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RISK AND RETURN IN VILLAGE ECONOMIES

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ABSTRACT

We present a framework for the study of risk and return of household enterprise in developing economies. We make predictions from two polar benchmarks: (1) an economy with Pareto optimal allocations under full risk sharing, and (2) an economy in which each autarky household absorbs risk in isolation. The full risk-sharing benchmark delivers the prediction that only aggregate covariate risk contributes to the risk premium of asset returns while idiosyncratic risk is fully diversified, consistent with analogous results derived from the Capital Asset Pricing Model (CAPM) in the finance literature. The economy with autarky households predicts that overall fluctuation at the household level is the only concern. Our framework allows us to empirically decompose the total risk in production technologies operated by households into aggregate and idiosyncratic components and provides us with a practical procedure to compute risk premium for each component separately. We apply the framework to monthly panel data from a household survey in rural Thailand where there are active risk-sharing and kinship networks. We find that there is nontrivial aggregate risk and there is a positive relationship between the expected returns on assets and the comovement of asset returns with the aggregate returns, as predicted by the full risk-sharing economy. There is residual idiosyncratic risk and it also contributes to the total risk premium, as predicted by the autarky benchmark. However, although idiosyncratic risk is the dominant factor in total risk, our study shows that it accounts for a much smaller share of total risk premium. Exposure to aggregate and idiosyncratic risk is heterogeneous across households as are the corresponding risk-adjusted returns, with important implications for vulnerability and productivity.

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1. Introduction

Many households in developing countries are engaged in and derive their income from farm and non-farm production activities. Measuring the risk and return of these household enterprises is therefore important as it helps us understand the vulnerability and productivity of these households and their business enterprises. In order to study risk and return, however, an appropriate framework is needed. In this paper, we present a framework, tailored around the institutions and informal arrangements observed on the ground in a developing economy. We then apply the framework to a long-running household survey with the requisite key variables on the production side that capture the risk and return from farm and non-farm business enterprises operated by the households.

The theoretical part of the paper presents two polar benchmarks. The first one is an economy with full risk-sharing that delivers Pareto optimal allocations of risk for the community as a whole, where risks are pooled efficiently over all households and production technologies. In contrast, the second benchmark considers an economy where each autarky household absorbs risk on its own. Our statistical analysis integrates these two extremes and allows us to distinguish and decompose the total risk faced by a household, as measured by the variance of the return on its productive assets, into two components: (1) systematic, aggregate, non-diversifiable risk, and (2) residual idiosyncratic, potentially diversifiable, risk. The full risk-sharing benchmark delivers the prediction that only aggregate covariate risk contributes to the risk premium of asset returns while idiosyncratic risk is fully diversified. The autarky benchmark, in contrast, predicts that aggregate and idiosyncratic risks should enter with the same weight because total risk is simply the sum of the risks from each component.

The predictions from the full insurance benchmark in this paper are similar to those derived from the Capital Asset Pricing Model (CAPM) in the finance literature.[1] It is important to note, however, that although the main predictions from our full risk-sharing benchmark are analogous to those of in the traditional finance literature, the economic environment behind our framework is different. In particular, the complete markets assumption in the benchmark models of the traditional asset pricing literature generally comes from the tradability of the assets and the access of participants to formal financial markets. Here we provide an alternative interpretation of the complete markets assumption based on informal arrangements that allow full risk-sharing allocation of consumption. Although the complete markets assumption in the finance literature is more likely to hold in an advanced economy with formal modern financial markets, the completes market environment in our paper is also likely to be achieved in a rural poor village economy where social networks are strong and informal financial arrangements that includes risk sharing are common.

In the empirical part of the paper, we apply our two benchmarks to monthly panel data from the Townsend Thai Survey, an integrated household survey conducted in rural and

[1] The traditional CAPM was originally proposed by Lintner (1965) and Sharpe (1964). The literature on theoretical and empirical CAPM since its first introduction is extensive. See Dybvig and Ross (2003) and Fama and French (2004) for a survey.

semi-urban villages in Thailand. Specifically, we study the risk and return of household's assets, which include fixed productive assets (such as machinery, livestock, and land), financial assets (such as deposits at financial institutions or informal lending), as well as those assets in between (such as inventories). Although the returns to tradable liquid financial assets are from interest, dividends, or capital gains, the returns to relatively illiquid real productive assets are mainly from the output they produce, as well as relatively infrequent capital gains. Our study also differs from the standard empirical consumption-based asset pricing in macroeconomics and finance literature. The consumption-based finance literature typically relies on countrywide aggregate consumption to explain asset risk and return of financial assets. In those studies, limited access to financial markets by a number of people in the economy potentially leads to several anomalies in financial research.[2] Our study is applied locally to collections of closely connected villages in which almost everyone is in a family network. The empirical strategies are analogous, but our study of risk and return of household enterprises in networked village economies is based on detailed household-level surveys, allowing us to link asset returns of the households with panel data of relevant market participants. It was the consumption data from these village economies that gave us the idea that informal risk sharing networks are working quite well, though not tested on the production side through rates of return.[3]

Our empirical analysis reveals several striking findings. First, we find that higher exposure to aggregate, non-diversifiable risk is related to higher expected returns on household assets, largely consistent with a prediction from the full risk-sharing benchmark model, which is in turn consistent to the prediction from the conventional CAPM. This main result is also robust to extended specifications where we include household human capital and allow for a time-varying stochastic discount factor. Second, when we decompose the total risk into two components, we find that idiosyncratic risk contributes as well to the risk premium, as it would in the economy with autarky households. However, there is a stark contrast between the quantity of risk and the impact on risk premia: although idiosyncratic risk is the dominant factor in total risk, it accounts for a much smaller share of total risk premium. That is, the amount of idiosyncratic risk is substantially, though not entirely, diversified away, so that the risk premium compensating for idiosyncratic risk is small. In contrast, the smaller amount of aggregate risk cannot be shed, and thus it has a relatively large effect on the risk premia. In sum, the full risk-sharing benchmark captures the larger part, though not all, of what is going on in the Thai village networked economies studies in this paper.

Related, we find that exposure to both aggregate and idiosyncratic risk of the household is correlated with some household characteristics. In our sample, exposure to both aggregate and idiosyncratic risk of a household is negatively correlated with household

[2] The consumption-based asset pricing model was pioneered by Breeden (1979), Lucas (1978), and Rubinstein (1976). Campbell (2003) provides a review of the development of the consumption-based model. Cochrane (2001) discusses how the traditional CAPM and the consumption-based model are interrelated. For literature on limited market participation in the developed economy context, see Mankiw and Zeldes (1991), Vissing-Jorgensen (2002), and Vissing-Jorgensen and Attanasio (2003).

[3] See Samphantharak and Townsend (2010), Kinnan and Townsend (2012), and Sripakdeevong and Townsend (2012).

head's age and initial wealth of the households. In other words, in contrast to the result of Calvet, Campbell, and Sodini (2010) who find that higher wealth households take on more risks, our result suggests that wealthier households seem to engage in production activities with lower risks. Aggregate risk is also negatively correlated with the education and age of household heads, and positively associated with household head being male. Households with younger head or higher initial leverage tend to have more exposure to idiosyncratic risk.

Thus this paper has several implications for the study of risk and return faced by households in developing economies. On the one hand, existing literature in development economics studies the return on assets and how it is directly related to the productivity and income of households and enterprises.[4] On the other hand, there are studies that focus on risk and volatility and how they determine the vulnerability of poor households.[5] Yet, to the best of our knowledge, there is little literature in development economics that systematically and directly links risk and return on household enterprises together. One exception is a recent study by Karlan, Osei, Osei-Akoto, and Udry (2013) who argue that risk is a constraint to agricultural investment and providing insurance to farmers in Ghana led to an increase in investment. Related, although the literature on risk sharing in consumption clearly distinguishes between aggregate risks that are not diversifiable and idiosyncratic risks that could be shared, we go further here and define and measure risk in a way that is consistent with both economics and finance theories.[6] Our model also allows us to test a full risk-sharing hypothesis from the production side, namely, the relationship between (aggregate and idiosyncratic components of) risk and returns of household enterprises. Specifically, our empirical results show that a household with high total risk (high variance of return on assets) may have lower risk premium than another household with seemly lower overall risk (low variance) if the household with more volatile return is facing idiosyncratic and hence (largely) diversifiable risk. Likewise, the household with low total risk could require a higher risk premium if most of that risk is covariate and hence nondiversifiable.

