check, and the results are shown in Table A.13. Various levels of fixed effects are considered in columns (1) through (6). In all specifications, the WTP is positive and significant. When logistic regression without fixed effects is used (Table A.14.), the WTP is still positive and significant at 1% level of significance in all specifications.

5.2 Volatility of Prices and Migration

This section provides evidence that the volatility of commodity prices matters for migration.

5.2.1 Net Sellers

Table 8 shows the results for the net sellers of each of the seven commodities (coffee, maize, beans, barley, wheat, teff, and sorghum) separately in each column. For example, column (1) shows the result from the sub-sample of the households that produce more coffee than what they consume. Top panel contains the OLS regression results from including the coefficient of variation (that vary by each community) of all the seven commodities as well as household-level controls as regressors. Only the coefficient estimate on the own coefficient of variation of each commodity is reported for the sake of brevity. Higher volatility of coffee, beans, and teff prices are each significantly related to higher incidences of out-migration of the net sellers of the respective crops.

Severe volatility in coffee prices can significantly impact the farm economy, because coffee is Ethiopia's major cash crop that accounts for 3.8% of Ethiopia's GDP (Taffessse et al., 2011) and

the largest portion in Ethiopia's export. Approximately 15 million people, or 15% of the total population of Ethiopia depend on coffee for their livelihoods (USDA, 2015). Beans are important sources of non-meat protein and income for smallholder producers in Ethiopia. Beans are the third-largest export crop in Ethiopia after coffee and sesame, and a higher-value crop that account for about 13% of cultivated land and about 10% of the agricultural value addition (Yirga et al., 2010). Teff accounts for the largest share of farmland among cereals and is often grown as a cash crop. According to FAO (2015), "Teff is second (to maize) in terms of quantity of production. However, because its market price is often two or three times higher than maize, teff accounts for the largest share of the total value of cereal production."

Losing the farmers producing these crops due to high price volatility may pose a threat to food security and livelihoods of smallholder agricultural households.

5.2.2 Net Buyers

The results for the net buyers of each of the seven crops are presented in Table 9. Results indicate that high price volatility of coffee and teff are significantly related to the out-migration of the net buyers of coffee and teff, respectively. This is not surprising given that coffee and teff accounts for the two largest budget shares among the seven crops. According to BBJ (2013) using the same data set, "Purchases of teff and coffee represent the largest household expenditures, with 21% and 15% of the average budget being devoted to them, respectively."

Coffee plays an important part in both social life and culture in Ethiopia. "Ethiopians love to drink coffee at mealtimes, special occasions, and during social gatherings. In terms of per capita consumption, Ethiopia is the largest coffee drinking country in Africa and one of the biggest in the world." (USDA, 2015) Teff is one of the five major cereal crops in Ethiopia (along with wheat, maize, sorghum, and barley) and is high in protein and mineral. Teff is an ingredient for *injera*, an important staple food item in Ethiopia.

Higher volatility of coffee and teff prices is significantly related to the out-migration of both the net sellers and the net buyers of coffee and teff, respectively. This is also consistent with the observation in BBJ (2013): "stabilizing coffee prices is more likely generate welfare gains than

stabilizing other commodity prices," if migration implies the negative welfare effects of high price volatility.

6 Concluding Remarks

This paper is the first to investigate the role of commodity price volatility in determining migration, a topic with important policy implications for urbanization and food security. Two potential channels by which price volatility can impact migration are examined: (i) individual household's attitudes towards price volatility, and (ii) village-level volatility in the prices of agricultural commodities. Based on the agricultural household model in which a rural household both produces and consumes a commodity, I incorporate migration decisions into family labor allocation decisions that are made under uncertainty in commodity price and urban wage.

Empirical results from the ERHS data for the period 1994-97 indicate that greater aversion to price volatility−represented by higher WTP for price stabilization of the seven most important crops in Ethiopia−is positively and significantly related to migration, both in terms of extensive and intensive margins. These results are remarkably robust to falsification tests, alternative definitions of both independent and dependent variables, the inclusion of various fixed effects pertaining to different levels of geographic units, and linear and non-linear specifications. A high level of WTP is an indication of a lack of flexibility in production, a lack of viable substitutes in consumption, as well as high budget share of food items. Further investigations into the community module indicate that migration is a coping strategy for negative welfare impacts of price volatility, markedly in the communities where daily markets, producer co-ops, food aid, food-for-work, and cash-for-work programs are unavailable. Therefore, price volatility matters when it comes to migration not only for individual households, but also for greater communities that are vulnerable to price volatility. The direct relationship between village-level price volatility and migration is examined as well. I find that high volatility of coffee prices is significantly related to the migrations of both the net sellers and the net buyers of coffee, and I find similar results for teff prices as well. These findings can inform migration policy, local development policy, and price stabilization policy in identifying the losers

and winners of price stabilization schemes and determining the type of households, communities, and commodities to be targeted for effective policy implementation.

Coming up with an exogenous measure of price volatility or attitudes towards price volatility is an intrinsically difficult task. Having to depend on secondary longitudinal data for empirical analysis, this study is not without the limitations that are inherent to the use of any observational data. Facing similar challenges, a number of assumptions had to be made by BBJ (2013) in estimating the WTP measure. These issues motivate using an experimental method that can facilitate a cleaner, causal identification.

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7 Figures and Tables

Figure 1. Kernel Density Estimation of Household WTP (1)

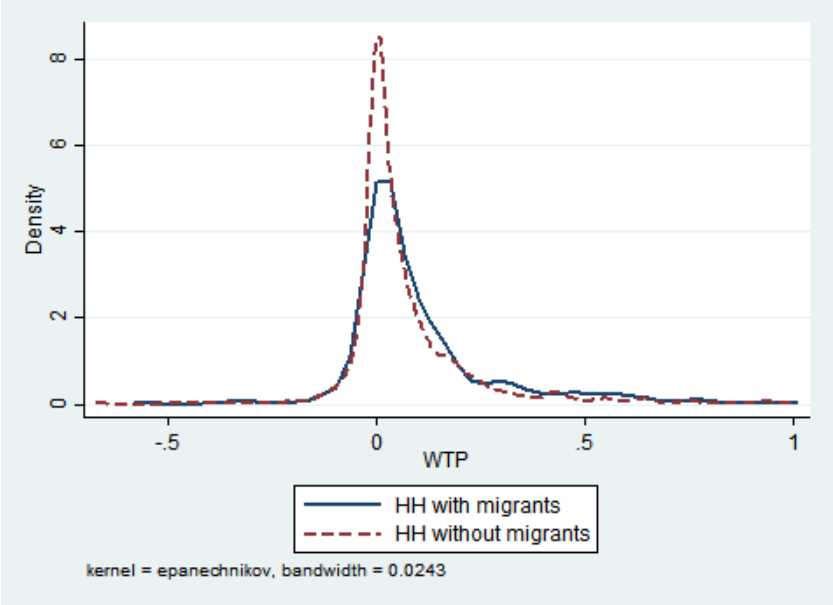

Figure 2. Kernel Density Estimation of Household WTP (2)

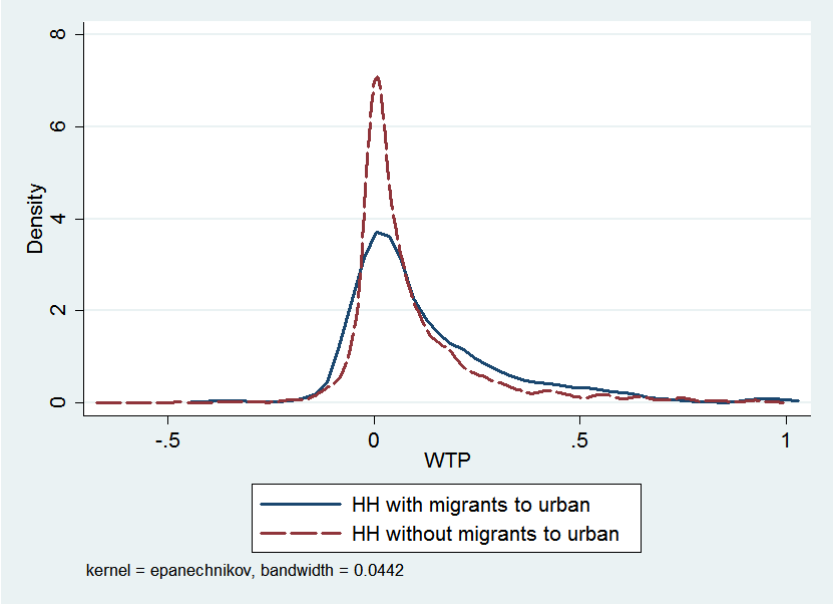

Figure 3. Cumulative Distribution Function of Household WTP (1)

