Migration, Consumption Smoothing and Household Income: Evidence from Thailand

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Abstract

The main argument of this paper is that migration does not necessarily reduce informal risk sharing in the village. We model migration as a kind of storage technology with uncertain payments for a household. Theoretical conditions, under which the “technology” can improve risk sharing in a dynamic limited commitment framework, are provided. Our empirical findings also show positive impacts of migration on risk sharing, in particular, when children migrate for education opportunities. The data are from the Townsend Thai Annual Surveys (1999-2010). The impacts of migration on income and on consumption smoothing are jointly estimated in a simultaneously determined system.

Key Words: Migration, Informal Risk Sharing, Consumption Smoothing, Income, Risk Aversion.

1 Executive Summary

In this paper, we discussed the impact of migration on household consumption smoothing from a theoretical perspective and an empirical perspective. Our theoretical and empirical results indicate that migration does not necessarily reduce informal risk sharing in the village. Using the Townsend Thai Annual Surveys (1999-2010), the impacts of migration on income and on consumption smoothing are jointly estimated in a simultaneously determined system.

We found that the overall impact of migration on household consumption smoothing is positive. Households are better insured in the within-village risk-sharing networks when one or more than one household member has migrated. At the same time, household per-capita income is increased by US$1961 due to migration. Our estimation results also suggest that who migrates for what purpose matters when measuring the impacts of migration. Household head migration and child migration for jobs contribute to a higher increase in per-capita income, but have little impact on consumption smoothing. In particular, households with children migrating for education are better insured compared to the others.

Our theoretical model considers migration as a cash-in-advance contract between the sending household and the migrant (Bulow and Rogoff, 1989). It can also be regarded as a kind of storage technology (as in Ligon et al., 2000), but with uncertain payments. In a dynamic limited commitment framework, we found that the impact of migration on risk sharing depends on the type of risk-sharing contract. If voluntary payments can be enforced before the realisation of the states in implementing the informal contract, in addition to ex post transfers, migration can improve risk sharing.

This is because, on the one hand, ex ante payments increase the amount of the support that the migrant receives, and then, increase the expected remittances. On the other hand, ex ante payments improve the level of commitment in the village and thus improve the efficiency of risk sharing as suggested by Gauthier et al. (1997).

In the empirical part, our strategy is to directly estimate the impacts of migration on household income and on consumption smoothing in a simultaneously determined system. Identification is a challenging task. Our endogenous variables are income, consumption growth and migration. We use land property rights as predetermined factors of income. It is suggested in the literature that secured land rights encourage invest- ment in land fertility and lead to substantially higher output (Goldstein and Udry, 2008). To our knowledge, there is no direct evidence in the literature that land rights are correlated with consumption growth. Nevertheless, De la Rupelle et al. (2009) found that land-right insecurity leads rural workers in China to migrate less, or for shorter periods. However, even where there exists a causal correlation between land rights and the choice of migration, we can still view land rights as a predetermined predictor of income, as long as the causal relationship is through the channel of an income effect. As it has been well explained in De la Rupelle et al. (2009), land-right insecurity increases migration costs that is the income loss caused by the loss of land. In other words, land rights only affect migration decisions through their impacts on incomes.

It is more tricky to construct the instrument for migration decisions. We cannot use the proxy of the migrants networks as an instrument, since risk-sharing networks are endogenous in our system. Instead, we consider the group of individual labourers that are similar in age to the migrants in the village in each cross section. Some of those labourers in the group are migrants, while others are not. We use the proportion of those labourers to the village population as a predetermined factor of migration. The reasons are as follows:

Given the land areas and the population size of the village, an increase in the number of labourers that are similar in human capital is likely to cause a decrease in the marginal labour productivity in the village. Migration is a way to improve labour resource allocation. We assume that labourers at the same age in the village are similar in the level of human capital. Then, any individual at the age of the migrants is more likely to migrate if the number of similar labourers is greater, given the size of the population. In practice, for each individual observed in the data, we picked the year when he or she reached the age of the migrants. The number of labourers at the same age at that year divided by the population size is considered as the value of the migration predictor for the individual. If the year is not covered in the survey, we filled the value of the predictor with the same ratio at the earliest year that we can observe. For those who had not reached the age, we used the same ratio at the contemporaneous year when the individual is observed. In this way, we constructed an instrument variable for migration, which has household-level variations across years, thanks to the relative long duration of the Townsend Thai survey.

As another important part of our empirical results, we recovered risk-aversion parameters following the approach developed in Dubois (2001). We use the estimated parameters to test the correlation between risk aversion and the migration decision, assuming that more risk-averse households are less likely to send away migrants if migration has a negative impact on consumption insurance. Our results show that, except from child migration for education, the other types of migration are not significantly correlated with risk aversion. The level of risk aversion is positively and significantly correlated with child migrating for education. These results indicate that child migration for education improves the level of insurance for the related households, whereas head migration and child migration for jobs are more likely to be motivated by higher incomes rather than by risk aversion.

Contents

2 Introduction

Labour migration in developing countries can be motivated by income gaps between the origins and the destinations, or can also be initiated by an effort to loosen constraints associated with a variety of market failures, such as the absence of a formal insurance market. It is more reasonable to consider an agent that migrated following a calculation of the benefits and costs from both aspects. In this paper, we jointly evaluate the impacts of migration on income and on consumption smoothing in a simultaneously determined system.

Many studies suggest that migration contributes to the income growth at the origins. As for the role of migration in risk reduction, the literature tends to have different opinions.

Rosenzweig and Stark (1989) found that female migration for the purpose of marriage is a way for rural Indian households to extend risk-sharing networks in order to mitigate income risks and facilitate consumption smoothing. Remittances sent back in response to negative shocks at the origins are direct evidence that migrants share risks with their families (Lucas and Stark, 1985; Yang and Choi, 2007).

However, some recent studies suggest that migration may not be an effective risk-reduction strategy since it can crowd out informal risk sharing in a village. Informal risk sharing has been identified as an important instrument for consumption smoothing in villages in many developing countries (e.g. Dubois, 2001; Fafchamps and Lund, 2003; Kinnan and Townsend, 2012; Kochelakota, 1996; Ligon et al., 2002; Townsend, 1994; Udry, 1994). Using the ICRISAT panel (2001-2004), Morten (2013) found that temporary migration reduces risk sharing in villages in India and, vice versa, that informal risk sharing discourages migration. The utility gain from migration is found to be lower, contrasting endogenous to exogenous risk sharing. Munshi and Rosenzweig (2016) suggest that the low rate of male migration in rural India could be explained by the existence of informal risk-sharing networks and missing insurance markets. Migrants risk losing insurance from the networks. If the utility reduction due to losing insurance cannot be compensated by the income gain from migration, the labourer will not migrate.

The literature mentioned above indicates that the particular types of migration are relevant with regard to risk sharing. For example, why is female migration for the purpose of marriage likely to extend risk-sharing networks while male migration is not? And, how about the other types of migration, such as migration for education?

We suggest the case in which the intra-household insurance contract between a migrant and his or her household can be nested inside the informal risk-sharing contract. From the household's aspect, the decision about migration is less restricted by one's own financial status since one is supported by the village network. From the village's aspect, migration benefits are redistributed through risk sharing. The aggregated risks in the village are reduced and every household in the network can benefit from an increase in aggregated resources and a decrease in consumption volatility. Thus, it does not necessarily follow that migration reduces risk sharing.

The last question that we raise about the previous studies is the following: Is the model of migration in the Indian society with a strict caste system representative of other developing counties? In this paper, we try to explore the above questions from both a theoretical and an empirical perspective.

Our theoretical model considers migration as a cash-in-advance contract between the sending household and the migrant (Bulow and Rogoff, 1989). It can also be regarded as a kind of storage technology (as in Ligon et al., 2000), but with uncertain payments. In a dynamic limited commitment framework, we found that the impact of migration on risk sharing depends on the type of risk-sharing contract. If voluntary payments can be enforced before the realisation of the states in implementing the informal contract, in addition to ex post transfers, migration can improve risk sharing.

In fact, a study by Bold and Dercon (2009) distinguished two types of risk-sharing contracts among insurance groups in villages in Ethiopia, in the sense that whether or not group savings are accumulated based on premiums paid ex-ante, in addition to the payments made after the realisation of the state. They found that groups with ex-ante payments are better off in consumption smoothing. Bold and Dercon (2009) provides evidence that ex ante payments is not just a theoretical concept but can be enforced in the real world. In the theory, Gauthier et al. (1997) showed that the enforcement of ex ante payments relaxes the ex post incentive constraint and improves the level of commitment in risk sharing.

The main argument of our theoretical analysis is that migration can improve risk sharing even in an economy with limited levels of commitment, provided that ex ante payments can be enforced. This is because, on the one hand, ex ante payments increase the amount of the support that the migrant receives, and then, increase the expected remittances. On the other hand, ex ante payments improve the level of commitment in the village and thus improve the efficiency of risk sharing as suggested by Gauthier et al. (1997).

In the empirical part, our strategy is to directly estimate the impacts of migration on household income and on consumption smoothing in a simultaneously determined system. Using the panel data from the Townsend Thai Annual Surveys (1997-2010),[1] we found that the overall impact of migration on household consumption smoothing is positive. Households are better insured in the within-village risk-sharing networks when one or more than one household member has migrated. At the same time, household per-capita income is increased by US$

[1]See Townsend (2013) for an introduction of the survey.

1961 due to migration.[2]

Our estimation results also suggest that who migrates for what purpose matters when measuring the impacts of migration. Household head migration and child migration for jobs contribute to a higher increase in per-capita income, but have little impact on consumption smoothing. In particular, households with children migrating for education are better insured compared to the others. The possible explanation related to our theoretical findings is as follows:

Our theoretical results show that the impact of migration on risk sharing depends on the implementation of ex ante transfers. In fact, ex ante payments are more likely to be enforceable if a small amount of ex ante transfers by one agent can support a large surplus that the agent can obtain from the payment. On the contrary, a high ex ante payment increases the incentive of the other agent who receives the payment ex ante to break the contract and run away with the payment.[3] If the villagers believe that education is a kind of investment with a high rate of return, they will be willing to contribute a small amount of money to the child who is going to a university in the city. These ex ante payments from the village increase the total expected values that would be sent back by the child, and at the same time relax ex post self-enforcing constraints in implementing the risk-sharing contract. This could explain why we found a higher level of risk sharing for child migrating for education.

As another important part of our empirical results, we recovered risk-aversion parameters following the approach developed in Dubois (2001). The idea is to derive the consumption growth equation from a full risk-sharing model, assuming CRRA utilities with heterogenous risk preferences that depend on household characteristics. We use the estimated parameters to test the correlation between risk aversion and the migration decision, assuming that more risk-averse households are less likely to send away migrants if migration has a negative impact on consumption insurance. Our results show that, except from child migration for education, the other types of migration are not significantly correlated with risk aversion. The level of risk aversion is positively and significantly correlated with child migrating for education. These results indicate that child migration for education improves the level of insurance for the related households, whereas head

[2]We consider migrants that were or are adult household members observed in the data and are absent from the village in each cross section. Household members defined in the Townsend Thai survey are individuals living in the household for at least six months out of the twelve months in the survey year and children who are studying away and are supported by members of this household. Thus, migration cases in our study include both those who migrate permanently and temporarily. In fact, in our data we observe that temporary migrants may become permanent migrants. Conversely, some migrants, having been away for a couple of years, may return to their households. We will present the details about the definition and construction of the migration indicators in Section 5.2 and in Appendix A.3.

[3]See discussions in Gauthier et al. (1997).

migration and child migration for jobs are more likely to be motivated by higher incomes rather than by risk aversion.

Our empirical model is a system of simultaneously determined equations. Identification is a challenging task. Our endogenous variables are income, consumption growth and migration. We use land property rights as predetermined factors of income. It is suggested in the literature that secured land rights encourage investment in land fertility and lead to substantially higher output (Goldstein and Udry, 2008). To our knowledge, there is no direct evidence in the literature that land rights are correlated with consumption growth. Nevertheless, De la Rupelle et al. (2009) found that land-right insecurity leads rural workers in China to migrate less, or for shorter periods. However, even where there exists a causal correlation between land rights and the choice of migration, we can still view land rights as a predetermined predictor of income, as long as the causal relationship is through the channel of an income effect. As it has been well explained in De la Rupelle et al. (2009), land-right insecurity increases migration costs that is the income loss caused by the loss of land. In other words, land rights only affect migration decisions through their impacts on incomes.

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In practice, for each individual observed in the data, we picked the year when he or she reached the age of the migrants. The number of labourers at the same age at that year divided by the population size is considered as the value of the migration predictor for the individual. If the year is not covered in the survey, we filled the value of the predictor with the same ratio at the earliest year that we can observe. For those who had not reached the age, we used the same ratio at the contemporaneous year when the individual is observed. In this way, we constructed an instrument variable for migration, which has household-level variations across years, thanks to the relative long duration of the Townsend Thai survey.