The insights from this paper have important policy implications. On the risk and vulnerability side, many policies and experimental interventions are aimed at providing safety nets to low income populations, and evaluating the impact of insurance products offered to them, given a presumption of exposure to high risk.[7] Here, again, we show that

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[4] Some recent studies on returns on assets in developing economies include De Mel, McKenzie, and Woodruff (2009) for Sri Lanka; Duflo, Kremer, and Robinson (2008) for Kenya; McKenzie and Woodruff (2008) for Mexico; Samphantharak and Townsend (2012) for Thailand; and Udry and Anagol (2006) for Ghana. However, these measures of returns are generally not adjusted for risk premium.

[5] For literature on vulnerability, see Morduch and Kamanou (2001), Hoddinott and Quisumbing (2003), Ligon (2004), Ligon and Schechter (2004), and Dercon (2006).

[6] The risk sharing literature is dated back to Wilson (1968). Mace (1991) and Cochrane 91991) apply the concept to the U.S. data. Examples of the studies on risk sharing in developing economies include Townsend (1994) and Morduch (2001) for India; Grimard (1997) for Cote d'Ivoire; Goldstein (1999) for Ghana; Chiappori, Samphantharak, Schulhofer-Wohl, and Townsend (2011) for Thailand; and Suri (2011) for Kenya and Cote d'Ivoire. In a recent study, Mobarak and Rosenzweig (2012) examine the interaction between informal risk sharing and the formal demand for insurance in India.

[7] Literature on insurance against poverty is extensive. For example, see an edited volume by Dercon (2004) for a collection of papers and case studies on this issue.

the much of the idiosyncratic part of that risk could be mitigated, particularly on the consumption side. Our findings also suggest that the remaining risk that is not diversified is then compensated by risk premia on asset returns. Likewise, high rates of return on enterprise assets in developing economies could, at first blush, be viewed as an indicator of financial constraints, that is, households and small businesses could not acquire additional finance to invest and expand. However, the higher return could well reflect the fact that the household is engaged in riskier production activities and gets compensated for the higher risk in the form of higher average return. Yet while risk adjustment does come to mind when the analysts and researchers see high returns, the way to adjust for such risks is less obvious. As in CAPM in finance literature, the work presented in this paper does provide us with a practical procedure to compute the appropriate risk-adjusted returns.

The paper proceeds as follows. Section 2 presents two benchmarks that we use to study risk and return in a village economy. Section 3 describes the data from the Townsend Thai Monthly Survey that we use in our empirical study. Section 4 presents the main empirical results on the relationship between expected returns and aggregate risks. We also extend our analysis to incorporate human capital, time-varying risks, and time-varying stochastic discounts. Section 5 quantifies idiosyncratic risks and analyzes their effects on risk premium and expected returns. Section 6 compares the contributions of aggregate and idiosyncratic risk premium to the total risk premium. Section 7 distinguishes the risk premium from the productivity of household enterprises, computing the household's risk-adjusted rate of return. We show in Section 8 that there is heterogeneity across households in their exposure to aggregate and idiosyncratic risks. The paper concludes in Section 9 with some important policy implications.

2. Theoretical Framework

2.1 The Underlying Environment

We start with an economy consisting of a set of nearby villages with J households, indexed by $j = 1, 2, ..., J$. There are I production activities, indexed by $i = 1, 2, ..., I$, that utilize capital as the only input. Each production technology delivers the same consumption goods and is linear in capital. Let k_j^i be the assets assigned to production activity i and operated by household j as of the end of the previous period, and let r_j^i be their returns, net of depreciation, realized at the beginning of the current period. The fluctuation and the pairwise comovement of the returns are represented by the variance-covariance matrix of the returns, Ω_r, of dimension JxI. A portfolio of assets could be formed by allocating assets to various households and various activities. Varying the weights of the assets in the portfolio creates a feasible set of all possible returns that could be achieved by available assets. Note that some of the points in this set could have zero weight for some of the assets, i.e., it is not necessary to have all of the assets included in a particular portfolio.[8]

[8] A familiar feasibility set derived from portfolios of assets is the mean-variance frontier. Any portfolio of

The rest of this section presents two polar benchmarks. For expositional clarity, we begin with the first benchmark economy with full risk-sharing that delivers Pareto optimal allocations of risk for the community as a whole. We show how technologies introduced in the underlying environment above are linked together when risks are pooled efficiently over all households and production technologies. Then, we discuss the second, opposite benchmark that considers an economy where each autarky household absorbs risk in isolation. Note that the underlying technologies are the same in both benchmarks.

2.2 A Full Risk-Sharing Benchmark

First we consider a benchmark case in which all households in the economy are able to completely pool and share risk from their production. Let k_M be the total assets of the aggregate economy (a collection of nearby villages in the empirical part of this paper), *M*, and r_M be the return on assets of the aggregate economy. A linear production technology with capital as the only input implies that

$$k_M = \sum_{j=1}^{J} k_j$$

$$r_M = \frac{\sum_{j=1}^{J} r_j k_j}{k_M} = \sum_{j=1}^{J} \theta_j r_j,$$

where $\theta_j = \frac{k_j}{k_M}$ is the share of the assets allocated to household *j*; k_j is the total assets of household *j* carried from the previous period (before the returns are realized); and r_j be the return on assets of the household. In other words, in terms of the previous notation,

$$k_j = \sum_{i=1}^{I} k_j^i$$

$$r_j = \frac{\sum_{i}^{I} r_j^i k_j^i}{k_j} = \sum_{i=1}^{I} \omega_j^i r_j^i,$$

where $\omega_j^i = \frac{k_j^i}{k_j}$ is the share of household *j*'s assets allocated to activity *i*. In this economy, the variance of the aggregate return is therefore

assets delivers a point on a mean-variance space that corresponds to the expected return and the variance of the constructed portfolio. Varying the weights allocated to available assets creates a feasible set of means and variances that could be achieved by all available assets. Note that this frontier is derived from the production technology alone, without any assumptions on preferences or optimization.

$$\text{var}\left(r_M\right)=\text{var}\left(\sum_{j=1}^{J}\theta_j r_j\right)=\sum_{j=1}^{J}\sum_{j'=1}^{J}\theta_j\theta_{j'}\sigma_{j,j'}=\sum_{j=1}^{J}\theta_j^2\sigma_j^2+\sum_{j=1}^{J}\sum_{j'\neq j}\theta_j\theta_{j'}\sigma_{j,j'},$$

where σ_j^2 is a variance of the return on household *j*'s assets and $\sigma_{j,j'}$ is a pairwise covariance between the return on assets of household *j* and another household j' in the economy. Note that as the number of households, *J*, becomes larger, the first component (the variance term) of the aggregate fluctuation converges to zero and only the second component (the covariance term) determines the fluctuation of aggregate return. This is intuitive. As more households are included in the risk-sharing economy, each household-specific idiosyncratic fluctuation contributes less and less to the aggregate fluctuation. In the limit, idiosyncratic risk is completely diversified away and only covariate risk remains. This covariate risk is the non-diversifiable risk of the economy.