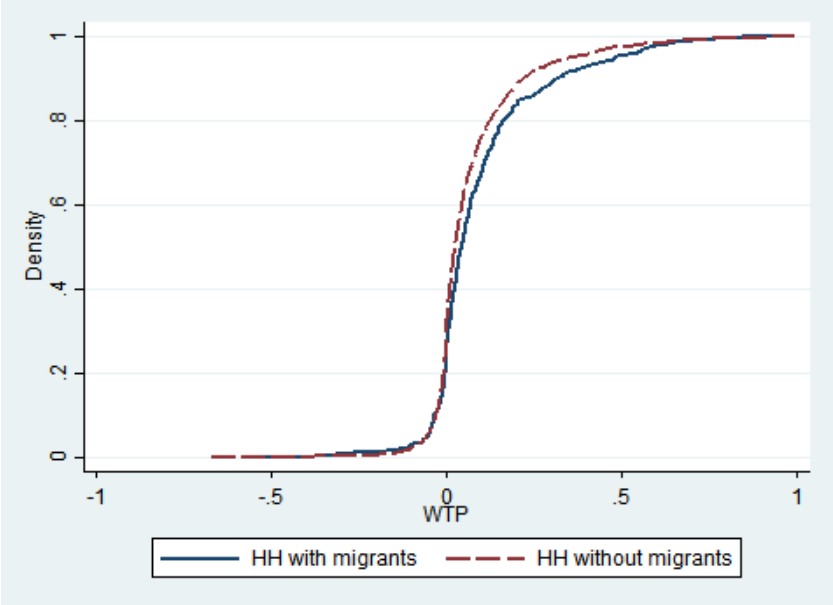

Figure 4. Cumulative Distribution Function of Household WTP (2)

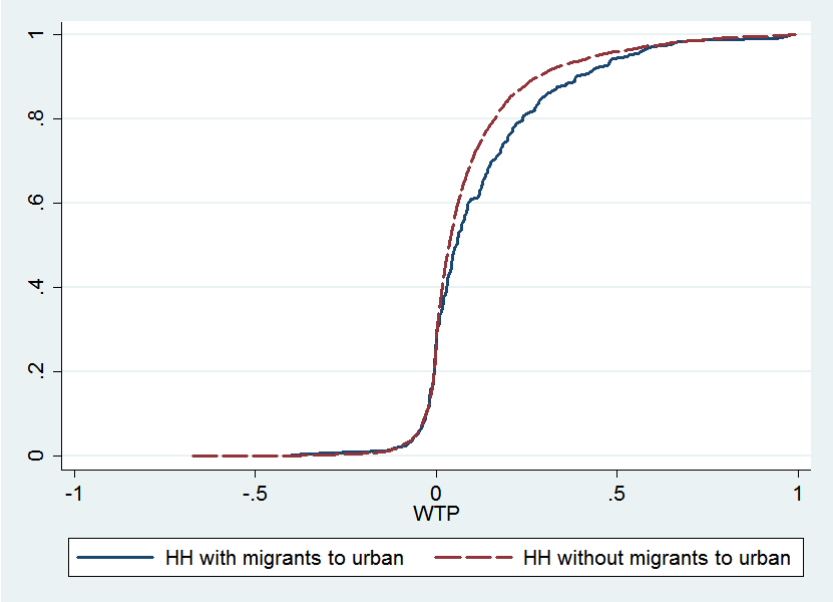

Figure 5. Fractional Polynomial Regression of the Original WTP

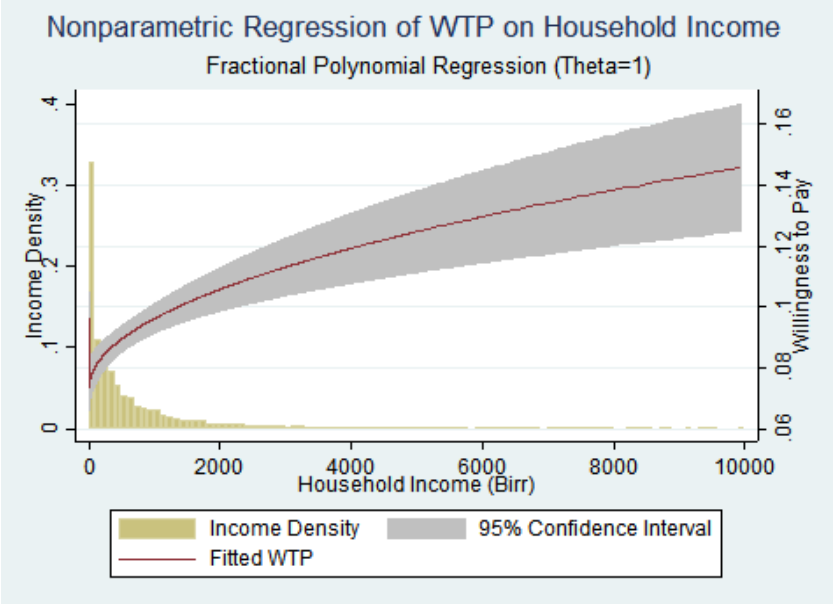

Figure 6. Fractional Polynomial Regression of the Alternative WTP

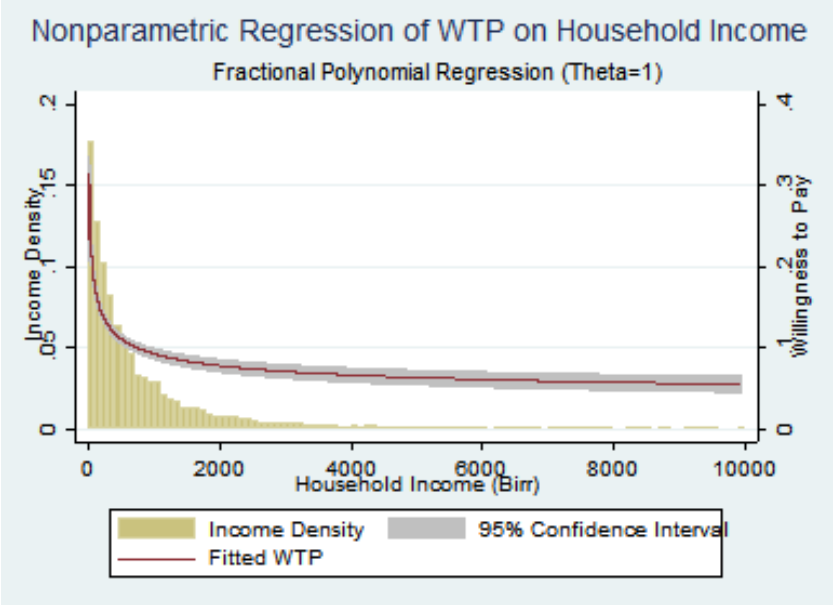

Table 1. Summary Statistics

a. Migration Variables

Variables	Unit	Mean	Std. Dev.	Min.	Max.	N
Migrate	0 or 1	0.181	0.385	0	1	5,613
Migrate for work	0 or 1	0.066	0.249	0	1	5,613
Migrate to urban areas	0 or 1	0.045	0.207	0	1	5,613
Migrate to rural areas	0 or 1	0.140	0.347	0	1	5,613
Migrate to urban areas for work	0 or 1	0.034	0.183	0	1	5,613
Migrate for marriage	0 or 1	0.106	0.307	0	1	5,613
Number of migrants within HHs with migrants	Persons	1.363	0.890	1	10	1,017

b. Key Explanatory Variables

Variables	Unit	Full Sample (N = 5,613)		Migrate=0 (N = 4,596)		Migrate=1 (N = 1,017)	
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Price Risk Attitudes							
WTP***	From -1 to 1	0.09	0.168	0.086	0.164	0.108	0.183
HH Characteristics							
Income***	Birr	816.54	6,268.46	807.47	6,884.70	859.72	1,725.53
Farm income***	Birr	442.80	6,120.09	456.76	6,745.75	380.19	1,171.97
Plot area***	ha	1.402	1.418	1.352	1.392	1.617	1.507
Autarky	0 or 1	0.025	0.155	0.026	0.159	0.015	0.124
Household size	Persons	5.576	3.151	5.578	3.129	5.598	3.227
Access to Credit							
Taken loan**	0 or 1	0.482	0.5	0.475	0.499	0.509	0.500
Loan from friends, rel.	0 or 1	0.314	0.464	0.310	0.462	0.330	0.470
Loan from bank	0 or 1	0.006	0.075	0.005	0.076	0.004	0.070
Loan for food**	0 or 1	0.192	0.394	0.187	0.390	0.212	0.409
Loan for travel***	0 or 1	0.01	0.099	0.008	0.090	0.016	0.128

***: Means for two sub-samples (migrate=0 and migrate=1) are statistically different with p-value<0.01.

**: Means for two sub-samples (migrate=0 and migrate=1) are statistically different with p-value<0.05.

*: Means for two sub-samples (migrate=0 and migrate=1) are statistically different with p-value<0.1.