Hansen-Sargan overi-dentification statistics [4] and C statistics [5] failed to reject the validity of our instruments. The LM test of redundancy of specified instruments rejects the null hypothesis and indicates that our instruments are not redundant (Baum et al., 2007).

The parameters are estimated through Three-stage Least Square regression method. We test the rank conditions of identification. The rank condition is satisfied for each equation in the system, and thus, the system is identified (Baum et al., 2007; Greene, 2002).

The paper is organised as follows: Section 2 introduces the theoretical illustration; Section 3 presents the construction of our empirical model and identification strategies; data are presented in Section 4; estimated results are discussed in Section 5; and, finally, we close this paper with our conclusion in Section 6. Tables, graphs and supporting paragraphs are listed in the Appendix.

3 A theoretical illustration

3.1 The setup

Consider two households in a village: i and j with a single good[6] in each time period $t \in \{1, 2, ...\}$. For each period, there is a positive finite set $\mathcal{S} = \{1, ..., S\}$ of states of nature. $Card\{\mathcal{S}\} = N$. Formally, uncertainty is captured by a Markov process with the probability of transition from state s to state r given by π_{sr}. we assume that $\pi_{sr} > 0$ for all s and r. In each period, household i and j receive respectively an income y_s^i and y_s^j of this single good. There is no formal insurance market. But i and j can ensure each other through an informal mutual insurance contract. The informal contract is self binding. In case of default, the household that fails to make the promised transfer will be excluded from all future insurance possibilities. We assume that the village is small and the households take the world interest rate ρ as given.

Households have twice continuously differentiable Bernoulli utility consumption functions $u(c)$, where $c \geq 0$ is the consumption, with $u'(c) > 0$, $u''(c) < 0$ for all $c > 0$. Households live infinitely and discount the future with a common factor β.

The precise timing of the realisation of various events within period t, is as follows:

- t_0: At the beginning of period t, the migration decision is made, along with a specification of the intra-household migration contract.

[4] See Hayashi (2000), page 227-8, 407 and 417.

[5] See Hayashi (2000), page 218-22 and page 232-34.

[6] It can be simply considered as money.

- t_1: The state of nature is realised.
- t_2: At the end of period t, remittances, voluntary transfers and consumption take place.

The migration contract in our model is short term, specifying how resources are shared between the migrant and the household within the period only.[7]

3.1.1 Migration and the support-remittance contract

We model the implicit contract between the migrant and the sending household as a cash-in-advance contract (Bulow and Rogoff, 1989). It can also be regarded as a kind of storage technology (Ligon et al., 2000). The household that decides to invest in migration at date t_0 receives remittances at date t_2. However, we are different from Ligon et al. (2000) in that the payments (remittances) generated from the technology are uncertain depending on the realisation of the states.

At date t_0, household i decides to ask one of the household members to migrate.[8] The household provides some support P^i in terms of a single good to the migrant. Then, ex post, the migrant pays the agreed remittance R^i_s back according to the realised state s.

As in Bulow and Rogoff (1989), the argument of whether or not the migrant accepts the arrangement is based on an arbitrage condition, and we do not need to place any restrictions on the utility of the migrant. Moreover, we assume that the migrant has full commitment to pay back the agreed remittances. The arrangement is accepted as long as the household support offers at least the expected market value of the remittance:

$$(1+\rho)P^i(t_0) = \mathbb{E}[R^i_s(t_2)], \tag{1}$$

where $\mathbb{E}[R^i_s(t_2)] = \sum_{r=1}^{S} \pi_{sr} R^i_s(t_2)$, and $R^i_s(t_2) \geq 0$.[9]

[7] Alternatively, we could think of long-term contracts with renegotiations. If there is no costs for renegotiations, we will have the same results.

[8] Migration can involve multiple migrants in a single household. However, for the purpose of simplicity, we consider only one migrant in one household. Obviously, we view migration as a collective household decision, instead of an individual decision. One may consider that migrants leave the village on their own independent will. We model migration as a household decision based on two important aspects of the findings in the literature. Firstly, migration is a movement significantly affected by household financial constraints (e.g. Halliday, 2006; Bryan et al., 2014). Secondly, the costs and benefits of migration are shared between the migrants and non-migrants within the household following intertemporal contractual arrangements other than altruism (Stark, 1991).

[9] The non-negativity means that there is no state of nature in which the household would accept a negative remittance. One must also have $P^i(t_0) \geq 0$, but this holds whenever (1) and the non-negativity of remittances hold.

Note that if the interest rate is higher, the support-remittance strategy becomes more attractive for household i, because a small amount of support can sustain a large amount of expected remittance.

3.1.2 Autarky values

In autarky, household i is excluded from any mutual insurance opportunities and has total resources:

$$z_s^i(t) = R_s^i(t_2) + y_s^i(t),$$

We assume that household income is comprised of a deterministic part and a stochastic part and $y_s^i(t) = y^i(t_0) + y_s^i(t_2)$. The support comes from the deterministic part of the income generated before the realisation of the state.

At date t_0, the expected utility maximization problem is equivalent to maximize the autarky utility in each realisation of the state, by choosing the level of consumption $c_s^i(t)$ and support $P^i(t_0)$. Denote $Z^i(z_s^i(t))$ as the autarky value of household i with resources $z_s^i(t)$ in state s:

$$Z^i(z_s^i(t)) = \max_{(R_r^i(t_2))_{r=1}^S} \Bigg\{ u^i\Big(z_s^i(t) - \frac{1}{1+\rho}\sum_{r=1}^S \pi_{sr} R_r^i(t_2)\Big) + \beta \sum_{r=1}^S \pi_{sr} \Big(Z^i\big(z_r^i(t+1)\big)\Big) \Bigg\}.$$

The autarky value function is increasing, differentiable and strictly concave. Denoting autarky consumption by $\widetilde{c}_s^i(z_s^i(t))$, the envelope condition implies:

$$\frac{\partial Z^i(z_s^i(t))}{\partial z_s^i(t)} = u^{i\prime}(\widetilde{c}_s^i(z_s^i(t))). \tag{2}$$

3.2 Risk sharing and consumption dynamics

Now we proceed to consider the dynamic programming subject to both migration and risk sharing. For the moment, we only consider voluntary transfers paid at date t_2. We will allow voluntary transfers paid at date t_0 later.

We assume that only household i participates in migration, but household j

does not.[10] Moreover, we assume full commitment by j, but none by i.[11] At date t_0, each household is aware of the previous history of shocks and the past moves of the other household. After the state is revealed, household i makes a transfer $\tau_s^i(t_2) \lesseqgtr 0$ to household j.

If household i deviates from the implicit risk-sharing arrangement, the entire agreement fails and household i is left in autarky (with remittances), implemented by specifying zero transfers in each of the subsequent periods. That is, deviation from the implicit arrangement leads to an exclusion from all future mutual insurance.

The resource constraint for each household is as follows:

$$c_s^i(t) = z_s^i(t) - \tau_s^i(t_2) - \frac{1}{1+\rho}\mathbb{E}[R_r^i(t_2)], \tag{3}$$

$$c_s^j(t) = z_s^j(t) + \tau_s^i(t_2), \tag{4}$$

which imply that:

$$c_s^j(t) = z_s(t) - \frac{1}{1+\rho}\mathbb{E}[R_r^i(t_2)] - c_s^i(t), \tag{5}$$

where $z_s(t) = z_s^j(t) + z_s^i(t)$ is the total resources available at date t in state s. The total resources include remittances received by household i. Hence, remittances also affect the aggregated welfare of the village, and form an element of the optimal dynamic contract.

We adopt a dynamic programming procedure and characterise the constrained efficient outcome path. More precisely, we maximise the utility of household j for each state at date t by choosing the level of support $P^i(t_0)$, consumption $c_s^i(t)$, and

[10]The model illustrates the situation in most of the villages in developing countries, where only a part of the households participates in migration. If we assumes that both of the households in the model participate in migration, and there is no coordination in migration decisions, we will have the same results. However, if the migration decisions are coordinated, and migrants leave together, we may have a very different picture of risk sharing. As it is discussed in Munshi (2014), by encouraging migrants to leave in groups, the sending village diversifies income sources, and at the same time, has less efficiency lost due to limited commitment, because the migrants can audit each other (this, however, is out of the range of the discussion in this paper).

[11]We posit a two-agent framework in the model. Intuitively, household j can be viewed as the rest of the risk-sharing group. Usually, we consider the case that an individual deviates from a group, instead of the contrary. Genicot and Ray (2003) take into account the possibility of group deviation in the risk-sharing group formation. They found that the possibility of group deviation leads to smaller groups and makes the risk-sharing groups less efficient. However, they did not consider the potential differences in costs involved in individual deviation and group deviation. We think that group deviation is more costly since coordination and negotiation is more difficult in collective decisions, and much less frequent than individual deviation in the real world. Thus, we assume full commitment for the party representing the rest of the risk-sharing group.

the continuation utilities $U_r^i(t+1)$ for each possible state in the next period, given the target utility $U_s^i(t)$ of household i and the total resources $z_s(t)$. Choosing the support level is equivalently to choosing $R_r^i(t_2)$, the expected remittances received at date t_2. Plus, the consumption level of household j is determined by equation (5).

Then the value function for household j depends on the current target utility of household i and the current total resource. The dynamic programming problem is written as follows:

$$\begin{aligned} U_s^j\Big(U_s^i(t); z_s(t)\Big) = &\max_{c_s^i(t),(U_r^i(t+1))_{r=1}^S,(R_r^i(t_2))_{r=1}^S} u^j \quad z_s(t) - \frac{1}{1+\rho}\mathbb{E}[R_r^i(t_2)] - c_s^i(t)\Big) \\ &+\beta \sum_{r=1}^{S} \pi_{sr} U_r^j\Big(U_r^i(t+1); z_r(t+1)\Big), \end{aligned}$$

subject to the following constraints:

$$\lambda_s^i(t): \quad u^i(c_s^i(t)) + \beta \sum_{r=1}^{S} \pi_{sr} U_r^i(t+1) \geq U_s^i(t), \tag{6}$$

$$\beta\pi_{sr}\phi_r^i(t+1): \quad U_r^i(t+1) \geq Z^i(z_r^i(t+1)), \quad \forall r \in \mathcal{S}, \forall t, \tag{7}$$

$$\pi_{sr}w_r^i(t+1): \quad R_r^i(t_2) \geq 0, \quad \forall r \in \mathcal{S}, \forall t. \tag{8}$$

$\lambda_s^i(t)$, $\phi_r^i(t+1)$, and $w_r^i(t+1)$ are Lagrange multipliers with respect to each constraint.

Condition (6) is the promise keeping constraint which states that the expected discounted utility of household i should not be lower than the target utility. Condition (7) is household i's incentive constraint. The right hand side of the inequality is the utility of household i in autarky excluding mutual insurance opportunities but with remittances. Household i will not have an incentive to deviate if the continuation utilities subject to risk sharing are not lower than the autarky utility. The last constraint (8) is the non-negativity constraints of the remittance in each state of the world.

We leave the derivation of the first order conditions and the process of calculation in the Appendix (A.1). Then, for all states, we have:

$$\begin{aligned} u^{i'}(c_s^i(t)) = &\beta(1+\rho)\sum_{r=1}^{S}\pi_{sr}u^{i'}(c_r^i(t+1)) + \frac{1+\rho}{\lambda_s^i(t)}\sum_{r=1}^{S}\pi_{sr}w_r^i(t+1) \\ &+ \frac{\beta(1+\rho)}{\lambda_s^i(t)}\sum_{r=1}^{S}\pi_{sr}\phi_r^i(t+1)(u^{i'}(c_r^i(t+1)) - u^{i'}(\widetilde{c}_r^i(z_r^i(t+1)))). \end{aligned} \tag{9}$$

Equation (9) characterises the household's optimal inter-temporal choices. If the incentive constraint and the non-negativity constraint are both relaxed, we obtain:

$$\frac{\mathbb{E}u^{i'}(c_r^i(t+1))}{u^{i'}(c_s^i(t))} = \frac{1}{\beta(1+\rho)}, \tag{10}$$

where $\mathbb{E}u^{i'}(c_r^i(t+1)) = \sum_{r=1}^{S} \pi_{sr} u^{i'}(c_r^i(t+1))$. Equation (10) is the usual Euler equation that characterises the optimal inter-temporal consumption under full risk sharing when the ratio of marginal consumption across periods is constant and does not depend on the realisation of the states.

Let's look back at equation (9). The second term in the equation comes from the non-negative constraints of remittances. It is positive as long as there exists zero remittance in certain realisation of states. It is zero if remittances are positive across all states and periods. The magnitude of this term depends on the number of binding non-negativity constraints of remittances. If the number of relaxed non-negativity constraints is high, this second term is smaller. If the number of binding non-negativity constraints is high, in other words, if the household i is more likely to face a zero remittance next period, this second term is large.[12]

The third term captures the impact of incentive constraints on the allocative efficiency. If the incentive constraints are binding, the sign of this term depends on the sign of $u^{i'}(c_r^i(t+1)) - u^{i'}(\widetilde{c}_r^i(z_r^i(t+1)))$. If the agreed consumption next period in the implicit contract is lower than the optimal autarky consumption, which is $c_r^i(t+1) < \widetilde{c}_r^i(z_r^i(t+1))$, the third term is positive, otherwise it is negative.