2.2.1 A Planning Problem for the Determination of Pareto Optimal Allocation of Risk

To determine an efficient allocation of assets across households and activities, we consider the social planning problem of maximizing a Pareto weighted sum of expected utilities subject to resource constraints. At the beginning of each period, each household *j* starts with an initial asset that consists of two components. The first component is the assets held from the previous period from all production activities, $\sum_{i=1}^{I}k_j^i$. The second component is their returns (net of depreciation), $\sum_{i=1}^{I}r_j^i k_j^i$. The household invests part of this initial wealth in terms of assets carried to the next period. The households may also pay or receive gifts and transfers to other households, as in a risk-sharing syndicate. For this social planning problem, the planner retains full control over the projects, assigns them to households, and chooses the assets to be allocated to each activity run by each household in the following period, $k_j^{i\prime}$, as well as the current gifts and transfers to each household *j*, the net τ_j.[9] Effectively, the planner determines the current period consumption for each household *j*,

$$c_j=\left(1+r_j\right)k_j-k_j{}'+\tau_j=\sum_{i=1}^{I}\left(1+r_j^i\right)k_j^i-\sum_{i=1}^{I}k_j^{i\prime}+\tau_j.$$

[9] In theory, one could interpret these gifts and transfers received or given by the household as the net difference from transactions in Arrow contingent securities purchased in advance and paid off in future states. Alternatively, we may assume that households fully commit to a date- and state-invariant risk-sharing rule that maps aggregate resources into a consumption allocation across the households. Knowing that this risk-sharing rule is locked in for the future, households choose, on their own, today which projects to undertake. The sharing rule can depend on Pareto weights and the functional form depends on particular utility functions assumed. This rule has been essentially estimated from the consumption data as in the literature on optimal risk sharing cited earlier.

The value function of the social planning problem at the weights λ_j, j = 1, 2,.. J, is

$$V(W;\Lambda) = \max_{k_j^{i\prime},\tau_j}\left(\sum_{j=1}^{J}\lambda_j u_j\left(\sum_{i=1}^{I}(1+r_j^i)k_j^i - \sum_{i=1}^{I}k_j^{i\prime} + \tau_j\right) + \phi E\left[V(W';\Lambda)\right]\right)$$

subject to the aggregate resource constraint, i.e., aggregate consumption plus aggregate savings, in the form of next-period capital, equals wealth,

$$\sum_{j=1}^{J}c_j + \sum_{j=1}^{J}k_j' = W$$

$$\sum_{j=1}^{J}\sum_{i=1}^{I}(1+r_j^i)k_j^i + \sum_{j=1}^{J}\tau_j = W, \qquad (1)$$

and the non-negativity constraint of capital,

$$k_j^{i\prime} \geq 0,$$

where ϕ is the common preference discount factor; Λ is a time-invariant vector of the Pareto weights for the households, λ_j where j *=1, 2, .. J*; and $u_j(\cdot)$ is the period utility function of a risk-averse household j, which is strictly concave, continuously differentiable, and increasing without satiation. W denotes the aggregate wealth of the whole economy at the beginning of the current period.[10] In other words, as stated earlier,

$$W = \sum_{j=1}^{J}\sum_{i=1}^{I}(1+r_j^i)k_j^i. \qquad (2)$$

The value function can be rewritten as

$$V\left(\sum_{j=1}^{J}\sum_{i=1}^{I}(1+r_j^i)k_j^i;\Lambda\right) = \max_{k_j^{i\prime},\tau_j}\left(\sum_{j=1}^{J}\lambda_j u_j\left(\sum_{i=1}^{I}(1+r_j^i)k_j^i - \sum_{i=1}^{I}k_j^{i\prime} + \tau_j\right) + \phi E\left[V\left(\sum_{j=1}^{J}\sum_{i=1}^{I}(1+r_j^{i\prime})k_j^{i\prime};\Lambda\right)\right]\right)$$

[10] The way this setup is written, it appears that the economy is closed, where the aggregate asset is identical to aggregate wealth. The model can be easily extended and reinterpreted to allow external borrowing and lending, simply by subtracting any economy-wide debt, D, and interest from the previous period, and adding potential new borrowing (to be paid back next period). External borrowing can be negative, i.e., savings. Specifically, assuming that the external interest rate is r, the right-hand side of resource constraint (1) becomes $\tilde{W} = W - (1+r)D + D'$. We can also allow outside stocks and mutual funds. What is important here is that these assets and liabilities are external to the small open economy under consideration and we take whatever they are as given, not included in our analysis of efficiency, the sub program here.

subject to the aggregate resource constraint such that the aggregate wealth *W* in equation (2) is substituted into the right-hand side of equation (1), which implies that the net transfers must sum to zero in the aggregate economy,

$$\sum_{j=1}^{J}\tau_j = 0. \tag{3}$$

The solutions to this planning problem for fixed Pareto weights correspond to Pareto optimal allocations, and all of the optima can be traced out as the Pareto weights are varied. For a given Λ, the first-order conditions are that

$$[\tau_j]: \lambda_j u_{jc}(c_j) = \mu \qquad \text{for all } j$$
$$[k_j^{i\prime}]: -\lambda_j u_{jc}(c) + \phi E\left[V_W(W')\left(1+r_j^{i\prime}\right)\right] \le 0 \qquad \text{for all } i \text{ and } j, \text{ with equality for } k_j^{i\prime} > 0, \tag{4}$$

where μ is the shadow price of consumption in the current period, the Lagrange multiplier on equation (3). Finally, for each $k_j^{i\prime} > 0,$ equation (4) implies

$$1 = \frac{\phi E\left[V_W(W')\left(1+r_j^{i\prime}\right)\right]}{\mu} = E\left[\frac{\phi V_W(W')}{\mu}\left(1+r_j^{i\prime}\right)\right] = E\left[m' R_j^{i\prime}\right], \tag{5}$$

where $R_j^{i\prime} = 1 + r_j^{i\prime}$ and m' is defined as

$$m' = \frac{\phi V_W(W')}{\mu}. \tag{6}$$

Equation (5) has some important properties. First, m', the stochastic discount factor or the intertemporal marginal rate of substitution, is common across households and across assets. The model also implies that equation (5) holds for each of the assets allocated to production activity *i* and run by household *j*, for any *i* and any *j*. This equation is equivalent to the pricing equation derived in the Consumption-based Capital Asset Pricing Model (CCAPM) in finance literature.[11] However, it is important to reiterate that although our empirical counterpart is similar to what has been derived in the CAPM literature, the transaction mechanism that delivers the predicted allocation outcomes is different. In asset pricing literature households (investors) trade their assets ex ante. Optimally allocated assets deliver the returns that the households in turn use to finance their consumption, ultimately maximizing their utility. Although asset reallocations are possible in this model, households do not necessarily trade their assets ex ante in some

[11] For the derivation of this equation from consumer-investor's maximization problem, see Lucas (1978), Hansen and Singleton (1983), and Cochrane (2001), for example.

markets. The rate of return on an asset is simply the real yield from holding it, namely net profits from it divided by capital invested.[12] Given asset holdings and given returns, transfers among households in the economy give an optimal consumption allocation, i.e., the consumption allocation under the full risk-sharing regime where the marginal rates of inter-temporal substitution are equalized across households. These inter-household transfers could be through formal securities. However, the actual mechanism is more realistically thought of as through informal financial markets or more as simply gifts within social networks. In fact, as was mentioned in the introduction, using the same data as in this paper, from the Townsend Thai Monthly Survey, Chiappori, Samphantharak, Schulhofer-Wohl, and Townsend (2013) find evidence of nearly complete risk sharing for households with relatives living in the same village and nearby villages, suggesting that gifts and insurance transfers among family-related households are providing something close to an allocation of securities in a complete market environment. Related, Samphantharak and Townsend (2010) find that membership in a kinship network reduces the effect of liquidity constraints on households' financing of fixed assets. Kinnan and Townsend (2011) show that active chains of transactions in gifts and loans, and kinship ties, are also important for households' ability to smooth investment and consumption, respectively, when tracing out links to external formal institutions.[13]

Second, due to the linear production technology, equation (5) also holds for any of the portfolios constructed by any combinations of the assets $k_j^{i\prime}$ for all *i* and all *j*. Specifically, if we consider a household as our unit of observation, equation (5) implies that $1 = E\left[m' R_j'\right]$, where R_j' is the weighted average return to the portfolio of the assets operated by household *j*, where the weights are the shares of each asset in household *j*'s portfolio, as defined earlier. This insight allows us to study the risk and return of a household's portfolio of assets instead of the risk and return of each individual asset. This implication is especially important in the empirical study where the classification of asset types and income streams is problematic, as one asset may be used in various production activities or various types of assets are used jointly in a certain production activity.[14]

[12] In the empirical section, net profits include capital gain (or loss) when assets were sold at higher (lower) prices than purchased, adjusted for depreciation. These transactions are however not common.