Table 1. Summary Statistics (continued)
c. Commodity Prices (Unit: Birr/kg, N = 5,621)

Variables	Mean	Std. Dev.	Coeff. of Var.	Min.	Max.
Coffee	14.695	5.607	0.382	3.584	26.685
Maize	1.296	0.392	0.302	0.658	2.859
Beans	1.889	0.414	0.219	1.035	3.153
Barley	1.511	0.434	0.287	0.658	2.532
Wheat	1.756	0.347	0.197	0.921	2.481
Teff	2.274	0.394	0.173	1.035	3.261
Sorghum	1.522	0.421	0.277	0.72	2.609

Table 2. Marketable Surpluses of Households (kg)

a. All Households (N = 5,621)

Variable	Mean	Std. Dev.	Min.	Max.
Coffee	-7.324	24.565	-290.81	240
Maize	-105.746	298.76	-2610	3,000
Beans	-40.014	93.45	-704.700	310.95
Barley	-93.852	336.199	-3765	1,169.5
Wheat	-61.571	235.956	-3132	2,500
Teff	-96.961	292.471	-2609.5	3,225.6
Sorghum	-36.69	187.805	-1,688	1,600

b. Net Sellers and Net Buyers of Staple Crops

	Net Sellers			Net Buyers		
	Mean	Std. Dev.	N	Mean	Std. Dev.	N
Coffee	37.81	43.13	458	-14.50	18.22	4,031
Maize	157.23	279.32	702	-349.76	349.44	2,015
Beans	50.06	51.17	155	-124.76	123.12	1,865
Barley	167.69	176.88	577	-435.05	514.02	1,435
Wheat	265.10	388.60	343	-277.29	295.21	1,576
Teff	171.71	327.59	468	-432.78	371.23	1,445
Sorghum	206.90	212.79	354	-344.18	311.03	812

Table 3. Main Results (1): Extensive Margin
Dependent Variable: Migrate (0 or 1)

	(1) All	(2) All	(3) All	(4) All	(5) Net Sellers	(6) Net Buyers
WTP	0.116***	0.118***	0.117***	0.114***	0.114*	0.123**
	(0.0443)	(0.0411)	(0.0414)	(0.0388)	(0.0613)	(0.0553)
Taken Loan			0.0162	0.0146	-0.0103	0.0293
			(0.0206)	(0.0212)	(0.0309)	(0.0307)
Loan from Friends and Rel.			-0.0291	-0.0329*	-0.00736	-0.0495
			(0.0185)	(0.0176)	(0.0364)	(0.0305)
Loan from Bank			-0.0884	-0.0904	-0.107	-0.0854
			(0.0547)	(0.0680)	(0.0897)	(0.0690)
Loan from NGO			-0.0427**	-0.0485**	-0.0428	-0.0582*
			(0.0205)	(0.0226)	(0.0423)	(0.0300)
Loan for Farming			0.0152	0.0135	0.00530	0.0323
			(0.0271)	(0.0239)	(0.0448)	(0.0374)
Loan for Business			0.0105	0.00827	-0.0522	0.0394
			(0.0463)	(0.0377)	(0.0645)	(0.0539)
Loan for Food			0.0302***	0.0364***	0.0504**	0.0317
			(0.0102)	(0.0112)	(0.0252)	(0.0214)
Loan for Travel			0.122*	0.117*	0.137	0.114*
			(0.0717)	(0.0683)	(0.104)	(0.0625)
Logged Income				0.0121***	0.0125**	0.0135***
				(0.00203)	(0.00638)	(0.00288)
Logged Nonfarm Income				-0.00575**	-0.00756*	-0.00495
				(0.00260)	(0.00400)	(0.00458)
Logged Business Income				0.0000974	-0.00102	-0.000264
				(0.00235)	(0.00420)	(0.00343)
Plot Area Per Person				0.0527**	0.0576*	0.0473
				(0.0262)	(0.0321)	(0.0346)
Household Size				0.000225	0.00116	-0.000841
				(0.00140)	(0.00235)	(0.00267)
Constant	0.168***	0.171***	0.169***	0.0957***	0.102**	0.0875***
	(0.0118)	(0.0107)	(0.0121)	(0.0154)	(0.0431)	(0.0222)
District-Round F.E.	No	Yes	Yes	Yes	Yes	Yes
N	5,613	5,613	5,604	5,604	2,300	3,304
R^2	0.002	0.002	0.005	0.013	0.012	0.016

Notes: Bootstrapped and clustered (at the district level) standard errors are in parentheses.
*: $p < 0.1$, **: $p < 0.0.05$, ***: $p < 0.0.01$.

Table 4. Main Results (2): Intensive Margin
Dependent Variable: Number of Migrants

	(1) LPM	(2) LPM	(3) FE LPM	(4) FE LPM	(5) Net Sellers	(6) Net Buyers	(7) Poisson	(8) Nega. Bi.
WTP	0.418***	0.376***	0.238***	0.237***	0.358***	0.179	0.484***	0.326***
	(0.104)	(0.106)	(0.0922)	(0.0755)	(0.120)	(0.111)	(0.176)	(0.113)
Taken Loan		0.0910**		0.0847*	0.0698	0.0897	0.207**	0.164*
		(0.0397)		(0.0437)	(0.0646)	(0.0582)	(0.100)	(0.0893)
Loan from Friends and Rel.		-0.00489		-0.0424	-0.00527	-0.0632	-0.102	-0.0895
		(0.0361)		(0.0351)	(0.0550)	(0.0522)	(0.0783)	(0.0877)
Loan from Bank		-0.161		-0.218**	-0.431***	-0.0291	-0.517	-0.635
		(0.140)		(0.0883)	(0.0786)	(0.198)	(1.457)	(1.464)
Loan from NGO		0.0458		-0.0913	-0.0503	-0.139**	-0.206*	-0.256*
		(0.0626)		(0.0558)	(0.0722)	(0.0644)	(0.121)	(0.131)
Loan for Farming		-0.0397		-0.00711	0.0460	-0.0395	-0.0258	-0.0242
		(0.0633)		(0.0795)	(0.133)	(0.0664)	(0.158)	(0.153)
Loan for Business		-0.158***		-0.163*	-0.286***	-0.128	-0.414*	-0.371
		(0.0558)		(0.0865)	(0.111)	(0.104)	(0.229)	(0.248)
Loan for Food		-0.0605*		-0.0305	-0.0735	0.000226	-0.0752	-0.0232
		(0.0327)		(0.0346)	(0.0567)	(0.0469)	(0.0664)	(0.0736)
Loan for Travel		0.0658		0.00848	0.0975	-0.105	-0.00654	0.145
		(0.0946)		(0.124)	(0.218)	(0.150)	(0.254)	(0.237)
Logged Income		0.0356***		0.0341***	0.0639***	0.0319***	0.100***	0.0943***
		(0.00901)		(0.00693)	(0.0247)	(0.00709)	(0.0183)	(0.0156)
Logged Nonfarm Income		-0.0102		-0.0112**	-0.0261***	-0.00144	-0.0273*	-0.0272**
		(0.00952)		(0.00568)	(0.00855)	(0.00759)	(0.0145)	(0.0136)
Logged Business Income		-0.0152		-0.00671	-0.00859	-0.00935	-0.0167	-0.00632
		(0.00961)		(0.00639)	(0.0136)	(0.00590)	(0.0157)	(0.0139)
Plot Area Per Person		0.0951*		0.0899***	0.0980*	0.0842***	0.179***	0.213***
		(0.0535)		(0.0281)	(0.0520)	(0.0260)	(0.0525)	(0.0450)
Household Size		0.00494		-0.00112	0.000357	-0.00308	-0.00212	-0.00510
		(0.00548)		(0.00454)	(0.00494)	(0.00494)	(0.0107)	(0.00837)
Constant	0.370***	0.131***	0.386***	0.198***	0.00764	0.211***		-0.672***
	(0.0348)	(0.0390)	(0.0364)	(0.0434)	(0.139)	(0.0449)		(0.180)
Control Variables	No	Yes	No	Yes	Yes	Yes	Yes	Yes
District-Round F.E.	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Clustered S.E.	Yes	Yes	Yes	Yes	Yes	Yes	No	No
N	5615	5606	5615	5606	2301	3305	5606	5606
R^2	0.006	0.024	0.002	0.012	0.018	0.013		

Notes: 1. Bootstrapped standard errors are in parentheses.
*: $p < 0.1$, **: $p < 0.0.05$, ***: $p < 0.0.01$.
2. Coefficient estimates for Poisson and negative binomial regressions shown in this table are marginal effects.