3.3 The change in risk sharing

The second term in equation (9) disappears if zero remittance takes place across all states. Given a discount factor, a certain level of risk sharing can be maintained between household i and j, but full risk sharing will not be achieved. The sign of the third term in equation (9) depends on the difference between the consumption levels of household i in risk sharing and in pure autarky (without remittances).

If remittances are positive in certain states, however, the possibility of facing a zero remittance is still high, the second term in equation (9) is large. At the same time, the autarky utility of household i is increased slightly by receiving positive remittances in some periods. It might be the case that the incentive constraints are not affected by the small amount of change in the autarky utility. The non-negativity constraints of remittances become the relatively more important source of inefficiency, compared to the incentive constraints. Moreover, if the third term in equation (9) is unchanged, the importance of the second term in equation (9)

[12] Zero remittance may happen, for instance, in a state of nature where the migrant outside the village faces a high probability of unemployment.

indicates smaller consumption levels for household i. The rise in autarky value due to migration probably is not able to compensate the loss of risk-sharing benefits. As a result, household i would prefer to stay in the risk-sharing arrangement, rather than return to the autarky with remittances.

However, when the possibility of receiving positive remittances is sufficiently high, the magnitude of the second term in equation (9) is small. Meanwhile, the households face more binding incentive constraints since the autarky value is raised significantly. For the third term in equation (9), if $u^{i'}(c_r^i(t+1)) \geq u^{i'}(\tilde{c}_r^i(z_r^i(t+1)))$, an increase in the autarky consumption increases the absolute value of this term. If $u^{i'}(c_r^i(t+1)) \leq u^{i'}(\tilde{c}_r^i(z_r^i(t+1)))$, an increase in the autarky consumption decreases the absolute value of this term. Then, as a whole, the magnitude of the third term is increased due to the rise in the autarky consumption. Contrasting the previous case, now the third term in equation (9) that comes from incentive constraints are the relatively more important sources of inefficiency. Household i will benefit from a higher level of consumption if i deviates from the risk-sharing arrangement and keeps self-insurance through migration. In other words, migration crowds out risk sharing.

In particular, when the interest rate is high, the support-remittance contract is more attractive, because a small amount of support can sustain a large amount of expected remittances. This may allow household i to have a higher consumption in each future period than that i would get in risk pooling with household j. As a result, there must be some states of nature when household i wants to deviate and stand alone. It would be too costly for household j to keep i staying in the risk-sharing contract. Autarky with completely no risk-sharing may be the optimal solution.

We summarise the above analyses in the following proposition:

Proposition 1. *The support-remittance contract between the migrant and the sending household may or may not crowd out informal risk sharing in the village, depending on the availability of positive remittances (i.e. how likely the household faces zero remittance across states). Migration that is related to high probabilities of zero remittance does not affect the risk-sharing arrangements. However, if the sending household tends to receive more positive remittances, the household is more likely to deviate from the risk sharing arrangements. Then, there will be less or no risk sharing in the village.*

3.4 Ex ante transfers

In this section, we will allow voluntary transfers at date t_0. This part of the analyses is built on Gauthier et al. (1997) and Ligon et al. (1998). Gauthier et al. (1997) showed that ex ante transfers can improve risk sharing in a dynamic limited commitment environment. Ligon et al. (1998) found that ex ante transfers do not enhance mutual insurance in the presence of a storage technology, since the effect of ex ante transfers is replaced by the effect of the storage. However in our model, we will show that, if the similar "storage technology" produces uncertain payments (remittances), introducing ex ante transfers into the dynamic contract is beneficial.

Suppose that at date t_0, household j makes an ex ant transfer $\tau(t_0)$ to household i. The transfer can be positive or negative. We assume that the transfer is feasible out of the income $y^i(t_0)$ or $y^j(t_0)$. The ex ante transfer increases the support that household i can provide to the migrant, and thus, increases the expected remittance $\mathbb{E}[R^i_r(t_2)]$ by $\mathbb{E}[\Delta R^i_r(t_2)]$, and we should have $\mathbb{E}[\Delta R^i_r(t_2)]{=}\tau(t_0)$. At the same time, the ex post transfer from j to i is reduced by $\mathbb{E}[\Delta R^i_r(t_2)]$. Equivalently, the ex post transfer from i to j is increased by $\mathbb{E}[\Delta R^i_r(t_2)]$.

The ex ante transfer changes the resources available to the households in autarky. The incentive constraint (7) needs to be modified as follows:

$$U^i_r(t+1) \geq Z^i_r(z^i_r(t+1) + \tau(t_0)), \quad \forall r \in \mathcal{S}, \forall t, for \quad \text{i}, \tag{11}$$

$$U^j_r(t+1) \geq Z^j_r(z^j_r(t+1) - \tau(t_0)), \quad \forall r \in \mathcal{S}, \forall t, for \quad \text{j}. \tag{12}$$

In addition, household j has an incentive to make the ex ant transfer at date t_0 only if his expected utility at date t_0 subject to the arrangement is higher than the expected utility without an ex ante transfer. This is the ex ante incentive constraint that we need to consider:

$$\sum_{r=1}^{S} \pi_{sr} U^j_r(t+1) \geq \sum_{r=1}^{S} \pi_{sr} Z^j_r(z^j_r(t+1)), \quad \forall r \in S. \tag{13}$$

To illustrate how this strategy may improve the risk-sharing arrangement, we consider the simplest case where there are only two states of nature $r \in \mathcal{S} = \{1, 2\}$. Note that the ex ant transfer should be chosen small enough that household i's incentive constraint is not violated. For household j, suppose that state 1 is a binding state given no ex transfers and state 2 is a nonbinding state. $\Delta R^i_r(t_2)$ can be larger or smaller than $\tau(t_0)$ depending on the state. If $\Delta R^i_r(t_2)$ is smaller than $\tau(t_0)$ in state 1 and is larger than $\tau(t_0)$ in state 2. The nonbinding constraint for j in state 2 remains relaxed after the introduction of the ex ante transfer. This is because the consumption on the left hand side of (12) is increased by $\Delta R^i_1(t_2)$, and at the same time, the consumption on the right hand side of (12) is increased by $\Delta R^i_1(t_2) - \tau(t_0)$. The magnitude of the increase on the left hand side is larger than that on the right hand side. Thus, the inequality of the nonbinding constraint still holds.

Now we consider the change in the incentive constraint in the binding state. On the left hand side, the consumption is increased by $\Delta R^i_1(t_2)$ after the introduction of the ex ant transfer. On the contrary, the consumption in autarky is decreased since we assume that $\Delta R_1^i(t_2)$ is smaller than $\tau(t_0)$. Hence, the investment from household j actually relaxes some ex post binding incentive constraints while the originally relaxed constraints are kept relaxed.

It is straightforward that the ex ante incentive constraint (13) is relaxed if the ex post incentive constraint (12) is relaxed.

We summarise the above theoretical results in the following proposition:

Proposition 2. *If the ex ante transfer is enforceable, risk sharing might be improved in the presence of the support-remittance contract, based on the fact that ex ante transfers increase expected remittances, and at the same time, relax some ex post incentive constraints in implementing the risk-sharing contract.*

Although remittances from migrated members provide insurance to the household, since the remittances are state contingent, it is not a guaranteed insurance. This fact makes the household less likely to fully stand alone. Furthermore, in the case where the ex ante transfer is allowed, the state contingency of the remittances make the migration contract more flexible than a pure storage technology, and thus, are likely to have a positive impact on risk sharing.

4 The empirical approach

4.1 Characterisation of consumption dynamics

We derive the consumption growth function using the parametric approach developed in Dubois (2001), which allows heterogenous risk preferences among households. The idea is to assume that relative risk aversion is a linear function of observed characteristics. Then, with a specification of CRRA utilities, consumption growth is derived from the Euler equation, which represents the optimal intertemporal consumption choices. Moreover, risk aversion parameters can be recovered from the estimation and can be used to test risk reduction motives of the choices of contracts. In the following part of this section, we will briefly introduce the assumptions, notations and the formula of the derived consumption equation in Dubois (2001). We leave a more detailed introduction including the instruments sets provided by Dubois (2001) in the Appendix (A.2).[13]

Assume that the instantaneous utility function for household i has the following isoelastic form:

$$\beta^t u_{it}(c) = exp(\alpha(\tilde{x}_{it}))\frac{c^{1-\theta(x_{it})}}{1-\theta(x_{it})}, \tag{14}$$

[13]For those who are interested in the econometric model and proofs, please refer to Dubois (2001).

where c is consumption and β is the discount factor. $\tilde{x}_{it}$ and x_{it} are vectors of variables which are observed household characteristics. $\tilde{x}_{it}$ and x_{it} contain the same set of variables in the empirical application. Their notations are distinguished because they will not be treated in the same manner in the econometric model. Households are assumed to have a constant relative risk aversion equal to $\theta(x_{it})$, which depends on some characteristics x_{it}. The multiplicative factor of marginal utility of consumption, $\alpha(\tilde{x}_{it})$, also depends on some observable characteristics.

The functions $\alpha(.)$ and $\theta(.)$ are assumed to have the following linear fomulas:

$$\theta(X_{it}) = 1 + X_{it}\theta, \tag{15}$$

$$\alpha(\tilde{X}_{it}) = \tilde{X}_{it}\alpha + \eta_{it}, \tag{16}$$

where $X_{it} = \{...\mathrm{x}_{it}...\}$ and θ is the aversion parameter with respect to each element in characteristics x_{it}. The homogeneity of relative risk aversion among agents is obtained when $\theta = 0$. η_{it} are defined as unobservable shocks. They are assumed to be additive to factors $\tilde{x}_{it}\alpha$ and are martingale independent across households conditional on x_{it}.

Measurement errors are also considered. Assume that $\tilde{c}_{it}$ is observed instead of true consumption c_{it}, and:

$$ln\tilde{c}_{it} = lnc_{it} + u^c_{it}, \tag{17}$$

where terms u^c_{it} are assumed to be independent and identically distributed across households and periods. Moreover, they are uncorrelated with preference shocks η_{it}. From now on, the superscript c denotes error terms related to consumption.

The marginal state of substitution of consumption between periods t and $t+1$ depends on the availability of contingent security markets and their relative prices, which is denoted by a random variable ε_{it+1}:

$$\frac{u'_{it+1}(c_{it+1})}{u'_{it}(c_{it})} = \varepsilon_{it+1}, \tag{18}$$

Intuitively, the consumption smoothing achieved by households may be perfect or imperfect depending on the contingent markets on which they can exchange. With full insurance markets, $\varepsilon_{it+1} = \varepsilon_{t+1}$, consumption smoothing only depends on global aggregated shocks. If the markets are complete within villages, then we have $\varepsilon_{it+1} = \varepsilon_{vt+1}$, where v denotes villages. Household consumption smoothing depends on village-level aggregated shocks. In both complete market cases, consumption smoothing does not depend on idiosyncratic shocks.

In practice, we further decompose ε_{it+1} as follows:

$$ln\varepsilon_{it+1} = e^c_{vt+1} + e^c_i - \xi^c_{it+1}, \tag{19}$$

where e^c_{vt+1} are village-year fixed effects, and e^c_i are household fixed effects. ξ^c_{it+1} are household specific idiosyncratic innovations. Assume that all kinds of idiosyncratic innovations are correlated with household income ω_{it+1}, such that $\xi_{it+1} = \delta[\omega_{it+1} - E_t\omega_{it+1}]$. The expected income $E_t\omega_{it+1}$ is assumed to be captured by household characteristics, that is x_{it+1}, as well as by unobserved e^c_i and e^c_{vt+1}.

Then $ln\varepsilon_{it+1}$ can be rewritten as follows:

$$ln\varepsilon_{it+1} = e^c_{vt+1} + e^c_i - \delta\omega_{it+1} \tag{20}$$

From equation (18), parameterised by (14), (15), and(16), with error structures (17) and (20), we obtain the consumption growth function:

$$\Delta ln\tilde{c}_{it+1} = \mathbb{X}_{it+1}\theta + \Delta\tilde{x}_{it+1}\alpha + \delta_1\omega_{it+1} + \delta_2\omega_{it+1} * m_{it+1} + \tilde{\upsilon}_{it+1}, \tag{21}$$

with $\mathbb{X}_{it+1} = -x_{it+1}\Delta ln\tilde{c}_{it+1} - ln\tilde{c}_{it}\Delta x_{it+1}$, and $\tilde{\upsilon}_{it+1} = \upsilon_{it+1} - \delta\omega_{it+1} = \Delta\eta_{it+1} - e^c_{vt+1} - e^c_i + (1 + x_{it+1}\theta)\Delta u^c_{it+1} + u^c_{it}\Delta x_{it+1}\theta$. Δ is the first difference operator defined by $\Delta X_{t+1} = X_{t+1} - X_t$.