[13] Empirically, complete market environment in village economies could be achieved through a combination of various mechanisms. Households may buy and sell their assets, including livestock and crop storage inventories. They can also borrow or lend money formally through financial institutions or informally through village moneylenders, friends, or relatives. Gifts among social networks and transfers from governments are also common. The studies that look at these mechanisms include Rosenzweig (1988), Rosenzweig and Wolpin (1993), Fafchamps, Udry, and Czukas (1998), Lim and Townsend (1998), and Jack and Suri (2011). We do not focus on these various mechanisms in this paper, but see Samphantharak and Townsend (2010) for quantification. The risk sharing implications of networks have also been studied in other economies. For example, using data from the randomized evaluation of *PROGRESA* program in Mexico, Angelucci, De Giorgi, and Rasul (2011) find that members of an extended family share risk with each other but not with households without relatives in the village. They also find that connected households achieve almost perfect insurance against idiosyncratic risk.

[14] For detailed discussions on this measurement issue, see Samphantharak and Townsend (2010 and 2012).

Third, the Pareto weights λ_j, j = 1, 2,… , J, are implicit parameters in equations (5) and (6) as they are arguments in the value function. Intuitively, marginal rates of substitution are common across households in any particular optimum but can vary across the many optima, as if moving along a contract curve. Our general analysis only requires that the risk sharing community be at a social optimum, not at any particular optimal allocation per se. However, when preferences aggregate in a Gorman sense, then the Pareto weights can be dropped from the analysis and it is as if a social planner were a "stand-in representative consumer" allocating assets among its various "selves". In this case, the marginal rates of substitution are the same across all optima.

Fourth, since $E\left[m' R_j^{i\prime}\right] = E\left[m'\right] E\left[R_j^{i\prime}\right] + \operatorname{cov}\left(m', R_j^{i\prime}\right)$, equation (5) can be rewritten as

$$
\begin{aligned}
1 &= E\left[m'\right] E\left[R_j^{i\prime}\right] + \operatorname{cov}\left(m', R_j^{i\prime}\right) \\
E\left[R_j^{i\prime}\right] &= \frac{1}{E\left[m'\right]} - \frac{\operatorname{cov}\left(m', R_j^{i\prime}\right)}{\operatorname{var}\left(m'\right)} \frac{\operatorname{var}\left(m'\right)}{E\left[m'\right]} \qquad (7) \\
E\left[R_j^{i\prime}\right] &= \gamma' + \beta_{m',ij} \psi_{m'}
\end{aligned}
$$

which implicitly defines the quantity and the price of aggregate nondiversifable risk. Specifically, $\beta_{m',ij} = -\dfrac{\operatorname{cov}\left(m', R_j^{i\prime}\right)}{\operatorname{var}\left(m'\right)}$ could be interpreted as the *quantity* of the risk of the assets used in activity i by household j that cannot be diversified, i.e., the risk implied by the comovement of the asset return and the aggregate return. Since this risk cannot be diversified away, even in the full risk-sharing environment, it must be compensated by a risk premium, which is a product of the quantity of risk and the *price* of the risk. The "price" of the risk is in turn equal to the common normalized non-diversifiable aggregate volatility of the economy, $\psi_{m'} = \dfrac{\operatorname{var}\left(m'\right)}{E\left[m'\right]}$. Finally, γ' is the risk-free rate or the rate of return on zero-beta assets since equation (7) implies $R_f{}' = \gamma' = \dfrac{1}{E\left[m'\right]}$ where $\operatorname{cov}\left(m', R_f{}'\right) = 0$.

Finally, the intuition behind this optimal allocation is straightforward. An optimal allocation of assets is a portfolio that delivers an aggregate consumption for the economy that maximizes the expected utility of the households in the economy. This optimal consumption allocation is stochastic, and its distribution is derived from the distribution of underlying assets in the optimal allocation. Since the households are risk averse, the optimal aggregate consumption represents a tradeoff between expected return and risk. In the full risk-sharing environment, idiosyncratic risks are diversified away, and this optimal aggregate consumption consists of only the aggregate nondiversifiable component. Note that some of the optimal asset holdings could be zero if they are not needed for the construction of the portfolio that delivers the optimal aggregate consumption. However, for all of the assets that are positively allocated, an optimal allocation implies that the stochastic intertemporal rates of substitution are equalized, i.e., the marginal utility from expected return, net of disutility from risk, from the next period is equal across these assets. Deviation from this condition implies that we can increase welfare by adjusting the asset allocation. This equalized intertemporal rate of substitution condition across assets means that the assets with lower expected return are held in this optimal portfolio because they are less risky than other assets. Since the only remaining risk in the full risk-sharing economy is the covariate risk, an optimal allocation implies the positive relationship between the expected return of the asset and its nondiversifiable risk as represented by beta.

2.2.2 Special Case: A Quadratic Value Function

We consider a special case where the value function of the social planning problem is quadratic in the total assets of the economy.[15] Specifically, we assume that

$$V(W) = -\frac{\eta}{2}\left(W - W^*\right)^2,$$

which implies that at W',

$$V_W(W') = -\eta\left(W' - W^*\right) = -\eta\left(\sum_{j=1}^{J}\sum_{i=1}^{I} R_j^{i\prime} k_j^{i\prime} - W^*\right) = -\eta\left(R_M{}' k_M{}' - W^*\right), \qquad (13)$$

where $k_M{}'$ is the total assets of the economy carried from the previous period and $R_M{}'$ is the return on assets of the aggregate economy, as defined earlier.

From equations (6) and (13),

$$m' = -\frac{\phi\eta\left(R_M{}' k_M{}' - W^*\right)}{\mu} = \frac{\phi\eta W^*}{\mu} - \frac{\phi\eta k_M{}'}{\mu} R_M{}',$$

Equally,

$$m' = a - bR_M{}', \qquad (14)$$

where *a* and *b* are implicitly defined.

[15] This special case is similar to what is assumed in Fama (1970). Note that common quadratic utility functions do Gorman aggregate and so we drop reference to Pareto weights.

Next, combining equation (14) with equation (7) derived earlier,

$$E\left[R_j^{i\prime}\right]=\gamma'-\frac{\operatorname{cov}\left(a-bR_M{}',R_j^{i\prime}\right)}{\operatorname{var}\left(a-bR_M{}'\right)}\frac{\operatorname{var}\left(a-bR_M{}'\right)}{E\left[a-bR_M{}'\right]}$$

$$E\left[R_j^{i\prime}\right]=\gamma'+\frac{\operatorname{cov}\left(R_M{}',R_j^{i\prime}\right)}{\operatorname{var}\left(R_M{}'\right)}\left(\frac{b\operatorname{var}\left(R_M{}'\right)}{a-bE\left[R_M{}'\right]}\right). \tag{15}$$

Finally, in this case,

$$E\left[R_j^{i\prime}\right]=\gamma'+\beta_{M,ij}\psi_M, \tag{16}$$

which is a linear relationship between the expected return of an asset, $E\left[R_j^{i\prime}\right]$, its nondiversifiable risk as measured by the comovement with the aggregate return, $\beta_{M,ij}=\frac{\operatorname{cov}\left(R_M{}',R_j^{i\prime}\right)}{\operatorname{var}\left(R_M{}'\right)}$, and the price of the nondiversifiable risk, $\psi_M=\frac{b\operatorname{var}\left(R_M{}'\right)}{a-bE\left[R_M{}'\right]}$. Note again that equation (16) holds for any assets or portfolios of assets, including the market portfolio, *M*, and the risk-free asset, *f*. Since $\beta_{M,M}=\frac{\operatorname{cov}\left(R_M{}',R_M{}'\right)}{\operatorname{var}\left(R_M{}'\right)}=1$ and $\beta_{M,f}=\frac{\operatorname{cov}\left(R_M{}',R_f{}'\right)}{\operatorname{var}\left(R_M{}'\right)}=0$, equation (16) also implies that $\gamma'=R_f{}'$ and $\psi_M=E\left[R_M{}'\right]-R_f{}'$. In other words, the price of the aggregate nondiversifiable risk is equal to the expected return on market portfolio in excess of the risk-free rate. This condition, presented in equation (16), is equivalent to the relationship between risk and expected return derived in the traditional Capital Asset Pricing Model (CAPM) in asset pricing literature. Finally, as discussed earlier, equation (16) also holds for any of the portfolios constructed by any combinations of the assets $k_j^{i\prime}$ for any *i* and any *j* because the production technologies are assumed to be linear in capital. In other words, for each household *j*, we have

$$E\left[R_j{}'\right]-R_f{}'=\beta_j\left(E\left[R_M{}'\right]-R_f{}'\right), \tag{17}$$

where R_j' is the return to household *j*'s portfolio and β_j is the beta for the return on household *j*'s assets with respect to the aggregate return,

$$\beta_j = \frac{\operatorname{cov}\left(R_M', R_j'\right)}{\operatorname{var}\left(R_M'\right)}. \tag{18}$$