Table 5. Falsification Tests
Dependent Variable: Migrate (0 or 1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
WTP	0.114***	0.0895***	0.113***		0.0961*	0.0955***	0.111***
	(0.0388)	(0.0316)	(0.0359)		(0.0525)	(0.0293)	(0.0277)
WTP Lag1		0.104**	0.110**				
		(0.0403)	(0.0547)				
WTP Lag2			0.0667				
			(0.0533)				
WTP Lead1				0.0651	0.0649		
				(0.0406)	(0.0422)		
Migrate Lag1						0.0789***	0.0833***
						(0.0164)	(0.0261)
Migrate Lag2							0.0486**
							(0.0196)
N	5,604	4,001	2,528	4,078	4,010	4,162	2,747
R^2	0.013	0.012	0.018	0.014	0.015	0.016	0.022

Notes:

1. Control variables included: access to loan, loan from friends and relatives, loan from bank, loan from NGO, loan for farming, loan for business, loan for food, loan for travel, income, non-farm income, business income, plot size per person, household size
2. District-round fixed effects are included in all specifications.
3. Standard errors bootstrapped and clustered at the district level are in parentheses.

*: $p < 0.1$, **: $p < 0.0.05$, ***: $p < 0.0.01$.

Table 6. Village-specific Characteristics (1)
Dependent Variable: Migrate (0 or 1)

	Daily Market		Producer Co-op		Seasonal Migration	
	(1) No	(2) Yes	(3) No	(4) Yes	(5) No	(6) Yes
WTP	0.121***	0.0304***	0.112***	0.119	0.0706	0.142***
	(0.0421)	(0.00528)	(0.0398)	(0.0730)	(0.0461)	(0.0512)
Taken Loan	0.0178	-0.0320***	0.0291	-0.0260	0.0146	0.0144
	(0.0235)	(0.00295)	(0.0253)	(0.0205)	(0.0210)	(0.0274)
Loan from Friends and Rel.	-0.0323*	-0.0384*	-0.0379*	-0.0228	-0.0570*	-0.0218
	(0.0195)	(0.0226)	(0.0201)	(0.0170)	(0.0338)	(0.0187)
Loan from Bank	-0.134	-0.0105	-0.0766	-0.342***	-0.0659	-0.103
	(0.0925)	(0.0681)	(0.0613)	(0.0236)	(0.146)	(0.0742)
Loan from NGO	-0.0523**	-0.0328	-0.0598**	-0.0159	-0.0859***	-0.0297
	(0.0257)	(0.0956)	(0.0287)	(0.0145)	(0.0196)	(0.0252)
Loan for Farming	0.0287	-0.162***	-0.00619	0.114***	0.0822	-0.00629
	(0.0285)	(0.0491)	(0.0254)	(0.0390)	(0.0962)	(0.0279)
Loan for Business	0.0371	-0.0359	0.0137	-0.0548	-0.111***	0.0280
	(0.0570)	(0.0308)	(0.0433)	(0.0588)	(0.0323)	(0.0462)
Loan for Food	0.0366***	0.0458	0.0291*	0.0602***	0.0421*	0.0341**
	(0.0141)	(0.0279)	(0.0152)	(0.0146)	(0.0215)	(0.0152)
Loan for Travel	0.112	0.158	0.116	0.121	0.154*	0.106
	(0.0810)	(0.142)	(0.0986)	(0.0945)	(0.0837)	(0.0689)
Logged Income	0.0116***	0.0174***	0.00970***	0.0196***	0.0181***	0.0107***
	(0.00216)	(0.00350)	(0.00241)	(0.00668)	(0.00529)	(0.00233)
Logged Nonfarm Income	-0.00486	-0.0117***	-0.00799***	0.00570	-0.00694***	-0.00507
	(0.00322)	(0.000902)	(0.00172)	(0.00744)	(0.00211)	(0.00359)
Logged Business Income	-0.00133	0.00750***	0.000648	-0.00283	0.00238	-0.000336
	(0.00287)	(0.000587)	(0.00378)	(0.00276)	(0.00336)	(0.00363)
Plot Area Per Person	0.0526*	0.421***	0.0683***	-0.00480	0.0437	0.0656*
	(0.0296)	(0.0534)	(0.0143)	(0.168)	(0.0689)	(0.0388)
Household Size	0.000470	-0.000131	0.00134	-0.00433	-0.000337	0.000477
	(0.00202)	(0.00121)	(0.00140)	(0.00673)	(0.00678)	(0.00139)
Constant	0.0945***	0.0838***	0.0858***	0.150***	0.0947	0.0890***
	(0.0186)	(0.0165)	(0.0183)	(0.0509)	(0.0622)	(0.0180)
N	5,073	531	4,443	1,161	1,636	3,968
R^2	0.013	0.033	0.015	0.020	0.019	0.012

Notes:

1. District-round fixed effects are included in all specifications.
2. Bootstrapped standard errors clustered at the district level are in parentheses.

*: $p < 0.1$, **: $p < 0.0.05$, ***: $p < 0.0.01$.

Table 7. Village-specific Characteristics (2)
Dependent Variable: Migrate (0 or 1)

	Food Aid		Cash-for-work		Food-for-work	
	(1) No	(2) Yes	(3) No	(4) Yes	(5) No	(6) Yes
WTP	0.130***	0.0153	0.130***	0.0215	0.119***	0.0563**
	(0.0416)	(0.0268)	(0.0427)	(0.0413)	(0.0392)	(0.0271)
Taken Loan	0.0291	-0.0370	-0.00238	0.133	0.0169	-0.0340
	(0.0238)	(0.0285)	(0.0110)	(0.0823)	(0.0210)	(0.0347)
Loan from Friends and Rel.	-0.0381	-0.0166	-0.0157	-0.143***	-0.0365**	0.0265***
	(0.0233)	(0.0105)	(0.0118)	(0.0368)	(0.0186)	(0.00353)
Loan from Bank	-0.0802	-0.218***	-0.122	-0.0416*	-0.0807	-0.190***
	(0.0706)	(0.0659)	(0.0818)	(0.0229)	(0.0645)	(0.0593)
Loan from NGO	-0.0544*	-0.0425	-0.0324	-0.178***	-0.0502**	-0.0307
	(0.0278)	(0.0275)	(0.0204)	(0.0554)	(0.0239)	(0.0525)
Loan for Farming	0.0145	-0.0188	0.0283	-0.0201	0.0231	-0.0200
	(0.0385)	(0.0483)	(0.0403)	(0.0133)	(0.0321)	(0.0168)
Loan for Business	-0.00455	0.0709	-0.00846	0.127	-0.000683	0.324***
	(0.0449)	(0.0758)	(0.0298)	(0.103)	(0.0348)	(0.00205)
Loan for Food	0.0202	0.0818***	0.0375***	0.0363**	0.0381***	0.0307**
	(0.0156)	(0.00680)	(0.0121)	(0.0168)	(0.0144)	(0.0156)
Loan for Travel	0.137**	-0.0297	0.0591	0.697***	0.127	-0.00940
	(0.0698)	(0.142)	(0.0747)	(0.0990)	(0.0881)	(0.0559)
Logged Income	0.0120***	0.0119***	0.0115***	0.0135***	0.0127***	0.0124***
	(0.00281)	(0.00317)	(0.00289)	(0.000573)	(0.00255)	(0.000380)
Logged Nonfarm Income	-0.00458	-0.00921***	-0.00533*	-0.0119***	-0.00438*	-0.0177***
	(0.00291)	(0.00233)	(0.00290)	(0.000963)	(0.00254)	(0.00199)
Logged Business Income	0.00176	-0.00927***	-0.000906	0.00953**	0.00140	-0.00744*
	(0.00315)	(0.00223)	(0.00283)	(0.00474)	(0.00303)	(0.00384)
Plot Area Per Person	0.0571	0.0354*	0.0527*	0.129	0.0551*	0.0355***
	(0.0387)	(0.0197)	(0.0271)	(0.194)	(0.0311)	(0.00119)
Household Size	0.000387	-0.00115	0.000413	0.00231**	-0.000320	0.00453**
	(0.00204)	(0.00267)	(0.00205)	(0.000925)	(0.00163)	(0.00219)
Constant	0.0862***	0.138***	0.106***	0.0168	0.0919***	0.0932***
	(0.0238)	(0.0108)	(0.0185)	(0.0203)	(0.0162)	(0.0326)
N	4,330	1,274	4,775	829	4,906	698
R^2	0.015	0.014	0.012	0.065	0.014	0.016

Notes:

1. District-round fixed effects are included in all specifications.
2. Bootstrapped standard errors clustered at the district level are in parentheses.