We use m_{it+1} representing the migration indicator. We can test the following hypotheses at the same time:

- H_1 :$\delta_1 = 0$, that is full insurance for households who do not participate in migration.
- H_2 :$\delta_1 + \delta_2 = 0$, that is full insurance for households who participate in migration.
- H_3 :$\delta_2 = 0$, that is households who participate in migration are the same as households who do not participate in the level of consumption insurance.
- H_4 :$\delta_2 \gtrless 0$, that is the change in log consumption in response to a unit change in income is bigger/smaller for households who participate in migration.

4.2 The income equation

The income equation has a reduced form as follows:

$$\omega_{it+1} = \beta_0 + \beta_1 m_{it+1} + \beta_2 x_{it+1} + \beta_3 z^\omega_{it+1} + e^\omega_{vt+1} + e^\omega_i + u^\omega_{it+1} + \xi^\omega_{it+1} \tag{22}$$

We simply write household income as a function of migration choices, household characteristics x_{it+1}, predetermined predictors z^ω_{it+1}, and the unobservables. The predetermined variables are directly correlated with income, but only influence migration choices and consumption growth through income. The unobservables are decomposed into village-year fixed effects e^ω_{vt+1}, individual household fixed effects e^ω_i, and random shocks ξ^ω_{it+1}. ξ^ω_{it+1} are assumed to be i.i.d. across households and periods. u^ω_{it} are classical measurement errors, and are independent from explanatory variables in the income equation.

The parameter that we are interested in is β_1. We would like to test:

H_5 : $\beta_1 \gtreqless 0$ for migration indicators, that is the income gains of migration is positive/zero/negative.

4.3 The migration decision function

Similarly, we model the migration decision as a linear function. Formally:

$$m_{it+1} = \rho_0 + \rho_1\omega_{it+1} + \rho_2 x_{it+1} + \rho_3 z^m_{it+1} + e^m_{vt+1} + e^m_i + u^m_{it+1} + \xi^m_{it+1} \tag{23}$$

where the superscript m is used to denote error terms in the migration equation. x_{it+1} are observed household characteristics. z^m_{it+1} are predetermined covariates that are correlated with migration, but only affect income and consumption growth through migration. ξ^m_{it+1} are random shocks that are assumed to be i.i.d across households and periods. u^m_{it+1} are standard measurement errors. e^m_{vt+1} are village-year fixed effects and e^m_i are household fixed effects.

5 Data and the construction of variables

5.1 Data

We use a panel from the Townsend Thai Annual Resurveys (1999-2010).[14] 15 households in each of the 64 villages were selected following a stratified and clustered random sampling process. The villages are distributed across four provinces (changwats) of Thailand. Two of them are located in the Central region relatively near Bangkok, and the other two are located in the poorer Northeast region. 739 households (about 62 per cent) were continuously observed over 12 years. Attrition was largely due to migration.[15] We performed a test of attrition bias and we did not find any significant bias in our model due to missing households (see Appendix A.5). Thus, we will use the balanced panel in the regressions.

5.2 Endogenous variables and predetermined predictors

Our endogenous variables are income, consumption growth and migration. Sources of revenues include agricultural production, wages, business operations, asset income (including rents), pensions and other welfare transfers. Remittances from relatives and friends are informal transfers and not counted in the calculation of income. The net income is obtained from the gross revenue minus input costs

[14]The survey was initiated in 1998 following a baseline survey in 1997. We did not use observations in 1997 and 1998, because more information about migrants was only collected starting from the 1999 survey.

[15]see Kaboski and Townsend (2012).

in production and in business activities. The total consumption was the sum of expenditures on an exclusive list of items, including expenses for food, alcohol, tobacco, gasoline, ceremonies, vehicle repairs, education, clothing and food consumed away from home.

We consider all the household members between 16 and 60 years old that are observed in the data. In each cross section, a migrant is considered someone who is absent from the household due to migration out of the village in that year or at a certain point of time before. The household-level migration indicator is defined by the absence of one or more household members as a result of migration. Different types of migration include household head migration, child migration through jobs, child migration through education, child migration through marriages and child migration through other ways. We presented the details about the definitions of migration indicators in the Appendix A.3.

We use land property rights as the predetermined factor of income. The Townsend Thai surveys collected information about the land title of each plot owned by a household. A land title deed in Thailand is a legal document that specifies the owner's rights over the land. A Chanote title deed is full ownership. There exist other title documents that are related to temporary occupation, use and occupation, confirmed right of possession or notification of possession of land. In fact, all the land title documents issued by the government, except Chanote, are still officially government land. In our data, 35 per cent of the plots are issued with Chanote, whilst 24 per cent of the plots do not have any land titles. For the rest of the plots, land owners do not have full ownership but have different levels of rights over occupation, possession, use, lease, sale etc. It is suggested in the literature that secured land rights encourage investment in land fertility and lead to substantially higher output (Goldstein and Udry, 2008).

Moreover, we need an instrument that is correlated with income but only affects consumption growth and migration through income. To our knowledge, there is no direct evidence in the literature that land rights are correlated with consumption growth. However, De la Rupelle et al. (2009) found that land-right insecurity causes rural workers in China to migrate less, or for shorter periods. Even if a causal correlation between land rights and the choice of migration exists, we can still view land rights as an excluded instrument, as long as the causal correlation is through the channel of an income effect. As it is well explained in De la Rupelle et al. (2009), land-right insecurity increases migration costs that is the income loss caused by the loss of land. In other words, land rights only affect migration decisions through their impacts on income.

It is more tricky to construct the instrument for migration decisions. We cannot use the proxy of the migrants' networks as an instrument, since risk-sharing networks are endogenous in our system. Nevertheless, we consider the group of individual labourers that are similar in age to the average age of the migrants in the village in each cross section. Some of those labourers in the group are migrants, while others are not. We use the proportion of those labourers to the village population as a predetermined factor of migration. The reasons are as follows:

Given the land areas and the population size of the village, an increase in the number of labourers that are similar in human capital is likely to cause a decrease in the marginal labour productivity in the village. Migration is a way to improve labour resource allocation. Thus, we assume that any individual at the age of the migrants is more likely to migrate if the number of similar labourers is greater given the size of the population, provided that labourers at the same age in the village are similar in the level of human capital.

In practice, we checked, for each individual observed in the data, the year when he or she reached the age of the migrants. We took the value of the predictor at that year, which is the number of labourers at the age of the migrants divided by the population size, as the value of the instrument. If the year is not covered in our data, we replaced the value with the predictor's value at the earliest year that we can observe. For those who had not reached the age, we used the contemporaneous value of the predictor. In this way, we constructed an instrument variable for migration, which has household-level variations across years.

In addition, household characteristics observed in the data, such as household size, the number of children, household head education, the occupation of the head, and total plot owned by the household, are all used as control variables in the regressions. We also control household fixed effects and village year fixed effects to control unobserved household characteristics and time-varying macro shocks.

The selection of excluded instruments for the system is crucial for the identification of the model. In Appendix A.4, we present the results of the identification tests. We also tested the validity and redundancy of our instruments. Our results show that the model is identified, the excluded instruments are valid, and that they are not redundant.

5.3 Summary statistics

Incomes and consumption are measured in Thai baht. We adjusted income and consumption to real per capita unites (standardised by adult-male equivalents) [16] using annual household composition data and regional Consumer Price Index

[16] The equivalent scales come from an Indian nutritional study by Townsend (1994), which are computed as follows: the weights depend on gender and age: 1 for male adults, 0.9 for female adults, 0.94 and 0.83 respectively for males and females between 13 and 18, 0.67 for children between 7 and 12, 0.52 for children between 4 and 6, 0.32 between 1 and 3 and 0.05 for babies of less than a year.

(base year 2011).[17]

Summary statistics are provided in Table (1). The mean of the per capita consumption is 18200 bahts that is about U.S.$607.[18] Average per capita income is about U.S.$1443. Consumption takes about 42 per cent of income on average. Per capita food consumption is about 36 per cent of the total consumption. Less than half of the average income comes from farm profit. Plots owned per household is 12.16 rai, which is equivalent to 1.95 hectares. Only one-third of the plots owned are entitled with full property rights. On average, the household head is 56 years old with an education less than five years. Half of the household heads are farmers. Average household size is 4.35.

Summary statistics about migration are presented in Table (2) and (3). The average age of individual migrants is 29. About 43 per cent of them are female. Almost half of them went to Bangkok. Households participating in migration make up 53 per cent of the total household-year observations across the 12 years. 9.6 per cent migration is household head or the head's spouse migration. Throughout the paper, we use head migration representing the household head migration or the head's spouse migration for simplicity. Eighty-seven per cent are related to the migrating of the households' second or third generation. Less than three per cent are related to the migration of other family members, such as the head's siblings, parents of the head, and other relatives. Almost half of the migration cases are realised through employment at destinations; four per cent are for the purpose of marriages; and eight per cent are for education opportunities. Migrating for family visits, conscriptions, ordainments etc. are summed up in other approaches.

6 Estimation results

Equation (21), (22), and (23) constitute the system of simultaneously determined equations. We jointly estimate the equations using Three-stage Least Square methods, allowing arbitrary forms of correlations among these equations. Estimation results are presented in Table (4), (5) and (6) for each equation respectively.

We first examine how migration, consumption smoothing and income are correlated in general. This is reg 1 presented in the tables. In reg 2, we introduced five more indicators which represent five different types of migration, including head migration, child migration through jobs, education, marriages, and other ways. We introduced more control variables in reg 3 in order to check the stability of the model.

[17]CPI data are available on the website of the Bureau of Trade and Economic Indices, Ministry of Commerce of Thai government

[18]In 2011, the exchange rate of baht to dollars was roughly 30 baht = U.S.$1.

At the end of this section, we will present the estimation of risk preference parameters and will test the correlation between the level of risk aversion and the choices of migration.

6.1 The income equation

We start with results of the income equation (22) presented in table (4). The first six rows in the table report the estimated β_1, the parameter of interest with respect to the contribution of migration to the contemporaneous household income.

We found a significant increase in per capita income due to migration (β_1^1). The average per capita income for households participating in migration is 58,830 baht higher (which is approximately U.S. $ 1961 or 38 per cent of the GDP in 2011 in Thailand) than that of non-migrant households.[19]

The contribution of head migration ($\beta_1^1 + \beta_1^2$) to income is significant and positive, but slightly smaller than that of child migrating through jobs ($\beta_1^1 + \beta_1^3$). One explanation could be that young workers earn more in the jobs at destinations, which are usually in the manufacture or construction sectors. Unsurprisingly, child migration through education and for marriage do not have a significant impact on per capita income.

We use the quantity of plots that households own with full property rights as a predetermined predictor of income. We find significant and positive correlation between the predictor and income. When we introduce the total plot area as another control variable, the coefficient of the predictor becomes smaller but is still significant. Intuitively, plots with full property rights are more productive since households usually invest more in them. As a result, given the total land owned by the household, more land with full property rights leads to a higher level of income.

We also use lagged log consumption as a control variable. Dubois et al. (2008) showed that lagged log consumption is a strong predictor of income. Our estimated coefficients of lagged log consumption are positive and significant. Explanations that could be consistent with this result have been provided in Dubois et al. (2008). It could be due to the fact that the change in consumption is a good indicator of the information that households have about income shocks. If the households have superior information, and they smooth income, income and the change in lagged consumption should be positively correlated. Alternatively, we could consider the increase in consumption as an increase in labour investment. It could be the nutrition effects, body-build or emotional construction that leads to higher labour quality. Thus, an increase in lagged consumption leads to a rise in labour efficiency,

[19] In 2011, GDP per capita in Thailand was U.S $ 5,192.12.

which would contribute to a higher income.[20]

Income in the last period is a strong predictor in the income equation. One unit increase in lagged income is correlated with ten per cent increase in income. We also found that head education is positively correlated with per capita income. The marginal effect of the household size is negative and is increasing as the size of the household grows. We did not find significant impact with regard to the age of the head and the number of children under 12 years old.

6.2 The consumption equation, risk preferences and marginal utility

Measuring the change in risk sharing

We now preceed to the estimated results of the consumption equation in Table (5). The set of parameters of interest δ, contains the coefficients of the income variable and the variables that are the products of income and the migration dummy variables. Statistical significance of δ indicates a rejection of full risk sharing. The magnitude of δ measures the extend of deviation from full risk sharing, since it is the change in consumption growth in response to a unit change in one's own income, given the village aggregate consumption.[21]

Our results show that full risk sharing is rejected overall (δ^1 and δ^2). The level of risk sharing is higher for observations with migration, since the average change in consumption growth in response to a unit change in their own income is smaller, compared to those without migration ($\delta^2 + \delta^1 < \delta^1$). In other words, households participating in migration are better insured in the within-village insurance market.

Head migration, child migration for jobs and child migration through other ways do not have a significant impact on the level of risk sharing (δ^3, δ^4 and δ^7), whereas child migration for education improves risk sharing significantly. Quantitatively, the change in consumption growth is -0.0015 ($\delta^1 + \delta^2 + \delta^5$) in response to a unit change in income. The coefficient related to the impact of migration for marriage is significant and negative (δ^6). However, the degree of deviation from full risk sharing is the largest for household-year observations with migration for marriage ($\delta^1+\delta^2+\delta^6$). In other words, we did not find positive impact of migration for marriage on risk sharing.