2.3 An Autarky Benchmark

The second, opposite benchmark case is an economy where households are in financial autarky and there is no risk sharing across households. The underlying environment, in terms of preferences, technologies, and initial conditions, is the same as in the risk sharing benchmark. In particular, production technologies deliver returns that are still correlated across housholds and production actitivities. However, households absorb risk in isolation from the rest of the community so that net incoming (or outgoing) transfers, τ_j, are zero for all *j*. In this benchmark, the value function of each household *j* is

$$V\left(W_j\right) = \max_{k_j^{i\prime}}\left(u_j\left(\sum_{i=1}^{I}\left(1+r_j^i\right)k_j^i - \sum_{i=1}^{I}k_j^{i\prime}\right) + \phi E\left[V\left(W_j'\right)\right]\right)$$

subject to the household's resource constraint and the nonnegativity constraint of asset holding

$$\sum_{i=1}^{I}\left(1+r_j^i\right)k_j^i = W_j, \text{ and } k_j^{i\prime} \geq 0.$$

Operationally, the Euler equation for asset allocation is of the same form for all activities *i* in which household *j* chooses to hold and operate. In this environment, the stochastic discount factor is specific for household *j* and not equalized across all households in the economy. Since risk cannot be shared across households, the total fluctuation of the rate of return on asset for each household consists of both the household's idiosyncratic compoment and the comovement with aggregate return. Alternatively speaking, since there is no risk sharing, each household cannot differentiate its idiosyncratic and aggregate risk, and both components of fluctuation in the rate of return are viewed and treated identically by the household. Their contribution to a risk premium would be the same.

2.4 Empirical Implications

To sum up, the two benchmarks presented in this section have several empirically testable implications. First, the full-risk sharing benchmark predicts that higher exposure to aggregate risk is associated with higher expected return. Second, the full risk-sharing benchmark also implies that the risk premium from idiosyncratic risk should be zero. If the volatility is idiosyncratic it should be completely shared and diversified away and should not contribute to the remaining risk premium. Third, the autarky benchmark implies that households would not differentiate the idiosyncratic component and the aggregate component of the total fluctuation of the rate of return. In this case, the risk premium from both components should be proportional to the contribution of each component's contribution to the total fluctuation. The rest of the paper presents an empirical analysis of these predictions.

3. Data

This section presents the background of the Townsend Thai Monthly Survey, some descriptions of the village economies covered in the survey, and descriptive statistics of the sampled households, the assets they hold, and the returns on those assets.

3.1 The Townsend Thai Monthly Survey

The Townsend Thai Monthly Survey is an on-going intensive monthly survey initiated in 1998 in four provinces of Thailand. Chachoengsao and Lopburi are semi-urban provinces in a more developed central region near the capital city, Bangkok. Buriram and Srisaket provinces on the other hand are rural and located in the less developed northeastern region by the border of Cambodia. In each of the four provinces, the survey is conducted in four villages. The four villages from the same province in our sample are located close to each other in the same township, a sub-provincial administrative unit called *tambon* in Thailand. There are inter-marriages among households within and across villages. Gifts and transfers across these nearby villages are common. In the northeastern province of Srisaket, nucleated clusters of households in a village are readily recognized, but the villages in Buriram have been subsumed by a growing town. For Lopburi and Chachoengsao in the central region, there are no recognizable village boundaries. We therefore use a township as the benchmark for empirical analysis in this paper.[16] Finally, to preserve the anonymity of our sampled households, we use the province name when we refer to its corresponding township in this paper.

The monthly survey began with an initial village-wide census where every structure and every household was enumerated and the defined "household" units were created based on sleeping and eating patterns.[17] Approximately 45 households were then sampled from each village. The survey itself began in August 1998 with a baseline interview on initial

[16] Although townships are larger than villages or kinship networks, households in the same townships are still located close to each other geographically. The aggregated townships however have larger number of observations than the villages or kinship networks, giving us more degree of freedom in statistical analyses. As an extreme example, the number of households in many kinship networks could be very small (less than 10). Also, presenting four regression results in each set of the analyses for each of the 16 villages or several networks would be overwhelming and not effectively illustrative. For these reasons, we choose to present the results from most of the analysis using a township as the definition of the aggregate economy. We show some of the results using villages and networks as the aggregate economy in the appendix.

[17] Specifically, an individual is considered as a part of the household if he or she lived in the household structure for at least 15 days during the past month.

conditions of sampled households. The monthly updates started in September 1998 and tracked inputs, outputs, and changing conditions of the same households over time.[18] The analysis presented in this paper is based on 156 months, the entire sample available at the time we write this paper, starting from month 5. The 156 months were from January 1999 to December 2011. This 156-month period also coincided with calendar years (13 years), allowing us to compare our results with and make use of the macroeconomic data provided by other sources. We include in this study only the households that were presented in the survey throughout the 156 months. Since we compute our returns on assets from net income generated from cultivation, livestock, fish and shrimp farming, and non-agricultural business, we also include in this study only the households that generated income from farm and non-farm business activities for at least 10 months during the 156-month period (on average about one month per year). In other words, we drop the households whose income was mainly exclusively from wage earnings. In the end, there are 541 households in the sample: 129 from (the sampled township in) Chachoengsao and 140 from Lopburi provinces in the central region, and 131 from Buriram and 141 from Srisaket provinces in the northeast.

3.2 Kinship Networks

One of the salient features of the households in the Townsend Thai Monthly Survey is the pervasive kinship network with extended families. The survey gathered information on close familial relatives that are not a part of the defined household. For each household, the survey asked in the initial baseline questionnaire whether their relatives were still alive and lived within the village or township. The relatives covered in the questionnaire include parents and siblings of the household head, parents and siblings of the head's spouse, and sons and daughters of the head.

Table 1 presents summary statistics on networks for each township in our sample. When we use a narrow definition of network as having at least one relative living in the same village, the table shows that majority of households in the northeastern provinces of Buraram and Srisaket belonged to a kinship network. The percentage was slightly lower in Lopburi and much lower in Chachoengsao, but more than half of the households in both provinces were still considered in a network. More dramatically, when we use a township to define local kinship networks, almost all households in all of the four townships have at least one relative living in the same township. Similar to the earlier finding, the table shows that the network at the township level was higher for households in Buriram and Srisaket in the northeast and Lopburi in the central region, and lower for households in Chachoengsao.

[INSERT Table 1]

3.3 Production Technology

Households in the Townsend Thai Monthly Survey are diverse in terms of wealth and combination of different production activities. Table 2 shows the revenue (gross of cost

[18] For detailed description of the survey, see Chapter 3 of Samphantharak and Townsend (2010).

of production) of the occupations in the sample. The unit of observation is a township in each province. There are five main occupations in the survey: cultivation, livestock raising, fish and shrimp farming, non-farm business, and wage earning. The table shows that non-farm business is prominent in the township in Chachoengsao province. Cultivation (mainly from cash crops such as corn, sorghum, and sunflower) and livestock raising (diary cattle) are the main occupations in Lopburi. In the northeastern region, non-farm business (retail trade and services) and wage earning contribute a large part of provincial revenues in our sample although most households in the northeast are farmers (mainly rice).[19]

[INSERT Table 2]

Table 3 presents descriptive statistics of the households in our sample at the beginning of the survey (December 1998). The unit of observation is a household. Median household sizes were similar across the four townships (5 member per household in Srisaket and 4 members in the other three townships). The overall distributions, illustrated by the quartiles, also show similar ranking. The statistics show that gender seems to be balanced between the number of males and females in all of the townships. In terms of age profiles, most of male and female household members were in the range of 15-64 years old, i.e., of working age. We compute household average age for each household and then identify the median average age among households within the same township. The median of the average age was slightly higher in the central regions (36 years for Chachoengsao and 32 years for Lopburi) relative to Northeastern region (28 years for Buriram and 32 years for Srisaket). The maximum number of years of education across household members within a particular household was highest in Chachoengsao (9 years for the median household), followed by Srisaket (7 years). Households in Buriram and Lopburi had the lowest education attainment (6 years).