*: $p < 0.1$, **: $p < 0.0.05$, ***: $p < 0.0.01$.

Table 8. Price Volatility and Migration: Net Seller
Dependent Variable: Migrate (0 or 1)

	(1) Coffee	(2) Maize	(3) Beans	(4) Barley	(5) Wheat	(6) Teff	(7) Sorghum
Cv	0.231***	0.180	7.235**	-0.496	0.911	1.4365*	1.171
	(0.031)	(0.238)	(2.640)	(0.556)	(0.664)	(0.757)	(0.592)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	458	702	155	576	342	463	353
R^2	0.0889	0.0326	0.1090	0.0689	0.0542	0.0464	0.0545

Table 9. Price Volatility and Migration: Net Buyer
Dependent Variable: Migrate (0 or 1)

	(1) Coffee	(2) Maize	(3) Beans	(4) Barley	(5) Wheat	(6) Teff	(7) Sorghum
Cv	0.156*	-0.194	0.611	0.055	0.157	0.871***	0.151
	(0.085)	(0.151)	(0.379)	(0.188)	(0.235)	(0.243)	(0.406)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	4,018	2,007	1,862	1,433	1,572	1,443	808
R^2	0.0257	0.0329	0.0341	0.0454	0.0278	0.0257	0.0386

Notes:

1. Control variables included: access to loan, loan from friends and relatives, loan from bank, loan from NGO, loan for farming, loan for business, loan for food, loan for travel, income, non-farm income, business income, plot size per person, household size

2. Standard errors clustered at the district level are in parentheses.

*: $p < 0.1$, **: $p < 0.0.05$, ***: $p < 0.0.01$.

8 Appendices

A.1. Derivation of Expression (4)

Case 1: $L^F > 0$, $L^U > 0$

For both L^F and L^U to have interior solutions, the following conditions must be both satisfied.

$$\begin{aligned} E\left[V_y(w^U - c)\right] &= E\left[V_y w^R\right] \\ E\left[V_y p F_{L^F}\right] &= E\left[V_y w^R\right] \end{aligned} \tag{17}$$

Therefore,

$$\begin{aligned} & E\left[V_y(w^U - c)\right] = E\left[V_y p F_{L^F}\right] \\ \Leftrightarrow\ & Cov[V_y, (w^U - c)] + E[V_y]\, E[w^U - c] = Cov[V_y, pF_{L^F}] + E[V_y]\, E[pF_{L^F}] \\ \Leftrightarrow\ & E[V_y] E[w^U - c - pF_{L^F}] = Cov[V_y, pF_{L^F}] - Cov[V_y, w^U - c] \\ \Leftrightarrow\ & E[w^U - c - pF_{L^F}] = \frac{F_{L^F} Cov[V_y, p] - Cov[V_y, w^U - c]}{E[V_y]} \end{aligned} \tag{18}$$

The second line follows from the identity $Cov(X, Y) = E(XY) - E(X)E(Y)$, and the last line follows from the assumption that utility is strictly increasing in income.

Case 2: $L^F = 0$, $L^U > 0$

For L^U to have an interior solution,

$$E\left[V_y w^R\right] = E\left[V_y(w^U - c)\right] \tag{19}$$

From the first order condition for L^F and the complementary slackness condition, if the following inequality holds, $L^F = 0$.

$$E\left[V_y p F_{L^F}\right] < E\left[V_y w^R\right] \tag{20}$$

From the above two conditions, the following is a sufficient condition to have $L^U = 0$.

$$\begin{aligned} & E\left[V_y(w^U - c)\right] > E\left[V_y p F_{L^F}\right] \\ \Leftrightarrow\ & Cov[V_y, (w^U - c)] + E[V_y]\, E[w^U - c] > Cov[V_y, pF_{L^F}] + E[V_y]\, E[pF_{L^F}] \\ \Leftrightarrow\ & E[V_y] E[w^U - c - pF_{L^F}] > Cov[V_y, pF_{L^F}] - Cov[V_y, w^U - c] \\ \Leftrightarrow\ & E[w^U - c - pF_{L^F}] > \frac{F_{L^F} Cov[V_y, p] - Cov[V_y, w^U - c]}{E[V_y]} \end{aligned} \tag{21}$$

The second line follows from the identity $Cov(X,Y) = E(XY) - E(X)E(Y)$, and the last line follows from the assumption that utility is strictly increasing in income.

Case 3: $L^F > 0$, $L^U = 0$

A farming household allocates positive labor hours to household farming. For L^F to have an interior solution,

$$E\left[V_y w^R\right] = E\left[V_y p F_{L^F}\right] \tag{22}$$

From the first order condition for L^U and the complementary slackness condition, if the following inequality holds, $L^U = 0$.

$$E\left[V_y(w^U - c)\right] < E\left[V_y w^R\right] \tag{23}$$

From the above two conditions, the following is a sufficient condition to have $L^U = 0$.

$$\begin{aligned} & E\left[V_y(w^U - c)\right] < E\left[V_y p F_{L^F}\right] \\ \Leftrightarrow\ & Cov[V_y, (w^U - c)] + E[V_y]\, E[w^U - c] < Cov[V_y, pF_{L^F}] + E[V_y]\, E[pF_{L^F}] \\ \Leftrightarrow\ & E[V_y]E[w^U - c - pF_{L^F}] < Cov[V_y, pF_{L^F}] - Cov[V_y, w^U - c] \\ \Leftrightarrow\ & E[w^U - c - pF_{L^F}] < \frac{F_{L^F} Cov[V_y, p] - Cov[V_y, w^U - c]}{E[V_y]} \end{aligned} \tag{24}$$

The second line follows from the identity $Cov(X,Y) = E(XY) - E(X)E(Y)$, and the last line follows from the assumption that utility is strictly increasing in income.

From the cases 1-3, the following condition must hold if $L^U \geq 0$.

$$E[\ \underbrace{w^U - c}_{\text{Gains from Migration}} - \underbrace{pF_{L^F}}_{\text{Gains from Agriculture}}\ ] \geq \frac{F_{L^F} \cdot \overbrace{Cov[V_y, p]}^{\text{Price Risk Attitude}} - \overbrace{Cov[V_y, w^U - c]}^{\text{Income Risk Attitude}}}{E[V_y]} \tag{25}$$

A.2. How $(Cov[V_y, p])$ and $(Cov[V_y, w^U - c])$ are related to risk attitudes towards price and income, respectively

To see why the terms $(Cov[V_y, p])$ and $(Cov[V_y, w^U - c])$ are associated with attitudes towards price and income risks, respectively, consider $(Cov[V_y, w^U - c])$ first. Given that c is a fixed parameter,

$\text{sign}(Cov[V_y, w^U - c]) = \text{sign}(Cov[V_y, w^U]) = \text{sign}(Cov[V_y, y]) = \text{sign}(V_{yy}) < 0$ given income risk aversion. The term $Cov[V_y, p]$ depends on attitudes towards price risk.[28] To see why, first note that $\text{sign}(Cov[V_y, p]) = \text{sign}(V_{yp})$. By Roy's Identity,

$$M = \frac{V_p}{V_y} \quad \Leftrightarrow V_y = \frac{V_p}{M} \tag{26}$$

where marketable surplus, denoted as M, is the difference between production and consumption of the staple commodity $(F - S)$. Therefore,

$$V_{yp} = \frac{V_{pp}}{M} - \frac{V_p}{M^2}\frac{\partial M}{\partial p} = \frac{V_{pp}}{M} - \frac{V_y}{M}\frac{\partial M}{\partial p} = \frac{V_{pp}}{M} - \frac{\epsilon V_y}{p} \tag{27}$$

where ϵ is the own-price elasticity of the marketable surplus. The sign of $Cov[V_y, p]$ thus depends on $M, p, V_y, \frac{\partial M}{\partial p}$, ϵ, and the household's attitudes towards price risk represented by V_{pp}.