One may question why the change in consumption is negative for migration related to education and marriage. A possible explanation may be related to the

[20] See details in Dubois et al. (2008).

[21] See Townsend (1994). We use village-year fixed effects to capture the village aggregated consumption in the estimation.

fact that lagged consumption are positively correlated with income. If the households have superior information and they can predict the change in the income in the next period, they are likely to adjust their contemporary consumption as well. In fact, households usually are well prepared for events such as children going to universities or a wedding. Then, it is not surprising that their consumption growth is negatively correlated with a change in income, since they adjust consumption according to their expectation about the income in the next period.

In order to testify the above postulation, we ran a OLS regression of lagged consumption on the migration dummy variables controlled for household fixed effects. The coefficients are positive and significant. We also tried to use food consumption and to introduce village-year fixed effects. The results are quite similar. This shows that it is likely that households adjust consumption in anticipation of migration in the next period.

Why does child migration for education improve risk sharing? Our theoretical results indicate that the impact of migration on risk sharing depends on whether ex ante transfers can be imposed in implementing risk-sharing in the village. Risk-sharing contracts are not directly observed in the data. However, we know that ex ante payments are more likely to be enforceable if only a small amount of ex ante transfers from one agent can support a large surplus that the agent can obtain from the payment. On the contrary, a rise in the ex ante payment increases the risks of defaults of those that receive the payments (Gauthier et al., 1997). If education is worthy of investment, relatives or neighbours are like to give a small amount of value to the child leaving for a university in the city. The small amount of investment increases the total expected values that would be sent back by the child in the future and, at the same time, relaxes ex post self-enforcing constraints in risk sharing. As a result, each household in risk sharing will benefit from an increase in the total aggregate resource and a higher level of insurance.

Parameters related to risk preference and marginal utility

θ estimated in the consumption equation include the set of risk-aversion parameters. Our results show that households are more risk averse if there are fewer people in the household, or if the land areas they own are smaller. Given the size of the household, more children are likely to be correlated with less risk averse. The characteristics of the head are also relevant. Households tend to be less risk averse if the heads are older or have more years of education. If the head's primary occupation is farming, the households tend to be less risk averse. This probably is related to the Thai government's protection for rice farmers, since rice is the most important export product for the country.

With the linear specification in the empirical model $\theta(X_{it}) = 1 + X_{it}\theta$, we calculated household risk aversion using the estimated θ. Table (7) presents the distributions of households' risk aversion. We did not see much differences in the distributions among the provinces in our data. A recent paper by Chiappori et al. (2014) estimated risk preferences in Thailand. We plotted the density distribution of our estimated risk aversion (see Figure (1)) and we found that the range of the distribution is quite similar to that presented in Chiappori et al. (2014).

The estimated α indicate the correlations between the control variables and the marginal utility of consumption. We found that the marginal utility decreases with household size, the number of children under 12 years old and plot areas. Older household heads, or heads with a higher education or with a primary occupation of farming also are correlated with smaller marginal utility of consumption.

6.3 Determinants for migration decisions

Table (6) presents the estimates of the migration equation. We found that per-capita income is positively correlated with households' participation in migration. Intuitively, higher per-capita income usually indicates more resources available for the support of migration. The lagged migration indicator is a strong predictor of the contemporary migration decision. The coefficient of the constructed instrument of migration is positive and significant. We also found that the households are more likely to participate in migration if the heads are farmers, the more plot areas owned the lower tendency to migrate and, the higher the education of the head the lower tendency to migrate.

6.4 Estimated risk preferences and the choices of migration

We use the estimated risk aversion to test the insurance motives of migration. If households become better insured through sending away migrants, we should find that more risk-averse households are more likely to participate in migration.

The results of conditional logit regressions on migration decisions are presented in Table (8).[22] We found that the estimated relative risk aversion are significantly correlated with child migrating for education. This result is consistent with our previous finding that child migrating for education improves the level of risk sharing for the sending households. The coefficients of the estimated risk aversion are insignificant for the other types of migration, which indicates that the other types of migration are less likely to be motivated by risk aversion.

[22]Random-effect probit regressions provide similar results.

7 Conclusion

In this paper, we provide theoretical and empirical evidence that migration can improve informal risk sharing in Thai villages. Theoretically, we found that migration is likely to improve risk sharing when ex ante payments are enforceable in implementing informal risk-sharing. Empirically, we found that different types of migration vary in their impacts on household income and on consumption growth, using the panel data from the Townsend Thai Annual Surveys (1997-2010). Household head migration and child migrating for jobs are more likely to be motivated by higher incomes instead of risk reduction. Whereas, child migrating for education has significant and positive impact on the level of risk sharing. We did not find a positive impact of migration through marriages on consumption smoothing, probably due to a different marriage culture in Thailand from that in India, that we will invest furthermore in future studies.

References

Baum, Christopher F, Mark E.Schaffer, and Steven Stillman (2007), "Enhanced routines for instrumental variables/generalized method of moments estimation and testing." *The Stata Journal*, 7, 465–506.

Bold, Tessa and Stefan Dercon (2009), "Contract design in insurance groups." *Oxford working paper, ISSN 1471-0498.*

Bryan, Gharad, Shyamal Chowdhury, and Ahmed Mushfiq Mobarak (2014), "Under-investment in a profitable technology: The case of seasonal migration in bangladesh." *NBER working paper.*

Bulow, J and K. Rogoff (1989), "Sovereign debt: is to forgive to forget ?" *The American Economic Review*, 79, 43–50.

Chiappori, Pierre-Andre, Krislert Samphantharak, Sam Schulhofer-Wohl, and Robert M. Townsend (2014), "Heterogeneity and risk sharing in village economies." *Quantitative Economics*, 5, 1–27.

De la Rupelle, Maëlys, Quheng Deng, Li Shi, and Thomas Vendryes (2009), "Land rights insecurity and temporary migration in rural china." *IZA discussing paper No. 4668.*

Dubois, Pierre (2001), "Consumption insurance with heterogeneous preferences. can sharecropping help complete markets?" *Econometric Society World Congress 2000 Contributed Paper 1597.*

Dubois, Pierre, Bruno Jullien, and Thierry Magnac (2008), "Formal and informal risk sharing in ldcs: Theory and empirical evidence." *Econometrica*, 76, 679–725.

Fafchamps, Marcel and Susan Lund (2003), "Risk-sharing networks in rural philippines." *Journal of Development Economics*, 71, 261–287.

Gauthier, C., M. Poitevin, and P. Gonzalez (1997), "Ex ante payments in self-enforcing risk-shairng contracts." *Journal of Economic Theory*, 76, 106–144.

Genicot, G. and D. Ray (2003), "Group formation in risk-sharing arrangements." *Review of Economic Studies*, 70, 87–113.

Goldstein, Markus and Christopher Udry (2008), "The profits of power: Land rights and agricutlural investment in ghana." *Journal of Political Economy*, 116, 981–1022.

Greene, W. (2002), *Econometric Analysis*, fifth edition. New York: Prentice-Hall.

Halliday, Timothy (2006), "Migration, risk and liquidity constraints in el salvador." *Economic Development and Cultural Change*, 54, 893–925.

Hayashi, F (2000), *Econometrics*. Princeton: Princeton University Press.

Kaboski, Joseph P. and Robert M. Townsend (2012), "The impact of credit on village economies." *American Economic Journal: Applied Economics*, 4(2), 98–133.

Kinnan, Cynthia and Robert M. Townsend (2012), "Kinship and financial networks, formal financial access and risk reduction." *American Economic Review*.

Kochelakota, N. R. (1996), "Implications of efficient risk sharing without commitment." *Review of Economic Studies*, 63, 595–609.

Ligon, E, J.P. Thomas, and T. Worral (2000), "Mutual insurance, individual savings and limited commitment." *Review of Economic Dynamics*, 3, 216–246.

Ligon, Ethan, Jonathan P. Thomas, and Tim Worrall (2002), "Informal insurance arrangements with limited commitment: Theory and evidence from village economies." *Review of Economic Studies*, 69, 209–244.

Lucas, Robert E. B. and Oded Stark (1985), "Motivations to remit: Evidence from botswana." *Journal of Political Economy*, 93, 901–918.

Morten, Melanie (2013), *Temporary Migration and Endogenous Risk Sharing in Village India*. Ph.D. thesis, Stanford University and Federal Reserve Bank of Minneapolis.

Munshi, Kaivan (2014), "Community networks and migration." *Working paper, prepared for The Oxford Handbook of the Economics of Networks.*

Munshi, Kaivan and Mark Rosenzweig (2016), "Networks and misallocation: Insurance, migration, and the rural-urban wage gap." *American Economic Review*, 106, 46–98.

Rosenzweig, Mark R. and Oded Stark (1989), "Consumption smoothing, migration, and marriage: Evidence from rural india." *Journal of Political Economy*, 97, 905–926.

Semykina, Anastasia and Jeffrey M. Wooldridge (2010), "Estimating panel data models in the presence of endogeneity and selection." *Journal of Econometrics.*

Stark, Oded (1991), *The Migration of Labor*. Basil Blackwell.

Townsend, R. M. (1994), "Risk and insurance in village india." *Econometrica*, 62, 539–591.

Townsend, Robert. M. (2013), "Townsend thai project household annual resurveys." *Harvard Dataverse, http://hdl.handle.net/1902.1/20818.*

Udry, C (1994), "Risk and insurance in a rural credit market: An empirical investigation in northen nigeria." *The Review of Economic Studies*, 61, 495–526.

Yang, Dean and HwaJung Choi (2007), "Are remittances insurance? evidence from rainfall shocks in the philipines." *The World Bank Economic Review*, 21, 219–248.

A Appendix

A.1 Characterising the optimal intertemporal consumption choice

In this section of the appendix, we will present in detail how we get the optimal intertemporal condition for consumption from solving the dynamic program in section (3.2).

The dynamic programming problem is written as follows:

$$U_s^j\left(U_s^i(t); z_s(t)\right) = \max_{c_s^i(t),(U_r^i(t+1))_{r=1}^S,(R_r^i(t_2))_{r=1}^S} u^j\left(z_s(t) - \frac{1}{1+\mathbf{r}}\mathbb{E}[R_r^i(t_2)] - c_s^i(t)\right)$$
$$+\beta\sum_{r=1}^S \pi_{sr} U_r^j\left(U_r^i(t+1); z_r(t+1)\right)$$

subject to the following constraints,

$$\lambda_s^i(t): \quad u^i(c_s^i(t)) + \beta\sum_{r=1}^S \pi_{sr} U_r^i(t+1) \geq U_s^i(t), \tag{24}$$

$$\beta\pi_{sr}\phi_r^i(t+1): \quad U_r^i(t+1) \geq Z_r^i(z_r^i(t+1)), \quad \forall r \in \mathcal{S}, \forall t, \tag{25}$$

$$\pi_{sr}w_r^i(t+1): \quad R_r^i(t_2) \geq 0, \quad \forall r \in \mathcal{S}, \forall t. \tag{26}$$

$\lambda_s^i(t)$, $\phi_r^i(t+1)$, and $w_r^i(t+1)$ are Lagrange multipliers with respect to each constraint.

The condition (24) is the promise keeping constraint which says that the expected discounted utility of household i should not be lower than the target utility. Condition (25) is household i's incentive constraint. The right hand side of the inequality is the utility facing household i in autarky excluding mutual insurance opportunities but with remittances. Household i will not have an incentive to deviate if the continuation utilities subject to risk sharing are at least not lower than the autarky utility. The last constraint (26) is the non-negativity constraints of the remittance in each state of the world.

To characterise the optimal path, we first derive the first order conditions:

$$c_s^i(t): \quad u^{j'}(c_s^j(t)) = \lambda_s^i(t)u^{i'}(c_s^i(t)), \tag{27}$$

$$R_r^i(t+1): \quad \frac{1}{1+\mathbf{r}}\pi_{sr}u^{j'}(c_s^j(t))$$
$$= \beta\pi_{sr}\frac{\partial U_r^j(\cdots)}{\partial z_r(t+1)} - \beta\pi_{sr}\phi_r^i(t+1)\frac{\partial Z_r^i(z_r^i(t+1))}{\partial z_r(t+1)} + \pi_{sr}w_r^i(t+1), \quad \forall r \in S, \tag{28}$$

$$U_r^i(t+1): \quad \lambda_s^i(t) = -\frac{\partial U_r^j(\cdots)}{\partial U_r^i(t+1)} - \phi_r^i(t+1). \tag{29}$$

The envelope conditions with respect to the total resources $z_s(y)$ is

$$\frac{\partial U_s^j(\cdots)}{\partial z_s(t)} = \lambda_s^i(t)u^{i'}(c_s^i(t)). \tag{30}$$

It is clear that the target utility U_s^j for household j is increasing with the total resources $z_s(t)$, but as the contracted value $c_s^i(t)$ given to household i increases, the marginal benefit from an additional unit of total resources falls. That is, although the remittances received by household i contribute to the aggregate resources, which may benefit also household j, if the current state consumption of household i that the household j has to commit to keep it inside the risk-sharing arrangement is too high, his marginal benefit from the increasing total resources is still small. In this case the informal risk-sharing contract may be still crowded out by the migration. Hence, household j trades off between the increasing benefit from the increasing common pot and the household i's incentives to stand alone.