[INSERT Table 3]

Finally, households in the central area seemed to have larger amount of assets and wealth. The median households in the townships in Chachoengsao and Lopburi held total household assets of 1.1 million baht at the beginning of the 156-month period in January 1999.[20] The average nominal total assets over 156 months were 1.7 and 1.6 million for these two townships in the central region. Most of the assets were held in the form of fixed assets, which includes land, buildings, machines, and other fixed assets used in agricultural and non-agricultural production activities, as well as livestock. Other assets are inventories, deposits at financial institutions, informal lending, and cash. The two provinces in the northeast, on the other hand, had less than half of assets and wealth as

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[19] Again, the sample in this paper does not include the surveyed households whose almost entire income was from wage earnings in all of the 156 months, as mentioned earlier.

[20] The exchange rate of the Thai baht against the US dollar had fluctuated over the 156-month period covered in this paper (January 1999 - December 2011). The rate was approximately 36-37 baht per US dollar at the starting point of our data in January 1999. It fluctuated around 40-42 baht per US dollar during 2000-2005. Since 2006, Thai baht had appreciated against the US dollar and the exchange rate was around 31 baht per dollar in 2011. Given this fluctuation, we report in this paper only the values in local currency.

compared to the two townships in the central region. The median household in the townships in Buriram and Srisaket had only 0.57 and 0.39 million baht of initial total assets, and 0.74 and 0.58 million baht of average assets over the sample period, respectively. Again, this finding reflects the fact that the central region was relatively more prosperous. Since part of the household assets could be financed by debts, Table 3 also presents statistics for household liabilities and shows that only a small fraction of household assets were financed by debt. The median leverage ratios, i.e., the ratios of total liabilities to total assets, were only 2% in Chachoengsao and 9% in Srisaket. Finally, the monthly average income of households in the sample also shows similar patterns. The median households in the central region earn more than three times than those in the northeast (over 10 thousand for the two townships in the central region versus approximately three thousand for the northeast).

3.4 Rate of Return on Assets

In this paper we use a household as our unit of analysis and consider the return on household's total assets instead of the return on specific assets. In effect, we consider the total assets as an *asset portfolio* that is composed of multiple individual asset classes (including both financial and fixed assets), and apply the predictions from our framework to study the risk and return of this portfolio instead of those of individual assets. We do so for two reasons. First, it is empirically challenging to make a distinct separation between different types of assets. Although not impossible, it is difficult and a bit arbitrary to assign the percentage use of the assets for distinct activities. Second, imposing some additional assumptions on the data to disaggregate assets into subcategories would likely induce measurement errors that would cause biases in our empirical analysis.[21]

The rate of return on assets (ROA) is defined as household's accrued net income divided by household's average total assets over the period from which the income was generated. This is a conventional way that financial accounting measures performance of productive assets. As a consequence, however, we ignore the possible curvature in households' underlying production functions, and we do not attempt to estimate the production functions in this study, effectively assuming a linear technology where marginal and average returns are equal. Since we would like to get the real rate of return rather than the nominal rate, we use the real accrued net income and the real value of household's total assets in the ROA calculation. The real variables were computed using the monthly Consumer Price Index (CPI) at the regional level from the Bank of Thailand. Although we realize that the inflation in each township could be different from the regional rate, at the time of writing this paper we still do not have a reliable measure of

[21] For similar reasons, we do not distinguish well the use of assets for production activity versus consumption activity. This could lead to a downward bias of our estimates on return to assets, as some of the assets that we include in the calculation were not used in production activity. Samphantharak and Townsend (2012) provide an exercise that classifies total assets into subcategories based on additional assumptions on production and consumption of the households, and analyze the sensitivity of the rate of return.

the price index at the village or township level, and hence relying on the regional statistics.[22]

Simple calculation of ROA raises one obvious problem. In our data, a household's simple net income embeds the contributions from human capital while we are interested in the risks and returns to household's tangible assets. The simple ROA is therefore overestimated. As a remedy, we calculate the compensation to household labor and then subtract this labor compensation from the total household income. This compensation to household labor includes both the explicit wage earnings from external labor markets and the implicit shadow wage from labor spent on household's own production activities.[23]

[INSERT Table 4]

Table 4 presents descriptive statistics for household ROA, averaged over time, both unadjusted and adjusted for compensation to household labor. The table also summarizes the standard deviations and the coefficients of variation of the unadjusted and adjusted ROA by township. The results in Table 4 show that median of annualized average adjusted ROA was 0.38% for Chachoengsao and 1.46% for Lopburi in the central region, and 0.28% for Buriram, and 1.99% for Srisaket in the northeast.[24] The fluctuation of adjusted ROA as measured by both the standard deviation and the coefficient of variation shows that adjusted ROA for the township in Chachoengsao fluctuated the least among the four townships. Based on the standard deviation, adjusted ROA of the townships in Lopburi and Srisaket fluctuated the most, but the township in Buriram had the highest coefficient of variation. Finally, we assume that the real risk-free rate is zero for all of the periods and for all of the townships.[25]

4. Aggregate Risk and Return on Assets

4.1 Household Beta as a Measure of Nondiversifiable Risk

As our full risk-sharing benchmark delivers testable implications analogous to those from the traditional asset pricing model in the finance literature, we apply a traditional test in as in the CAPM literature to the benchmark. The test contains two stages. In the first stage, we compute the asset beta of each household's portfolio of assets to get

[22] In an earlier version of this paper, we also used alternative calculations of ROA in the analysis, namely, ROA computed only from fixed assets (i.e., excluding financial assets) and nominal ROA (i.e., not adjusted for inflation). The main conclusions do not change.

[23] See Townsend and Yamada (2008), Samphantharak and Townsend (2012), and Appendix A of this paper for detailed discussions on how to impute wages from non-market production activities.

[24] Excluding land and building structure from total assets, the median ROA is 1.27 for Chachoengsao and is 4.55 for Lopburi in the Central region, and 1.11 for Buriram and 4.23 for Srisaket in the Northeast.

[25] Note that in finance literature, the *Sharpe ratio* measures the expected excess return relative to the volatility of the return, where the excess return is the difference between the rate of return and the risk-free rate. In other words, the Shape ratio is an inverse of the coefficient of variation of the excess return on assets. Given our assumption on the risk-free rate being zero, the Sharpe ratio for the returns in this study is just the inverse of the coefficient of variation of ROA.

household's β_j for all household *j*. We define a township as the aggregate economy and use township average real returns on assets as aggregate return R'_M. These returns are computed as total net income in the township divided by the township's total assets (simple average between the beginning and the end of the month). To avoid the effect of each household *j*'s return on the township return, for each household *j*, we do not include the household's own net income and assets in the calculation of its corresponding township return, i.e., we compute a leave-out mean. As shown in equation (18), an asset beta of household *j* is defined as $\beta_j = \frac{\operatorname{cov}\left(R_M{}', R_j{}'\right)}{\operatorname{var}\left(R_M{}'\right)}$, which is the key ratio of moments we need. Operationally, it is identical and easily computed as a regression coefficient from a simple regression of $R'_{j,t}$ on $R'_{M,t}$. Specifically, the first stage, we compute β_j from a time-series regression

$$R'_{j,t} = \alpha_j + \beta_j R'_{M,t} + \varepsilon_{j,t}. \qquad (19)$$

In the second stage, we test the expected return and beta relationship derived earlier in equation (16). We first compute the expected rate of return on assets of household *j*, $E\left[R'_j\right]$. Empirically, this expected return is computed as a simple time-series average of monthly rates of return, $\overline{R'_j} = \frac{\sum_{t=1}^{T} R'_{j,t}}{T}$. Finally we run a cross-sectional regression of household's average asset return on its beta estimated earlier in equation (19) across all households in each township at a time.

$$\overline{R'_j} = \alpha + \psi \widehat{\beta}_j + \eta_j. \qquad (20)$$

With the assumption that the real rate of return on risk-free assets is equal to zero, the null hypotheses from equation (20) are that (1) $\psi = E\left[R'_M\right]$ and (2) the constant term α is zero.