A.3. Derivation of the Coefficient of Absolute Price Risk Aversion

This is shown in Barrett (1996) and is reproduced here. From expression (27) in A.2, $V_{pp} = V_{yp}M + V_y\frac{\partial M}{\partial p}$. From expression (26), $V_{py} = V_{yy}M + V_y\frac{\partial M}{\partial y} = V_{yp}$ (by symmetry). Therefore, $V_{pp} = M\left[V_{yy}M + V_y\frac{\partial M}{\partial y}\right] + V_y\frac{\partial M}{\partial p}$.

V_{pp} and V_{yp} can then be expressed as the following.

$$V_{pp} = \frac{MV_y}{p}\{\epsilon + \beta(\eta - R)\} \qquad V_{yp} = \frac{V_y}{p}\{\beta(\eta - R)\} \tag{28}$$

where β is a budget share of the marketable surplus of the commodity $(\frac{pM}{y})$, η is the income elasticity of the marketable surplus $(\frac{\partial M}{\partial y}\frac{y}{M})$, R is the Arrow-Pratt coefficient of relative risk aversion of households, and ϵ is the own-price elasticity of the marketable surplus $(\frac{\partial M}{\partial p}\frac{p}{M})$.

Therefore,

$$A \equiv -\frac{V_{pp}}{V_y} = -\frac{M}{p} \cdot \{\beta(\eta - R) + \epsilon\} \tag{29}$$

A.4. Necessary and Sufficient Condition for Price Risk Aversion

Claim. *Both net sellers and net buyers are averse to price risk ($A > 0$) if and only if $R > \eta + \frac{\epsilon}{\beta}$.*
Proof. This is shown in Barrett (1996) and is reproduced here. For both sellers and net buyers, $A > 0$ if and only if $\frac{M}{p} \cdot \{\beta(\eta - R) + \epsilon\} < 0$ by expression (5).

[28] This is shown in Barrett (1996) and is reproduced here.

For net sellers, $M, \beta > 0$.
$\frac{M}{p}\{\epsilon + \beta(\eta - R)\} < 0$
$\Leftrightarrow \epsilon + \beta(\eta - R) < 0$
$\Leftrightarrow \beta(\eta - R) < -\epsilon$
$\Leftrightarrow \eta - R < -\frac{\epsilon}{\beta}$
$\Leftrightarrow R > \eta + \frac{\epsilon}{\beta}$ ■
For net buyers, $M, \beta < 0$.
$\frac{M}{p}\{\epsilon + \beta(\eta - R)\} < 0$
$\Leftrightarrow \epsilon + \beta(\eta - R) > 0$
$\Leftrightarrow \beta(\eta - R) > -\epsilon$
$\Leftrightarrow \eta - R < -\frac{\epsilon}{\beta}$
$\Leftrightarrow R > \eta + \frac{\epsilon}{\beta}$ ■

A.5. Proof of Claim I

Claim I. *If a household is a net seller of a normal good S, aversion to price risk ($V_{pp} < 0$) is a sufficient condition for $Cov[V_y, p] < 0$.*[29]

Proof. $V_{pp} < 0$
$\Rightarrow R > \eta + \frac{\epsilon}{\beta}$ by A.4.
$\Rightarrow \beta R - \beta\eta > \epsilon$ $\because \beta > 0$ for net sellers.
$\Rightarrow \beta R - \beta\eta > 0$ $\because \epsilon > 0$ for net sellers.
$\Rightarrow \beta(\eta - R) < 0$
$\Rightarrow \frac{V_y}{p}\{\beta(\eta - R)\} = V_{yp} < 0$
$\Rightarrow Cov[V_y, p] < 0$ ■

A.6. Proof of Claim II

Claim II. *If a household is a net buyer of a normal good S, aversion to price risk ($V_{pp} < 0$) is a sufficient condition for $Cov[V_y, p] > 0$.*[30]

Proof. $V_{pp} < 0$
$\Rightarrow R > \eta + \frac{\epsilon}{\beta}$ by A.4.
$\Rightarrow \beta R - \beta\eta < \epsilon$ $\because \beta < 0$ for net buyers.
$\Rightarrow \beta R - \beta\eta < 0$ $\because \epsilon < 0$ for net buyers.
$\Rightarrow \frac{V_y}{p}\{\beta(\eta - R)\} = V_{yp} > 0$
$\Rightarrow Cov[V_y, p] > 0$ ■

[29] The same result was shown by Barrett (1996) to show that a price risk-averse net seller will underemploy labor.
[30] The same result was derived by Barrett (1996) to show that a price risk-averse net buyer will overemploy labor.

A.7. Variable Descriptions

Variable	Descriptions
Dependent Variables	
Migrate	1 if there is a household member who left the household since the previous round of the survey. 0 otherwise. Excludes leaving a household due to the following reasons: death; parents were too sick to care for; divorced/out of family; returned home; to look after other relatives; conscripted into the army; sick, went for treatment.
Migrate for Work	1 if there is a household member who left the household for the following reasons: to look for work; to take up jobs; to be near to the place of work; to run own farm or enterprise. 0 otherwise.
Migrate to Urban Areas	1 if there is a household member whose current residence is an urban area in this district; Addis Ababa; or other urban areas. 0 otherwise.
Migrate to Urban Areas for Work	Interaction of "Migrate for work" and "Migrate to urban areas"
Migrate for Marriage	1 if there is a household member who migrated to live with spouse or for marriage. 0 otherwise.
Number of Migrants	Number of household members who left their households since the previous round of the survey
Independent Variables	
WTP	Household-level willingness-to-pay to stabilize prices of the seven most important commodities (coffee, maize, beans, barley, wheat, teff, sorghum) at their means, expressed as a proportion of household income, estimated by BBJ (2013). Ranges from -1 to 1.
Taken Loan	1 if anyone in a household has ever taken a loan during the previous 5 years. 0 otherwise. Includes both cash and in-kind.
Loan from Friends and Relatives	1 if anyone in a household has ever taken a loan from friends and relatives during the previous 5 years. 0 otherwise. Includes both cash and in-kind.
Loan from Bank	1 if anyone in a household has ever taken a loan from banks during the previous 5 years. 0 otherwise. Includes both cash and in-kind.
Loan from NGO	1 if anyone in a household has ever taken a loan from NGOs during the previous 5 years. 0 otherwise. Includes both cash and in-kind.
Loan for Farming	1 if anyone in a household has ever taken loan during the previous 5 years. in order to buy a farm; to buy inputs such as seeds and fertilizer; to buy livestock. 0 otherwise. Includes both cash and in-kind.
Loan for Business	1 if anyone in a household has ever taken loan during the previous 5 years. in order to start an off-farm business. 0 otherwise. Includes both cash and in-kind.
Loan for Food	1 if anyone in a household has ever taken loan during the previous 5 years. in order to buy food and goods. 0 otherwise. Includes both cash and in-kind.
Loan for Travel	1 if anyone in a household has ever taken loan during the previous 5 years. in order to pay for travels. 0 otherwise. Includes both cash and in-kind.