The Envelope conditions forwarded by one period ahead imply

$$\frac{\partial U_r^j(\cdots)}{\partial U_r^i(t+1)} = -\lambda_r^i(t+1), \tag{31}$$

$$\frac{\partial U_r^j(\cdots)}{\partial z_r(t+1)} = \lambda_r^i(t+1)u^{i'}(c_r^i(t+1)). \tag{32}$$

Equation (11) implies that

$$\lambda_s^i(t) = \frac{u^{j'}(c_s^j(t))}{u^{i'}(c_s^i(t))}. \tag{33}$$

Substitute (14) into (13), we obtain the evolution of the ratio between the two households' marginal utility of consumption,

$$\lambda_r^i(t+1) = \lambda_s^i(t) + \phi_r^i(t+1), \quad \forall r \in S, \quad \forall t > 0. \tag{34}$$

From equation (33)(34), the ratio of the marginal utilities of the two households is kept constant across time and states unless the limited commitment incentive constraints are binding. If the limited commitment constraint of household i is relaxed so $\phi_r^i(t+1) = 0$, the ratio of the marginal utility is constant. If the constraints are binding, this ratio is no longer constant, and we obtain the limited commitment solution.

Using equation (2)(27)(32) and(34), equation (28) yields

$$\begin{aligned}\pi_{sr}u^{i'}(c_s^i(t)) = \beta(1+\mathbf{r})\pi_{sr}u^{i'}(c_r^i(t+1)) + \frac{1+\mathbf{r}}{\lambda_s^i(t)}\pi_{sr}w_r^i(t+1) \\ + \frac{\beta(1+\mathbf{r})}{\lambda_s^i(t)}\pi_{sr}\phi_r^i(t+1)(u^{i'}(c_r^i(t+1)) - u^{i'}(\tilde{c}_r^i(z_r^i(t+1)))), \quad \forall r \in S.\end{aligned} \tag{35}$$

Summing equations (35) over all the states $r \in S$ yields

$$
\begin{aligned}
u^{i'}(c_s^i(t)) = \beta(1+\mathbf{r}) \sum_{r=1}^{S} \pi_{sr} u^{i'}(c_r^i(t+1)) + \frac{1+\mathbf{r}}{\lambda_s^i(t)} \sum_{r=1}^{S} \pi_{sr} w_r^i(t+1) \\
+ \frac{\beta(1+\mathbf{r})}{\lambda_s^i(t)} \sum_{r=1}^{S} \pi_{sr} \phi_r^i(t+1)(u^{i'}(c_r^i(t+1)) - u^{i'}(\widetilde{c}_r^i(z_r^i(t+1)))). \quad (36)
\end{aligned}
$$

Equation (36) characterises the household's optimal inter-temporal choice. If the limited commitment incentive constraint and the non-negativity constraint are relaxed, we obtain

$$
\frac{\mathbb{E}u^{i'}(c_r^i(t+1))}{u^{i'}(c_s^i(t))} = \frac{1}{\beta(1+\mathbf{r})}, \quad (37)
$$

where $\mathbb{E}u^{i'}(c_r^i(t+1)) = \sum_{r=1}^{S} \pi_{sr} u^{i'}(c_r^i(t+1))$. Equation (37) is the usual Euler equation which characterises the optimal inter-temporal consumption and support choice.

A.2 The consumption growth function

We start from the equation (9) in our theoretical analyses. It characterises the household's optimal inter-temporal consumption choices and investment choice on migration. Following Dubois (2001), we rewrite equation (9) as follows:

$$
\frac{u'_{it+1}(c_{it+1})}{u'_{it}(c_{it})} = \varepsilon_{it+1}, \quad (38)
$$

We do not know the real status of the constraints faced by household i. As in Dubois (2001), we write the unobserved part of the above equation as a random variable ε_{it+1}. The marginal state of substitution of consumption between periods t and $t+1$ depends on the availability of contingent security markets and their relative prices. Intuitively, the consumption smoothing achieved by households may be perfect or imperfect depending on the contingent markets on which they can exchange. With full insurance markets, $\varepsilon_{it+1} = \varepsilon_{t+1}$, consumption smoothing only depends on global aggregate shocks. If the markets are complete within villages, then we have $\varepsilon_{it+1} = \varepsilon_{vt+1}$, where v denotes villages. Household consumption smoothing depends on village-level aggregate shocks. In both complete market cases, consumption smoothing achieved by households does not depend on idiosyncratic shocks.

Assume that the instantaneous utility function for household i has the following isoelastic form:

$$\beta^t u_{it}(c) = exp(\alpha(\tilde{x}_{it}))\frac{c^{1-\theta(x_{it})}}{1-\theta(x_{it})}, \tag{39}$$

where c is consumption at time t and β is the discount factor. $\tilde{x}_{it}$ and x_{it} are vectors of variables which are observed household characteristics. $\tilde{x}_{it}$ and x_{it} contain the same set of variables in the empirical application. Their notations are distinguished because they will not be treated in the same manner in the econometric model. Households are assumed to have a constant relative risk aversion equal to $\theta(x_{it})$, which depends on some characteristics x_{it}. The multiplicative factor of marginal utility of consumption, $\alpha(\tilde{x}_{it})$, also depends on some observable characteristics.

The functions $\alpha(.)$ and $\theta(.)$ are assumed to have the following linear fomulas:

$$\theta(X_{it}) = 1 + X_{it}\theta, \tag{40}$$

$$\alpha(\tilde{X}_{it}) = \tilde{X}_{it}\alpha + \eta_{it}, \tag{41}$$

where θ is a vector of constant risk aversion parameters with respect to each element in characteristics x_{it}. The homogeneity of relative risk aversion among agents is obtained when $\theta = 0$. η_{it} are defined as unobservable shocks. They are assumed to be additive to factors $\tilde{x}_{it}\alpha$ and are martingale independent across households conditional on x_{it}.

Take equation (39), (40), and (41) into equation (38), and we get:

$$\Delta lnc_{it+1} = [-x_{it+1}\Delta lnc_{it+1} - lnc_{it}\Delta x_{it+1}]\theta + \Delta\tilde{x}_{it+1}\alpha + \Delta\eta_{it+1} - ln\varepsilon_{it+1}, \tag{42}$$

where Δ is the first difference operator defined by $\Delta X_{t+1} = X_{t+1} - X_t$.

Measurement errors are also considered. Assume that $\tilde{c}_{it}$ is observed instead of true consumption c_{it}, and:

$$ln\tilde{c}_{it} = lnc_{it} + u^c_{it}, \tag{43}$$

where terms u^c_{it} are assumed to be independent and identically distributed across households and periods. Moreover, they are uncorrelated with preference shocks η_{it}. From now on, the superscript c denotes error terms related to consumption. Taking into account (43), (42) becomes:

$$\Delta ln\tilde{c}_{it+1} = [-x_{it+1}\Delta ln\tilde{c}_{it+1} - ln\tilde{c}_{it}\Delta x_{it+1}]\theta + \Delta\tilde{x}_{it+1}\alpha + \upsilon_{it+1}, \tag{44}$$

with $\upsilon_{it+1} = \Delta\eta_{it+1} - ln\varepsilon_{it+1} + (1 + x_{it+1}\theta)\Delta u^c_{it+1} + u^c_{it}\Delta x_{it+1}\theta$.

The error term υ_{it+1} actually contains three different sources of shocks. $\Delta\eta_{it+1}$ is the unobserved specific effect, which is related to preferences. $(1+x_{it+1}\theta)\Delta u_{it+1}+u^c_{it}\Delta x_{it+1}\theta$ is the variation that comes from measurement errors. The random terms $ln\varepsilon_{it+1}$ are aggregate temporary shocks, and they may or may not contain idiosyncratic shocks in addition, depending on the hypothesis made on market completeness. If market is complete (full insurance), consumption variation will not respond to idiosyncratic shocks and will depend only on aggregate shocks.

It is obvious that the explanatory variables $[-x_{it+1}\Delta ln\tilde{c}_{it+1} - ln\tilde{c}_{it}\Delta x_{it+1}]$ are correlated with the error terms. In particular, two sets of instrumental variables, which are theoretically orthogonal to preference shocks and measurement errors, are constructed in Dubois (2001). The sets of instruments are:

Instruments set 1 : $\Delta x_{it+1}lnc_{it-1}$ and $x_{it}\Delta\tilde{x}_{it} - x_{it+1}\Delta^2\tilde{x}_{it+1}$,

Instruments set 2 : Set 1 adds $\Delta x_{it+1}(x_{it+1}+x_{it}-x_{it-1})lnc_{it-1}$ and $x^2_{it+1}\Delta^2\tilde{x}_{it+1}-x^2_{it}\Delta\tilde{x}_{it}$.

These instruments are theoretically valid under complete market hypotheses in the sense that they are strongly correlated with the endogenous explanatory variables $[-x_{it+1}\Delta ln\tilde{c}_{it+1} - ln\tilde{c}_{it}\Delta x_{it+1}]$, but are uncorrelated with error terms υ_{it+1}, when $ln\varepsilon_{it+1}$ contain only time specific or village-time specific aggregate shocks.[23]

The main objective of Dubois (2001) is to test the complete market hypotheses. A direct way to do the test is to introduce an idiosyncratic innovation in the regression. If the coefficient is significantly different from zero, then the full insurance market hypotheses are rejected. Otherwise, complete market hypotheses are not rejected. In our paper, we want to test the complete market hypotheses. But more importantly, we would like to quantitatively measure the difference in the level of consumption smoothing between the households that participate in migration and those that do not.

In order to serve our research objective better, our specification on the error structure will be slightly different from that in Dubois (2001) from now on. We decompose $ln\varepsilon_{it+1}$ as follows:

$$ln\varepsilon_{it+1} = e^c_{vt+1} + e^c_i - \xi^c_{it+1}, \tag{45}$$

where X_{it} ={...x$_{it}$...} and e^c_{vt+1} are village-year fixed effects, and e^c_i are household fixed effects. ξ^c_{it+1} are household specific idiosyncratic innovations. Assume that all kinds of idiosyncratic innovations are correlated with household income ω_{it+1}, such that $\xi_{it+1} = \delta[\omega_{it+1} - E_t\omega_{it+1}]$. The expected income $E_t\omega_{it+1}$ is assumed to

[23] A proof of the theoretical validity of instruments is provided in Dubois (2001), we will not replicate the proof in our paper.

be captured by household characteristics, that is x_{it+1}, as well as by unobserved e_i^c and e_{vt+1}^c.

Then $ln\varepsilon_{it+1}$ can be rewritten as follows:

$$ln\varepsilon_{it+1} = e_{vt+1}^c + e_i^c - \delta\omega_{it+1} \quad (46)$$

Define m_{it+1} as the migration indicator, which equals to 1 if household i participates in migration at time $t+1$, and 0 otherwise. Then our empirical model representing consumption smoothing is as follows:

$$\Delta ln\tilde{c}_{it+1} = \mathbb{X}_{it+1}\theta + \Delta\tilde{x}_{it+1}\alpha + \delta_1\omega_{it+1} + \delta_2\omega_{it+1} * m_{it+1} + \upsilon_{it+1}, \quad (47)$$

with $\mathbb{X}_{it+1} = -x_{it+1}\Delta ln\tilde{c}_{it+1} - ln\tilde{c}_{it}\Delta x_{it+1}$, and $\tilde{\upsilon}_{it+1} = \upsilon_{it+1} - \delta\omega_{it+1} = \Delta\eta_{it+1} - e_{vt+1}^c - e_i^c + (1 + x_{it+1}\theta)\Delta u_{it+1}^c + u_{it}^c\Delta x_{it+1}\theta$.

A.3 Variable construction

Started from 1999, household members who had left the households in the last twelve months before the date of the interview are enumerated in the Townsend Thai surveys, including information about why they left, and where he or she stayed. A household is defined in the survey as a group of people who lived and ate in the house for at least six months out of the last 12 months before the date of the interview. Children who are studying away from home and are supported by members of this household are also included in the household members. By only counting the household members who left the households in the survey year, we are likely to underreport migrants in the household. For example, if one works in Bangkok for seven months, one is not counted as a household member since he or she lives in the house less than six months, and as a result, is not counted as a member who migrated.

To avoid this problem, we listed every individual who at least once was present in a household as a household member over the 12 years in the survey. And then, combining the records of their presence and absence in the household member roster with the information about their movements in and out of the village, we generated a dummy for each individual migrant. It is equal to one, if the individual was absent from the household due to migrating for more than six months in the survey year, or if the individual was present in the household but migrated for less than six months in the survey year. At the household-year level, we counted all individual migrants. Subsequently, we are able to construct *a migration indicator m_{it}, which is equal to 1 if there is at least one stock of individual migrant in household i at year t, otherwise it is equal to 0.* By definition, the length of migration can range from a few days to a few years that are covered in the survey periods.