4.2 Empirical Results

We present in Panel A of Table 5 the regressions using township as our definition of aggregate economy and using all 156 months in our sample at once. The results show that the regression coefficient of household beta is positive for all of the regressions except for the township in Buriram. We then look at a stronger null hypothesis that $\psi = E\left[R'_M\right]$ comparing the magnitude of the estimated regression coefficient $\widehat{\psi}$ with the township expected return, estimated by the time-series average $\overline{R'_M} = \frac{\sum_{t=1}^{T} R'_{M,t}}{T}$. The table also provides each township's aggregate expected return. For the two townships in the central region (Chachoengsao and Lopburi), the regression coefficients are statistically indifferent from the township average return (at 10% level of significant), consistent with the prediction from our model. However, the coefficients are different from the township average return for the township in Srisaket. The zero constant implication is also satisfied.

[INSERT Table 5 and Figure 1]

To illustrate our results graphically, Figure 1 plots the beta of household *j* on the horizontal axis against the expected return on household *j*'s asset on the vertical axis for each of the four townships analyzed in this study. In general, the figures show a positive relationship between household beta and its expected return. Overall, the results in this section suggest that a major implication of the model captures a substantial part of the data. In particular, higher risk, as measured by the co-movement of household ROA and township ROA, is associated with higher average return. The positive ψ implication from the model is pervasive in the data at various levels of aggregation. The more stringent test of $\psi = \overline{R'_M}$ is more difficult to satisfy.[26]

4.3 Critiques and Extensions

There are issues related to the empirical findings in the previous section. We list some of them and explore possible extensions of the analysis to address some these issues here.

4.3.1 Measurement Errors

The positive relationship between beta and expected (or mean) return could be driven by measurement errors if the measurement errors of household ROA are positively correlated with the measurement errors of aggregate ROA. This is of course possible in our data since survey data are in general vulnerable to measurement errors. We attempt to minimize possible measurement errors in various ways. First, we use the household portfolio as our unit of observation when we compute household beta. Since the value of and income from the household portfolio are better defined and easier to measure than those of individual assets, using portfolios likely deliver household betas that are less affected by measurement errors than individual asset betas.[27] Second, when we compute the market ROA for each household in the first-stage time-series regressions, we exclude the household itself from the calculation. One could still argue that the problem may remain if the measurement errors of the household are correlated with the measurement errors of other households in the township. For example, if we use the same village-wide price of rice to calculate the revenue (hence income and ROA) of all of the households in the village, measurement errors in the price will lead to a positive correlation between

[26] One may argue that kinship networks are local and operate better at the village or network levels than at the township level. We present a similar analysis at the village and network levels in the appendix. The over conclusions remain for most of the villages and networks.
[27] Empirically, this argument is similar to Black, Jensen, and Scholes (1972) who introduced the idea to use portfolios of assets rather than individual assets in the empirical CAPM literature.

household ROA and village (and consequently township) ROA. In our sample, however, the common village-wide prices are used only for the calculation of revenue from rice (or some other agricultural outputs). For other production activities, we use direct answers on revenue from those production activities to compute household ROA. Since our empirical results are robust for townships, villages, and networks with and without major revenues from cultivation, we do not think that this problem is a source of the measured correlation.

4.3.2 Change in Household Composition of Assets and Production Activities

Similar to the traditional CAPM in the finance literature, our empirical strategy assumes that household betas are time-invariant. This assumption allows us to estimate household betas from time-series regressions. In reality, household betas could be time-varying. Our sample consists of households engaged in multiple occupations over the period of 13 years. It is likely that the composition of household occupations (and hence assets and their associated risks) of some of our sampled households had changed during this period. Similarly, the expected aggregate returns $E\left[R_M'\right]$ could change over time as well, not least from changes in conditioning factors.

We explore this issue by conducting our empirical analysis, similar to what presented in Section 4, on the subsamples of 60 months (5 years) at a time. Specifically, we first estimate household's β_j and expected return using the time-series data from month 5 to month 64 (years 1-5) for all households. We then perform a similar exercise using the time-series data from month 17 to month 76 (years 2-6), and so on until the five-year window ends in month 160 (years 9-13). With all of the estimated $\widehat{\beta_{j,t}}$ and expected return from all of the 9 subperiods *t* for all households *j*, we finally estimate equation (20) using the pooled household-subperiod data.[28] Panel B of Table 5 presents the second-stage regression results. The table shows that the main prediction of our model still holds for most of the subsample, i.e. higher beta is associated with higher expected (average) return. Note that allowing for time-varying risk (beta), the prediction from the model is also satisfied for Buriram. However, the null hypothesis that the constant term is equal to risk-free rate (assumed to be zero in this paper) is rejected in all of the four provinces.

4.3.3 Aggregate Human Capital

The model presented earlier in this paper implies that a household's beta captures all of the aggregate, non-diversifiable risk faced by the household. It is possible that there is omitted variable bias in the estimation of beta if the average return on township total assets is not the only determinant of the aggregate risk. Aggregate wealth, *W*, in the economy-wide resource constraint (2) likely comes from other assets in addition to tangible capital held by the households in the economy. As discussed in Section 3.2 and shown in Table 2, labor income contributes a large share of household income in our

[28] Again, this empirical strategy is similar to the empirical CAPM literature by Black, Jensen, and Scholes (1972). The difference is that instead of moving the window month by month, we move the window 12 months (1 year) at a time.

sample, even after eliminating households with all income as labor income. Omitting human capital from the resource constraint implies that the economy-wide average return on physical assets (both financial and non-financial) might not capture the aggregate non-diversifiable risk of the economy. We address this issue by computing an additional household beta with respect to return to aggregate human capital, proxied by the change in aggregate labor income of all households in the economy.[29] In particular, the first-stage time-series regression becomes

$$R'_{j,t} = \alpha_j + \beta^a_j R^a_{M,t}{}' + \beta^h_j R^h_{M,t}{}' + \varepsilon_{j,t}$$

where $R^a_{M,t}{}'$ represents the return to aggregate physical (non-human) asset and $R^h_{M,t}{}'$ is the return to aggregate human capital. The second-stage cross-sectional regression is

$$\overline{R'_j} = \alpha + \psi^a \widehat{\beta^a_j} + \psi^h \widehat{\beta^h_j} + \eta_j .$$

[INSERT Table 6]

We then extend our previous empirical analysis to include human capital. The first four columns of Table 6 show that the regression coefficient of beta with respect to human capital is not statistically significant in our sample, except for Srisaket. However, after controlling for the township return to human capital, the regression coefficients of beta with respect to total tangible capital (financial, inventory, and fixed assets) remain positively significant in all of the four townships.

4.3.4 Time-Varying Stochastic Discount Factor

Similar to the traditional CAPM in finance literature, our full risk-sharing benchmark assumes that parameters that determine stochastic discount factors are time-invariant when we take the benchmark to the empirical analysis. For example, the stochastic discount factor, m', in equation (9) is assumed to depend on the time-invariant parameters *a* and *b*. However, parameters *a* and *b* are in theory determined by the shadow price of consumption goods, μ, which likely moves over time as the aggregate consumption of the economy changes. In order to capture this time-varying stochastic discount factor, we follow a strategy introduced by Lettau and Ludvigson (2001a and 2001b) who show that the parameters *a* and *b* are the functions of consumption-wealth

[29] This strategy is used in finance literature by Jagannathan and Wang (1996). Their strategy is based on a simplified *ad hoc* assumption that labor income, *L*, follows an autoregressive process $L_t = (1+g)L_{t-1} + \varepsilon_t$. Therefore, human capital, *H*, defined as the discounted present value of the labor income stream, is approximated by $H_t = \frac{L_t}{r-g}$, where *r* is the discount rate on human capital and both *r* and *g* are taken as constants. In this case, the rate of change in human capital can be proxied by the rate of change in labor income.

ratio.[30] The log consumption-wealth ratio, *cay*, in turn depends on three observable variables, namely log consumption, *c*; log physical (non-human) wealth, *a*; and log labor earnings, *y*.

$$cay_t = c_t - w_t = c_t - \omega a_t - (1-\omega) y_t,$$

where ω is the share of physical wealth in total wealth.