A.7. Variable Descriptions (continued)

Variable	**Descriptions**
Logged Income	Inverse hyperbolic sine (IHS) transformation of household income, (in Birr, including in-kind) during the last four months as of the date of survey
Logged Nonfarm Income	Inverse hyperbolic sine (IHS) transformation of household income, (in Birr, including in-kind) from nonfarm activities during the last four months as of the date of survey
Logged Business Income	Inverse hyperbolic sine (IHS) transformation of household income, (in Birr, including in-kind) from running businesses during the last four months as of the date of survey
Plot Area per Person	Household plot area (in ha) divided by the number of household members
Household Size	Number of household members
MS_k	Household marketable Surplus (in kg) of commodity k, or quantity supplied minus quantity demanded of commodity k. $k \in \{1, 2, ...7\}$
P_k	Price (in Birr/kg) of commodity k. $k \in \{1, 2, ...7\}$

A.8. Reasons for Migration (Frequency)

	Round 1	Round 2	Round 3	Round 4	Total
1. To be with parent	22	90	74	179	365
2. To be near to school / For education	9	34	27	45	115
3. Parents were to sick to care for	3	4	3	11	21
4. Sent to relatives/friends	29	49	40	53	171
5. To live with spouse/marriage	363	63	67	387	880
6. Divorced / Out of family	36	37	28	55	156
7. Returned home	9	39	55	85	188
8. To look for work	49	49	49	129	276
9. To take up a job	24	36	21	50	131
10. To be near to their places of work	7	3	1	17	28
11. To run own farm or enterprise	2	1	2	8	13
12. Contract ended	2	14	12	27	55
13. Land shortage	1	1	1	2	5
14. Drought	5	-	-	-	5
15. To look after other relatives	10	34	29	25	98
16. Conscripted into the army	6	14	3	8	31
17. Sick, went for treatment	1	3	3	4	11
18. Migrated, intentions unknown	3	12	8	20	43
20. Other	31	8	14	16	69
Total	612	491	437	1,121	2,661

Notes: This table presents reasons for leaving households reported in the rounds 1-4 of the survey. The most common reasons for household members to leave home are family-related reasons (to be with parents and spouse, marriage, divorce, and to look after relatives). On average, labor migration (migration aiming to look for work, to take up a job, to be near to their places of work, to run own farm or enterprise) happens in about 16 percent of all cases.

A.9. Destinations for Migration (Frequency)

Destination	Round 1	Round 2	Round 3	Round 4	Total
1. This village	236	116	112	433	897
2. Rural area, this district	127	102	95	211	535
3. Rural area, neighboring district	65	51	50	85	251
4. Other rural area	36	69	62	137	304
5. Urban area, this district	22	35	23	40	120
6. Addis Ababa	50	31	40	68	189
7. Other urban area	68	68	44	99	279
8. Other/ Don't know	12	13	6	20	51
Total	616	485	432	1,093	2,626

Notes: This table is constructed from the survey question that asks current residences of the household members who had left their households. It is notable that migration to rural areas (destinations 1-4) happens more frequently than migration to urban areas (destinations 5-7). On average, in about 75 percent of all cases, migrants ended up in rural areas (destinations 1-5). This is consistent with the fact that Ethiopia is one of the least urbanized countries in the world. Also, in about 60 percent of all cases, migrants end up in some places within the district (destinations 1, 2, and 5).

A.10. Robustness Check (1): Alternative Definitions of Migration

	(1) Urban	(2) Outside Distr.	(3) Within Distr	(4) Work	(5) Marriage
WTP	0.0512**	0.0515**	0.0795**	0.00252	0.0856**
	(0.0240)	(0.0218)	(0.0393)	(0.0172)	(0.0342)
Taken Loan	0.000459	0.00798	0.0258	0.00387	0.0481***
	(0.0111)	(0.0126)	(0.0224)	(0.00856)	(0.0162)
Loan from Friends and Rel.	-0.00147	-0.00739	-0.0440***	0.0108	-0.0497***
	(0.00794)	(0.0149)	(0.0141)	(0.00735)	(0.0143)
Loan from Bank	-0.0758***	0.0199	-0.138***	-0.0486	-0.136***
	(0.0170)	(0.0445)	(0.0327)	(0.0299)	(0.0188)
Loan from NGO	-0.0252**	-0.0233*	-0.0436**	-0.00651	-0.0542***
	(0.0112)	(0.0141)	(0.0189)	(0.00951)	(0.0137)
Loan for Farming	0.00829	0.0217	-0.00434	0.00978	-0.0290**
	(0.0169)	(0.0234)	(0.0208)	(0.0233)	(0.0127)
Loan for Business	0.0319	-0.00207	0.00244	0.0367	-0.0100
	(0.0321)	(0.0367)	(0.0210)	(0.0362)	(0.0221)
Loan for Food	-0.000169	0.0129	0.0290**	0.00166	-0.00000793
	(0.00694)	(0.00929)	(0.0138)	(0.0112)	(0.0104)
Loan for Travel	0.00612	0.0392	0.0678	-0.00786	0.0459
	(0.0353)	(0.0593)	(0.0575)	(0.0366)	(0.0626)
Logged Income	0.00179	0.00403**	0.00850***	0.00196	0.00775***
	(0.00131)	(0.00160)	(0.00202)	(0.00158)	(0.00236)
Logged Nonfarm Income	0.00131	-0.00150	-0.00368	0.00119	-0.00399*
	(0.00120)	(0.00125)	(0.00247)	(0.00170)	(0.00211)
Logged Business Income	0.00175*	0.00306**	-0.00158	0.00183	-0.00252
	(0.000912)	(0.00151)	(0.00202)	(0.00155)	(0.00214)
Plot Area Per Person	0.0146	0.0168*	0.0415**	0.0209***	0.0181
	(0.0105)	(0.00999)	(0.0191)	(0.00808)	(0.0140)
Household Size	0.000200	0.000178	0.00141	0.000754	0.000966
	(0.000743)	(0.000684)	(0.00113)	(0.00127)	(0.00138)
Constant	0.0242**	0.0329**	0.0505***	0.0293***	0.0527***
	(0.00973)	(0.0134)	(0.00880)	(0.00918)	(0.0141)
N	5,604	5,610	5,610	5,606	5,606
R^2	0.006	0.005	0.011	0.004	0.009

Notes:

1. District-round fixed effects are included in all specifications.
2. Bootstrapped standard errors clustered at the district level are in parentheses.

*: $p < 0.1$, **: $p < 0.0.05$, ***: $p < 0.0.01$.

A.11. Robustness Check (2): Alternative Definition of WTP
Dependent Variable: Migrate (0 or 1)

	(1) LPM	(2) FE LPM	(3) FE LPM	(4) FE LPM	(5) Net Sellers	(6) Net Buyers
Alternative WTP	0.0697	0.0774*	0.0731	0.110***	0.116**	0.125**
	(0.0484)	(0.0447)	(0.0472)	(0.0390)	(0.0466)	(0.0513)
Taken Loan			0.0153	0.0130	-0.0137	0.0345
			(0.0247)	(0.0235)	(0.0286)	(0.0393)
Loan from Friends and Rel.			-0.0403**	-0.0429**	-0.00930	-0.0708**
			(0.0203)	(0.0193)	(0.0346)	(0.0352)
Loan from Bank			-0.0747	-0.0725	-0.0743	-0.0728
			(0.0572)	(0.0639)	(0.102)	(0.0568)
Loan from NGO			-0.0598***	-0.0638***	-0.0353	-0.0942***
			(0.0227)	(0.0235)	(0.0404)	(0.0307)
Loan for Farming			0.0302	0.0271	0.0198	0.0551
			(0.0297)	(0.0341)	(0.0541)	(0.0588)
Loan for Business			0.0273	0.0205	-0.0485	0.0584
			(0.0282)	(0.0347)	(0.0596)	(0.0487)
Loan for Food			0.0532***	0.0580***	0.0640**	0.0570**
			(0.0149)	(0.0140)	(0.0258)	(0.0249)
Loan for Travel			0.131*	0.126	0.137	0.130**
			(0.0698)	(0.0853)	(0.0974)	(0.0578)
Logged Income				0.0212***	0.0229***	0.0257***
				(0.00316)	(0.00763)	(0.00482)
Logged Nonfarm Income				-0.00447	-0.00674*	-0.00304
				(0.00303)	(0.00394)	(0.00443)
Logged Business Income				0.0000755	-0.000665	-0.00160
				(0.00287)	(0.00453)	(0.00442)
Plot Area Per Person				0.0464	0.0558*	0.0325
				(0.0347)	(0.0296)	(0.0492)
Household Size				0.00127	0.00169	0.000433
				(0.00188)	(0.00277)	(0.00323)
Constant	0.176***	0.180***	0.179***	0.0235	0.0144	-0.00266
	(0.0150)	(0.0145)	(0.0200)	(0.0232)	(0.0612)	(0.0346)
Control Variables	No	No	Yes	Yes	Yes	Yes
District-Round F.E.	No	Yes	Yes	Yes	Yes	Yes
N	4,253	4,253	4,248	4,248	2,163	,2085
R^2	0.001	0.002	0.006	0.015	0.014	0.023

Notes: Bootstrapped standard errors clustered at the district level are in parentheses.
*: $p < 0.1$, **: $p < 0.0.05$, ***: $p < 0.0.01$.