Information available about the migrants in the data is summarised in table (2). Only migrants from 16 to 60 years old are considered in the analyses. They are the migrants who are able to leave the household independently and are more likely to make economic contributions to the household. The average age of them is 29 over all the person-year observations. Women make up around 43 per cent of the total migration cases. Bangkok is the most popular migration destination, which takes 47 per cent of the overall cases. About 20 per cent of the migrants choose to stay nearby, that is with-in the home province. Another 30 per cent of the migrants migrate out of the province.

We counted individual migration cases and generated the migration indicators at the household-year level. Moreover, we generated indicators representing different types of migration, using the information about who migrated and the purpose of the movement. The migration indicators are formally defined as follows:

Individual migrant : a migrant is or was a household member that migrated out of the village at a survey year. He or she was no longer counted as a migrant in a year if the movement related to migration had stopped at the beginning of the year.[24]

Migration : $m_{it} = 1$ if there is one stock of individual migrant in household i at year t; 0 otherwise.

Head migration : $m_{it} = 1$ and the migrant is or was the head of the household.

Child migrating for jobs : $m_{it} = 1$ and the migrant is a child or a grandchild of the head, migrating for the purpose of working at the destination.[25]

Child migrating for education : $m_{it} = 1$ and the migrant is a child or a grandchild of the head, migrating for schools at the destination.

Child migrating for marriages : $m_{it} = 1$ and the migrant is a child or a grandchild of the head, migrating for marriage at the destination.

Child migrating for others : $m_{it} = 1$ the migrant is a child or a grandchild of the head, migrating for other reasons.[26]

[24]In other words, he or she returned to the village in the previous year and did not leave again in the year.

[25]If the household head left with a child, we counted the case as head migration. We talk about child migration if and only if the second or the third generation migrated. We have a small number of overlapped observations involving children migrating for different purposes, and thus, the types of child migrating is not exclusively defined.

[26]Other reasons include family visits, conscriptions, ordainments, vacations etc. Reasons unknown due to missing or ambiguous records are also counted in other reasons.

Summary statistics about households' migration participation are provided in table (3). Households that participate in migration make up 54 per cent of the total 5326 household-year observations across the 12 years. Among the migration households, about 10 per cent are related to the household head migration. Eighty-seven per cent are related to child migration. Less than three per cent are related to other family members, such as the head's siblings and the parents of the head.

We are interested in migration related to jobs, marriage and education. Close to half of the migration are for jobs. Five per cent are for marriage. And around eight per cent are for education opportunities.

A.4 Identification tests

In this section we evaluated the identification status by applying various identification tests on our model. We started with a test of the order and rank condition for identification (see Greene (2002), page 392). The order condition states that the number of exogenous variables excluded from one single-equation estimated with instrumental variables must be at least as large as the number of endogenous variables included in the equation. It is a necessary but not sufficient condition for identification. It ensures that the system of equations has at least on solution, but it does not ensure that it has only one solution. The rank condition for identification states that the reduced-form coefficient matrix is of full column rank. The rank condition ensures that there is exactly one solution for the structural parameters given the reduced-form parameters. We follow Baum et al. (2007) and use the stata module "checkreg3" to examine the order and rank condition for each equation in our model. Unless the rank condition is satisfied for each equation in the system, the system is unidentified. The results showed that all our three equations in the model are identified, and thus, the system is identified.

Further more, we checked the orthogonality conditions of our excluded instruments, which are the instruments sets defined in Appendix A.2, the land property right proxy and the constructed predetermined predictor of migration. We performed the Sargan-Hansen test of overidentifying restrictions on the instrumental variables. The joint null hypothesis is that the instruments are valid instruments, i.e. uncorrelated with the error terms in the system. The reported Hansen-Sargan overidentification statistic following a 3sls estimation is 8.383, which failed to reject the validity of our instruments. An alternative way to test the exogeneity of our instruments is to calculate the C statistics after an estimation of the consumption equation using 2sls (see Hayashi (2000), page 218-22). The reported C statistics is 0.926, which indicates a failure to reject the orthogonality of our excluded instruments. In the meantime, we tested the redundancy of our instruments. Excluded instruments are redundant if the asymptotic efficiency of the estimation is not improved by using them. The LM test of redundancy of specified instruments rejects the null hypothesis and indicates that our instruments are not redundant.

A.5 Test attrition bias

Given that missing data in the panel are mainly due to migration (Kaboski and Townsend, 2012), it is possible that our results are biased due to attrition. In this section, we applied an approach developed by Semykina and Wooldridge (2010) to test attrition bias.

Semykina and Wooldridge (2010) presented a parametric and a non-parametric approach to test and correct selection bias, when the equation of interest contains endogenous explanatory variables as well as unobserved heterogeneity, particularly when instruments are correlated with the unobserved effect. We follow the parametric approach, which is valid under the assumption that the errors in the selection equation are normally distributed. The approach includes adding a hazard function into the primary regression function. If the estimated coefficient of the hazard function is significantly different from zero, the hypothesis of no attrition bias will be rejected. Otherwise, we get consistent estimates of parameters with the hazard function in the regression. We will briefly introduce the parametric correction procedure in the following paragraphs.

Define the selection indicator k_{it}. $k_{it} = 1$ if household i at time t continues to be present in the survey in the next period $t + 1$. Otherwise, $k_{it} = 0$. As previously mentioned, the identification of our model depends on the observability of variables in two consecutive time periods, which differs from Semykina and Wooldridge (2010). Formally, the real selection indicator in our model is actually $\tilde{k}_{it+1} = k_{it} \cdot k_{it+1}$. The variables in the model are only observable when $\tilde{k}_{it+1} = 1$.

Define a latent variable $\tilde{k}^*_{it}$ and model the selection function as:

$$\tilde{k}^*_{it+1} = Q^k_{it+1}\beta^k + \upsilon^k_{it+1}, \qquad t = 1, ..., T. \tag{48}$$

The superscript k denotes that variables and parameters are in the selection function. υ^k_{it+1} are idiosyncratic errors. The selection indicator, $\tilde{k}_{it+1}$, is generated as:

$$\tilde{k}_{it+1} = 1[\tilde{k}^*_{it+1} > 0] = 1[Q^k_{it+1}\beta^k + \upsilon^k_{it+1} > 0], \tag{49}$$

where $1[\cdot]$ is the indicator function. Assume that:

$$\upsilon^k_{it+1}|Q^k_{it+1} \sim Normal(0, 1), \qquad t = 1, ..., T, \tag{50}$$

so that $\tilde{k}_{it+1}$ follows a probit model.

The vector Q^k_{it} is restricted to contain only instrumental variables and the exogenous variables in the primary function. Formally the selection function is as follows:

$$\tilde{k}_{it+1} = 1[\tilde{k}^*_{it+1} > 0] = 1[Q^k_{it+1}\beta^k + \upsilon^k_{it+1} > 0],$$
$$\upsilon^k_{it+1}|Q^k_{it+1} \sim Normal(0,1), \qquad t = 1, ..., T,$$

If υ^k_{it+1} is related to unobserved shocks in the regression equations, there will be bias due to attrition. Assume that:

$$E(ln\varepsilon_{it+1}|Q^k_{it+1}, \tilde{k}_{it+1}) = \rho E(\upsilon^k_{it+1}|Q^k_{it+1}, \tilde{k}_{it+1}), \qquad t = 1, ..., T. \tag{51}$$

From the usual probit calculation:

$$E(\upsilon^k_{it+1}|Q^k_{it+1}, \tilde{k}_{it+1}) = \lambda(X^k_{it+1}\beta^k), \qquad t = 1, ..., T, \tag{52}$$

where $\lambda(\cdot)$ denotes the inverse Mills ratio, and $\lambda(\cdot) = \frac{\phi(\cdot)}{\Phi(\cdot)}$, where $\phi(\cdot)$ is the standard normal pdf, and $\Phi(\cdot)$ is the standard normal cdf. For each time period, it is easy to estimate $P(\tilde{k}_{it+1} = 1|X^k_{it+1}) = \Phi(X^k_{it+1}\beta^k)$ using the probit model. Then, we could use the estimates to obtain the Inverse Mills Ratios, $\hat{\lambda}_{it+1} \equiv \lambda(Q^k_{it+1}\hat{\beta}^k)$.

To test attrition bias, we estimate the consumption growth equation using the 2sls regression with $\hat{\lambda}_{it+1}$ as an additional control variable. Household characteristics, the proxy of land proper rights, the constructed pre-determinant of migration are used as instruments. In practice, we use the same set of instruments in the selection function and in the primary equation. Parameters are identified because of the nonlinearity of the inverse Mills ratio. The asymptotic variance is estimated using panel bootstrap. This involves resampling cross-sectional units (and all time periods for each unit sampled) and using the bootstrap sample to approximate the distribution of the parameter vector.

Estimated results are presented in table (9). The estimated coefficient of the inverse Mills ratio is small and insignificant. This result supports a rejection of the existence of attrition bias.

A.6 Table and graphs

Table 1: Summary statistics

Variables[a]	Balanced panel Mean	Std.Dev
Real consumption adult-male equivalent	1.82	2.03
Real food consumption adult-male equivalent	0.65	0.36
Real net income adult-male equivalent	4.33	6.64
Real farm profit adult-male equivalent	0.63	2.98
Real wage income adult-male equivalent	1.34	2.61
Plot areas (rai)	12.16	18.05
Plot areas with full ownership (rai)	4.40	9.90
Age of the head	55.95	12.83
Years of education of the head	4.27	2.91
Highest education in the household (years)	8.66	3.89
The primary occupation of the head is farmer	0.51	0.50
Household size	4.35	1.82
The no. of children under 12	0.48	0.69
The no. of adults above 40	1.17	1.08
The number of male adults in the household	2.13	1.25
Households	739	
Observations	8868	

Note: (a) The unit of analysis is the household-year. Only continuously observed households are considered. The unit for value denominated variables are 10,000 Thai bahts. Income and consumption are adjusted to real per capita units (standardised using adult-male equivalents) using annual household composition data and regional Consumer Price Index (base year 2011). The unit of plot areas is rai, and 1 rai = 1600 m^2. Demographics are measured in the initial survey.

Table 2: Individual migrants (16-60 years old[a])

	Panel mean
Age (years)	29.36
Female (%)	42.92
Destinations (%)	
Outside this village but in this tambon (subdistrict)	4.18
Outside this tambon but in this amphoe (district)	5.10
Outside this amphoe but in this changwat (province)	10.39
In Bangkok	47.34
Other provinces	28.81
Other destinations	2.76
	N
Migrants	1492
Observations	12573

Note: (a) The table reports descriptive statistics for all observed individual migrants from 16 to 60 years old over the survey periods. The unit of analysis is individual-year.

Table 3: Household migration participation[a]

	% in pooled data
Households participate in migration	53.65
Who migrated in these households	
The head or his or her spouse migrated	9.60
Children or grand children of the head migrated	87.41
Other family members migrated	2.99
Migration approaches[b]	
For jobs	48.30
For marriage	4.69
For education	8.41
Others and unknown	38.6
	N
Households	623
Observations	5326

Note: (a) The unit of analysis is the household-year. Only continuously observed households are considered. (b) Migration approaches are not exclusively defined. There exists a small overlap between different approaches.

Table 5: Consumption dynamics

Variables[a]	reg 1 b(se)b	reg 2 b(se)	reg 3 b(se)
Dependent variable: Δ ln(consumption)			
δ:			
δ^1 Income	0.006***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)
δ^2 Migration∗income	-0.004***	-0.002*	-0.002*
	(0.001)	(0.001)	(0.001)
δ^3 Head migration∗income		-0.001	-0.001
		(0.001)	(0.001)
δ^4 Child migration through jobs∗income		-0.00028	-0.00025
		(0.00057)	(0.00056)
δ^5 Child migration through education∗income		-0.003**	-0.003**
		(0.001)	(0.001)
δ^6 Child migration through marriages∗income		-0.009***	-0.009***
		(0.001)	(0.001)
δ^7 Child migration through other ways∗income		-0.00007	-0.00006
		(0.00066)	(0.00065)
$\theta : x_{it+1}$			
Household size	-0.023***	-0.023***	-0.022***
	(0.003)	(0.003)	(0.003)
Head age	-0.01408***	-0.01403***	-0.01376***
	(0.00032)	(0.00031)	(0.00031)
Head education (years)	-0.023***	-0.022***	-0.022***
	(0.003)	(0.003)	(0.003)
No. of children under 12	-0.015*	-0.014	-0.013
	(0.008)	(0.007)	(0.007)
Plot areas (100 rai)			-0.077*
			(0.031)
Head occupation is farmer			-0.022*
			(0.009)
$\alpha : \tilde{x}_{it+1}$			
Household size	-0.008***	-0.009***	-0.008***
	(0.001)	(0.001)	(0.001)
Head age	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)
Head education (years)	-0.011***	-0.010***	-0.011***
	(0.003)	(0.002)	(0.002)
No. of children under 12	-0.011**	-0.010**	-0.009**
	(0.004)	(0.004)	(0.004)
Plot areas (100 rai)			-0.060*
			(0.024)

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Variables[a]	reg 1 b(se)[b]	reg 2 b(se)	reg 3 b(se)
Head occupation is farmer			-0.009*
			(0.004)
Constant	-0.00014	0.00003	0.00018
	(0.00250)	(0.00247)	(0.00242)
Village-year fixed effects	yes	yes	yes
Household fixed effects	yes	yes	yes
IV set 1[27]	yes	yes	yes
IV set 2	no	no	yes
N	7384	7384	7384

Note: This table presents the estimated results for the consumption equation. Results are estimated through three-stage least square regressions, taking the system of equations as simultaneously determined and allowing arbitrary correlations among these equations. The unit of analysis for variables is the household-year. Only continuously observed samples are considered in the regressions. (a) The unit for value denominated variables are 10,000 Thai bahts. Income and consumption are adjusted to real per capita units (standardised using adult male equivalents) using annual household composition data and regional Consumer Price Index (base year 2011). (b) Standard deviations of the estimated coefficients are in the parentheses. $*(p < 0.05), **(p < 0.01), ***(p < 0.001)$.