A.12. Robustness Check (3): Various Fixed Effects and Clustered S.E. Dependent Variable: Migrate (0 or 1)

	(1)	(2)	(3)	(4)	(5)	(6)
WTP	0.114***	0.0945**	0.112***	0.0940**	0.107***	0.0891*
	(0.0388)	(0.0461)	(0.0407)	(0.0442)	(0.0395)	(0.0515)
Taken Loan	0.0146	0.0151	0.0112	0.0118	0.0188	0.0114
	(0.0212)	(0.0192)	(0.0234)	(0.0218)	(0.0249)	(0.0227)
Loan from Friends and Rel.	-0.0329*	-0.0280*	-0.0305	-0.0249	-0.0313*	-0.0250
	(0.0176)	(0.0154)	(0.0194)	(0.0181)	(0.0182)	(0.0188)
Loan from Bank	-0.0904	-0.0490	-0.0837	-0.0457	-0.0867	-0.0529
	(0.0680)	(0.0603)	(0.0741)	(0.0784)	(0.0731)	(0.0716)
Loan from NGO	-0.0485**	-0.0365*	-0.0455**	-0.0336	-0.0458*	-0.0254
	(0.0226)	(0.0220)	(0.0219)	(0.0214)	(0.0263)	(0.0269)
Loan for Farming	0.0135	0.00403	0.0103	0.00149	0.0105	0.00207
	(0.0239)	(0.0280)	(0.0254)	(0.0268)	(0.0262)	(0.0218)
Loan for Business	0.00827	-0.0106	0.00781	-0.00950	-0.00186	-0.0125
	(0.0377)	(0.0511)	(0.0435)	(0.0482)	(0.0453)	(0.0530)
Loan for Food	0.0364***	0.0368***	0.0382***	0.0392**	0.0270**	0.0310***
	(0.0112)	(0.0143)	(0.0135)	(0.0157)	(0.0114)	(0.0104)
Loan for Travel	0.117*	0.108*	0.118*	0.109	0.119	0.110
	(0.0683)	(0.0623)	(0.0646)	(0.0744)	(0.0860)	(0.0755)
Logged Income	0.0121***	0.0126***	0.0119***	0.0128***	0.00979***	0.0123***
	(0.00203)	(0.00242)	(0.00225)	(0.00272)	(0.00289)	(0.00244)
Logged Nonfarm Income	-0.00575**	-0.00397*	-0.00548**	-0.00378	-0.00462*	-0.00376
	(0.00260)	(0.00231)	(0.00271)	(0.00264)	(0.00263)	(0.00236)
Logged Business Income	0.0000974	-0.000111	0.000492	-0.0000283	0.00251	0.00121
	(0.00235)	(0.00276)	(0.00294)	(0.00324)	(0.00288)	(0.00307)
Plot Area Per Person	0.0527**	0.0545**	0.0500**	0.0518**	0.0506*	0.0526*
	(0.0262)	(0.0274)	(0.0215)	(0.0255)	(0.0286)	(0.0304)
Household Size	0.000225	0.000965	0.000411	0.00106	0.000512	0.00117
	(0.00140)	(0.00190)	(0.00201)	(0.00190)	(0.00195)	(0.00208)
Time Trend		-0.0114**		-0.0111*		-0.0106
		(0.00543)		(0.00581)		(0.00761)
Constant	0.0957***	0.115***	0.0950***	0.112***	0.101***	0.112***
	(0.0154)	(0.0260)	(0.0180)	(0.0221)	(0.0245)	(0.0359)
Fixed Effects	Dist.-Round	District	Village-Round	Village	Region-Round	Region
Number of Groups	60	15	72	18	24	6
Clustered S.E.	District	District	Village	Village	Region	Region
Time Trend	No	Yes	No	Yes	No	Yes
N	5,604	5,604	5,576	5,576	5,576	5,576
R^2	0.013	0.015	0.012	0.015	0.012	0.015

Notes: Standard errors are in parentheses. *: $p < 0.1$, **: $p < 0.0.05$, ***: $p < 0.0.01$.

A.13. Robustness Check (4): Conditional Logit Model with Fixed Effects Dependent Variable: Migrate (0 or 1)

	(1)	(2)	(3)	(4)	(5)	(6)
WTP	0.756***	0.611***	0.745***	0.608**	0.713***	0.578*
	(0.178)	(0.226)	(0.214)	(0.240)	(0.185)	(0.322)
Taken Loan	0.1000	0.0970	0.0764	0.0750	0.133	0.0771
	(0.154)	(0.120)	(0.137)	(0.108)	(0.150)	(0.112)
Loan from Friends and Rel.	-0.220*	-0.179**	-0.202*	-0.159	-0.214**	-0.167*
	(0.118)	(0.0815)	(0.121)	(0.0976)	(0.105)	(0.0967)
Loan from Bank	-0.606	-0.348	-0.576	-0.325	-0.591	-0.371
	(4.041)	(4.653)	(3.934)	(5.245)	(2.452)	(5.097)
Loan from NGO	-0.327*	-0.231**	-0.308*	-0.211*	-0.305	-0.158
	(0.180)	(0.117)	(0.183)	(0.120)	(0.198)	(0.195)
Loan for Farming	0.0737	0.0161	0.0475	-0.00322	0.0580	0.00928
	(0.228)	(0.171)	(0.267)	(0.152)	(0.202)	(0.245)
Loan for Business	0.0816	-0.0747	0.0777	-0.0688	-0.0111	-0.0918
	(0.318)	(0.348)	(0.258)	(0.280)	(0.335)	(0.300)
Loan for Food	0.242***	0.247**	0.255***	0.263***	0.179**	0.207***
	(0.0862)	(0.114)	(0.0920)	(0.0758)	(0.0872)	(0.0584)
Loan for Travel	0.663**	0.593	0.669*	0.598*	0.664*	0.595**
	(0.320)	(0.373)	(0.368)	(0.327)	(0.365)	(0.301)
Logged Income	0.0919***	0.0921***	0.0916***	0.0936***	0.0731***	0.0900***
	(0.0218)	(0.0155)	(0.0232)	(0.0163)	(0.0217)	(0.0195)
Logged Nonfarm Income	-0.0415**	-0.0270	-0.0401**	-0.0258	-0.0338*	-0.0258
	(0.0192)	(0.0179)	(0.0175)	(0.0159)	(0.0194)	(0.0176)
Logged Business Income	-0.00224	-0.00267	0.000564	-0.00209	0.0141	0.00631
	(0.0165)	(0.0173)	(0.0137)	(0.0185)	(0.0136)	(0.0186)
Plot Area Per Person	0.304***	0.309**	0.292***	0.295**	0.294***	0.303
	(0.0869)	(0.142)	(0.0903)	(0.118)	(0.0722)	(0.239)
Household Size	0.000831	0.00604	0.00202	0.00667	0.00292	0.00787
	(0.0144)	(0.0100)	(0.0146)	(0.0129)	(0.0127)	(0.0136)
Time Trend		-0.0782*		-0.0760**		-0.0721
		(0.0458)		(0.0349)		(0.0665)
Fixed Effects	Dist.-Round	District	Village-Round	Village	Region-Round	Region
Clustered S.E.	District	District	Village	Village	Region	Region
Number of Groups	60	15	72	18	24	6
Time Trend	No	Yes	No	Yes	No	Yes
N	5,604	5,604	5,576	5,576	5,576	5,576

Notes: Bootstrapped standard errors are in parentheses. *: $p < 0.1$, **: $p < 0.0.05$, ***: $p < 0.0.01$.

A.14. Robustness Check (5): Conditional Logit Model without Fixed Effects
Dependent Variable: Migrate (0 or 1)

	(1)	(2)	(3)	(4)	(5)
WTP	0.718***	0.714***	0.612***	0.625***	0.733***
	(0.190)	(0.219)	(0.154)	(0.214)	(0.190)
Round 2		-0.715***		-0.726***	
		(0.0834)		(0.0964)	
Round 3		-0.775***		-0.786***	
		(0.0974)		(0.121)	
Round 4		-0.173**		-0.165*	
		(0.0832)		(0.0980)	
Time Trend					-0.0782**
					(0.0380)
Controls	No	No	No	No	Yes
District Dummy	No	No	Yes	Yes	No
Round Dummy	No	Yes	No	Yes	No
Time Trend	No	No	No	No	Yes
N	5,613	5,613	5,613	5,613	5,604

Standard errors in parentheses

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

Notes: Control variables included: access to loan, loan from friends and relatives, loan from bank, loan from NGO, loan for farming, loan for business, loan for food, loan for travel, income, non-farm income, business income, plot size per person, household size

Bootstrapped standard errors are in parentheses. *: $p < 0.1$, **: $p < 0.0.05$, ***: $p < 0.0.01$.