[27] About the introduction of the instrument sets, please refer to Appendix (A.2)

Table 4: The income equation

Variables[a]	reg 1 b(se)[b]	reg 2 b(se)	reg 3 b(se)
Dependent variable: Income			
β:			
β_1^1Migration	5.883***	7.717***	7.650***
	(0.319)	(0.454)	(0.452)
β_1^2Head migration		-1.318*	-1.278*
		(0.535)	(0.533)
β_1^3Child migration through jobs		-0.799*	-0.848**
		(0.321)	(0.320)
β_1^4Child migration through education		-0.144	-0.167
		(0.463)	(0.461)
β_1^5Child migration through marriages		-0.068	0.020
		(0.615)	(0.614)
β_1^6Child migration through other ways		-1.241***	-1.237***
		(0.306)	(0.305)
Plot area with full property rights (rai)	0.028**	0.032***	0.022*
	(0.009)	(0.009)	(0.010)
Lagged ln(consumption)	0.484***	0.587***	0.566***
	(0.114)	(0.122)	(0.122)
Lagged income	0.083***	0.102***	0.097***
	(0.011)	(0.011)	(0.011)
Household size	-0.224***	-0.184**	-0.807***
	(0.057)	(0.058)	(0.182)
The age of the head	-0.001	-0.00031	0.069
	(0.009)	(0.00886)	(0.054)
Head education (years)	0.330***	0.316***	0.322***
	(0.042)	(0.043)	(0.042)
No. of children under 12y	0.019	0.009	0.286
	(0.126)	(0.129)	(0.226)
Head occupation is farmer	-0.110	-0.200	-0.569**
	(0.155)	(0.166)	(0.184)
The square of household size			0.060***
			(0.018)
The square of head age			-0.00061
			(0.00046)
The square of the no. of children under 12y			-0.127
			(0.092)
Plot area (100 rai)			3.106***
			(0.616)
Constant	0.062	0.049	0.051
	(0.129)	(0.131)	(0.130)
Village-year fixed effects	yes	yes	yes
Household fixed effects	yes	yes	yes
N	7384	7384	7384

Note: This table presents the estimated results for the income equation. Results are estimated through three-stage least square regressions, taking the system of equations as simultaneously determined and allowing arbitrary correlations among these equations. The unit of analysis for variables is the household-year. Only continuously observed samples are considered in the regressions. (a) The unit for value denominated variables are 10,000 Thai bahts. Income and consumption are adjusted to real per capita units (standardised using adult male equivalents) using annual household compostion data and regional Consumer Price Index (base year 2011). (b) Standard deviations of the estimated coefficients are in the parentheses. $*(p < 0.05), **(p < 0.01), ***(p < 0.001)$.

Table 6: Migration choices

Variables[a]	reg 1 b(se)[b]	reg 2 b(se)	reg 3 b(se)
Dependent variable: migration			
Income	0.034***	0.026***	0.026***
	(0.001)	(0.001)	(0.001)
Migration in the last period	0.540***	0.548***	0.548***
	(0.009)	(0.009)	(0.009)
Predetermined predictor of migration	0.975**	1.005**	0.999**
	(0.350)	(0.360)	(0.360)
Household size	-0.002	-0.005*	-0.009
	(0.002)	(0.002)	(0.007)
Head education (years)	-0.010***	-0.007***	-0.007***
	(0.002)	(0.002)	(0.002)
No. of children under 12y	0.001	0.002	-0.012
	(0.006)	(0.005)	(0.010)
The square of household size		0.00044	
			(0.00071)
The head occupation is farmer			0.028***
			(0.008)
Plot area (100 rai)			-0.094***
			(0.025)
Constant	0.004	0.005	0.005
	(0.006)	(0.005)	(0.005)
Village-year fixed effects	yes	yes	yes
Household fixed effects	yes	yes	yes
N	7384	7384	7384

Note: This table presents the estimated results for the equation of the migration decision, with the general migration indicator as the dependent variable. Results are estimated through three-stage least square regressions, taking the system of equations as simultaneously determined and allowing arbitrary correlations among these equations. The unit of analysis for variables is the household-year. Only continuously observed samples are considered in the regressions. (a) The unit for value denominated variables are 10,000 Thai bahts. Income and consumption are adjusted to real per capita units (standardised using adult male equivalents) using annual household size data and regional Consumer Price Index (base year 2011). (b) Standard deviations of the estimated coefficients are in the parentheses. $*(p < 0.05), **(p < 0.01), ***(p < 0.001)$.

Table 7: Distribution of estimated relative risk aversion

	Percentiles								
Province id	**min**	**10th**	**25th**	**50th**	**75th**	**90th**	**max**	**Std.Dev**	**N**
07	-0.57	-0.23	-0.11	0.02	0.15	0.24	0.43	0.18	2340
27	-0.61	-0.18	-0.06	0.06	0.16	0.22	0.42	0.16	2220
49	-0.52	-0.21	-0.13	-0.01	0.14	0.22	0.40	0.17	1992
53	-0.65	-0.23	-0.14	0.00	0.13	0.21	0.49	0.17	2314
Total	-0.65	-0.22	-0.11	0.02	0.14	0.22	0.49	0.17	8866

Note: The table reports summary statistics from the distribution of estimates of household's risk aversion $\theta(z_{it})$. The risk aversion estimates are calculated by $\hat{\theta}(X_{it}) = 1 + X_{it}\hat{\theta}$, and $\hat{\theta}$ are estimated coefficients from reg 2 in the consumption equation. The unit of analysis is household-year. Only continuously observed samples are considered.

Table 8: Relative risk aversion and the choice of migration

	Migration b/se	Head b/se	children∗job b/se	children∗education b/se	children∗marriages b/se	Children∗others b/se
Dependent variable: the migration indicators[a]						
Estimated relative risk aversion[b]	9.527	10.408	11.345	62.660***	-26.589	2.374
	(6.860)	(12.960)	(6.911)	(14.730)	(23.119)	(6.964)
Household size	-0.703***	-0.277	0.181	1.470***	-1.011	-0.197
	(0.176)	(0.322)	(0.176)	(0.365)	(0.590)	(0.177)
Head education	0.210	0.065	0.419*	1.427***	-0.416	0.194
	(0.162)	(0.307)	(0.169)	(0.340)	(0.550)	(0.165)
Head age	0.108	0.156	0.212*	0.904***	-0.358	0.034
	(0.097)	(0.180)	(0.097)	(0.209)	(0.326)	(0.098)
The head occupation is farmer	0.031	0.193	0.170	0.085	-0.483	0.119
	(0.141)	(0.279)	(0.140)	(0.250)	(0.514)	(0.134)
Household fixed effects	yes	yes	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes	yes	yes
N	3408	804	2532	1032	360	2520

Note: This table presents the results of conditional logit estimation. The unit of analysis is household-year. Only continuously observed samples are considered in the regressions. (a) The dependent variables from the left to the right are respectively: the indicator for head migration, child migrating for jobs, for education, for marriage and for others. (b) The estimated risk aversion are obtained by $\hat{\theta}(z_{it}) = 1 + z_{it}\hat{\theta}$. $\hat{\theta}$ are part of the estimated coefficients in the consumption equation (reg2). (c) Standard deviations of the estimated coefficients are in the parentheses. $*(p < 0.05), **(p < 0.01), ***(p < 0.001)$.

Table 9: Test attrition bias

	2sls b/se
Dependent variable: Δ ln(consumption)	
δ:	
Income	0.011
	(0.006)
Migration$*$income	-0.025*
	(0.012)
$\theta : x_{it+1}$	
Household size	-0.035***
	(0.002)
Head age	-0.012***
	(0.000)
Head education (years)	-0.031***
	(0.002)
No. of children under 12	-0.002
	(0.006)
$\alpha : \tilde{x}_{it+1}$	
Household size	-0.041***
	(0.011)
Head age	-0.003***
	(0.001)
Head education (years)	-0.035***
	(0.005)
No. of children under 12	-0.004
	(0.006)
Inverse Mills ratio	-0.049
	(0.027)
Constant	-0.001
	(0.003)
Village-year fixed effects	yes
Household fixed effects	yes
N	6871

Note: This table presents the estimated results for the consumption equation with a test of attrition bias. Results are estimated through two-stage least square regressions. Income and the products of income and the migration dummies are instrumented with household characteristics, land property rights and the constructed predeterminate predictor of migration. (a) The unit for value denominated variables are 10,000 Thai bahts. Income and consumption are adjusted to real per capita units (standardised using adult male equivalents) using annual household composition data and regional Consumer Price Index (base year 2011). (b) Standard deviations of the estimated coefficients are estimated through bootstrap with 50 replications and are presented in the parentheses. $*(p < 0.05), **(p < 0.01), ***(p < 0.001)$.

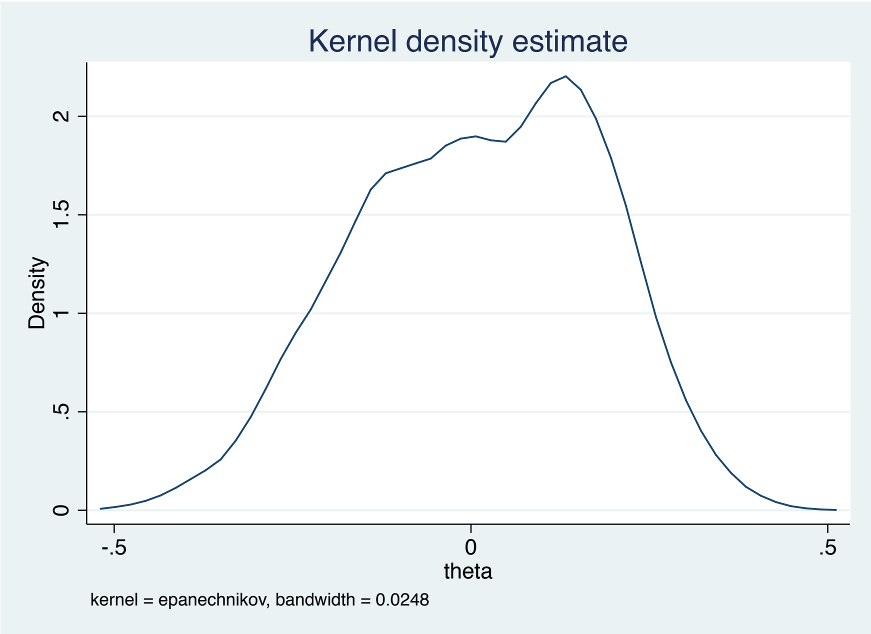

Figure 1: Distribution of estimated risk aversion

About the Migrating out of Poverty Research Programme Consortium

Migrating out of Poverty is a research programme consortium (RPC) funded by the UK's Department for International Development (DFID). It focuses on the relationship between migration and poverty – especially migration within countries and regions - and is located in five regions across Asia and Africa. The main goal of ***Migrating out of Poverty*** is to provide robust evidence on the drivers and impacts of migration in order to contribute to improving policies affecting the lives and well-being of impoverished migrants, their communities and countries, through a programme of innovative research, capacity building and policy engagement. The RPC will also conduct analysis in order to understand the migration policy process in developing regions and will supplement the world renowned migration databases at the University of Sussex with data on internal migration.

The ***Migrating out of Poverty*** consortium is coordinated by the University of Sussex, and led by CEO Professor L. Alan Winters with Dr Priya Deshingkar as the Research Director. Core partners are: the Refugee and Migratory Movements Research Unit (RMMRU) in Bangladesh; the Centre for Migration Studies (CMS) at the University of Ghana; the Asia Research Institute (ARI) at the National University of Singapore; the African Centre for Migration & Society (ACMS) at the University of the Witwatersrand in South Africa; and the African Migration and Development Policy Centre (AMADPOC) in Kenya.

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