Since we do not observe the share of non-human wealth, ω, we cannot directly compute the log consumption to wealth ratio, cay_t. Instead, we follow Lettau and Ludvigson (2001a) and obtain the value of cay_t from

$$\widehat{cay}_t = c_t^* - \widehat{\omega} a_t^* - \hat{\theta} y_t^* - \hat{\delta},$$

where the starred variables are the observed quantities from our data and the hatted values are the estimated coefficients from the township time-series regression

$$c_t^* = \delta + \omega a_t^* + \theta y_t^* + \varepsilon_t.$$

Next, in the second stage, for each household, we compute five beta's with respect to: (1) the aggregate return on physical capital, $R_{M,t}^{a}{}'$; (2) the aggregate return on human capital (as computed in the previous subsection), $R_{M,t}^{h}{}'$; (3) the predicted value of $\widehat{cay}_t$ computed in the first stage; (4) the interaction between $R_{M,t}^{a}{}'$ and $\widehat{cay}_t$; and (5) the interaction between $R_{M,t}^{h}{}'$ and $\widehat{cay}_t$.

$$R'_{j,t} = \alpha_j + \beta_j^a R_{M,t}^{a}{}' + \beta_j^h R_{M,t}^{h}{}' + \beta_j^{cay} \widehat{cay}_t + \beta_j^{cay*a} \left(\widehat{cay}_t * R_{M,t}^{a}\right)' + \beta_j^{cay*h} \left(\widehat{cay}_t * R_{M,t}^{h}{}'\right) + \varepsilon_{j,t} \quad (21)$$

Finally, in the final stage we follow Lettau and Ludvigson (2001b) and run a cross-sectional regression of household's expected return (as computed by a time-series average of household ROA) on the five beta's computed in the second stage.

$$\overline{R'_j} = \alpha + \psi^a \widehat{\beta_j^a} + \psi^h \widehat{\beta_j^h} + \psi^{cay} \widehat{\beta_j^{cay}} + \psi^{cay*a} \widehat{\beta_j^{cay*a}} + \psi^{cay*h} \widehat{\beta_j^{cay*h}} + \eta_j. \quad (22)$$

[30] To show that the consumption-wealth ratio summarizes the expectation of future returns, Lettau and Ludvigson (2001a) start from the resource constraint in period *t* analogous to equation (1) in Section 2 of this paper, $W_{t+1} = (1 + r_{M,t+1})(W_t - C_t)$, where W_t, C_t, and $r_{M,t+1}$ are wealth, consumption, and market rate of return in period *t*. Following Campbell and Mankiw (1989), the log-linear approximation of this constraint yields $c_t - w_t \approx E_t \sum_{s=1}^{\infty} \rho_w^s (r_{M,t+s} - \Delta c_{t+s}),$ where $\rho_w = \frac{W-C}{W}$ or the steady-state investment to wealth ratio.

The results are shown in the last four columns of Table 6. First, now the coefficient for human capital beta becomes positive and significant for two out of the four townships (Lopburi and Srisaket). The coefficient for $\widehat{cay}_t$ is also positively significant for the two townships in the northeast. However, the coefficient for the interaction terms are either not significant or have a wrong sign. Overall, with the additional factors, the regression coefficient of market non-human physical assets, the main variable from our model, remains positively significant for all of the four townships.[31]

5. Idiosyncratic Risk and Return on Assets

Our empirical work thus far has abstracted from the presence of idiosyncratic risk and focused on the implications from the full risk-sharing benchmark. However, there are reasons why idiosyncratic risk may matter. Despite several mechanisms described earlier (purchase and sale of inventories, livestock or fixed assets; borrowing and lending with formal and informal financial institutions; gifts among relatives and friends; and transfers from government), there can be several obstacles that prevent the village economies from achieving complete market outcomes, including full risk sharing. These obstructions include limited commitment, moral hazard, and hidden income, for example.[32] With any of departures from complete risk sharing, the expect return on assets may contain a risk premium that compensates for the exposure to these idiosyncratic risks.[33]

We follow Fama and Macbeth (1973) and compute idiosyncratic risks from the standard deviation of the residuals from each of the household's time-series regressions in the first step, i.e. the residuals from equation (21). This strategy is consistent with the decomposition of total risk, as measured by the variance of the return on assets, into aggregate (nondiversifiable) and idiosyncratic (diversifiable) components.[34]

Since equation (21) could be rewritten in a matrix form as $R'_{j,t} = X'_{M,t}\beta_j + \varepsilon_{j,t}$, we have

[31] Although the results are not reported here, we also perform similar analyses using alternative estimation methods. Specifically, we compute standard error of the second-stage regressions using bootstrapping. We also use Fama-Macbeth (1973) procedure to correct for possible correlation across the residuals in equation (22). The overall conclusions remain robust.

[32] For examples, see Kocherlakota (1996) for limited commitment, Attanasio and Pavoni (2009) for moral hazard, Thomas and Worrall (1990) for hidden income, and Karaivanov and Townsend (2011) for moral hazard, limited commitment and unobservable investment. Kinnan (2010) provides an empirical analysis of the first order conditions of three types of models.

[33] In finance literature, Merton (1987) and Malkiel and Xu (2002) show that under-diversified investors demand a return compensation for bearing idiosyncratic risk. Using the exponential GARCH models to estimate expected idiosyncratic volatilities, Fu (2009) finds a significantly positive relation between the estimated conditional idiosyncratic volatilities and expected returns.

[34] In empirical finance literature, monthly idiosyncratic risks are usually computed from the volatility of the return using daily returns during the month (or their lags).[34] Since our data is monthly, we cannot apply this strategy to our model. In addition to Fama and MacBeth (1973), a recent study by Calvet, Campbell, and Sodini (2007) also uses the same risk decomposition strategy as the one in this paper.

$$\mathrm{var}\left(R_j'\right) = E\left[\beta_j'\Omega_M\beta_j\right] + \mathrm{var}\left(\varepsilon_j\right), \tag{23}$$

where Ω_M is the variance-covariance matrix of the aggregate variables in equation (21). The first term of the right hand side of equation (23) is therefore the aggregate risk while the second term is the variance of the residual. We consider this variance of the residual, σ_j^2, henceforth simply referred as household sigma*,* as our measure of idiosyncratic risks as it summarizes the volatility of the returns that are not captured by aggregate factors such as aggregate returns on human and non-human assets, consumption-wealth ratio of the aggregate economy, and their interaction terms.

[INSERT Table 7]

Panel A of Table 7 presents the decomposition of the total risk faced by the households in our sample, based on equation (23), using beta's estimated earlier from equation (21). The table shows that a large part of the volatility of the return to household assets comes from the idiosyncratic component, in all four townships. This however is not inconsistent with the model, which allows for idiosyncratic risks in the technologies. Our full risk-sharing benchmark does predict however that idiosyncratic risk should not affect the expected return on assets, despite their large contribution to the total risk faced by the households. This is because in an economy with full risk-sharing, idiosyncratic risk is completely diversified away and do not need compensation. In other words, the idiosyncratic risk premium is zero in such environment.

In order to test this hypothesis, we add household sigma computed from regression (21), $\widehat{\sigma_j^2}$, as an additional explanatory variable to equation (22).

$$\overline{R_j'} = \alpha + \psi^a \widehat{\beta_j^a} + \psi^h \widehat{\beta_j^h} + \psi^{cay} \widehat{\beta_j^{cay}} + \psi^{cay*a} \widehat{\beta_j^{cay*a}} + \psi^{cay*h} \widehat{\beta_j^{cay*h}} + \psi^{\sigma} \widehat{\sigma_j^2} + \eta_j. \tag{24}$$

The results in Table 8 show that higher idiosyncratic risks as measured by household sigma are associated with higher average returns in all of the four townships. However, the coefficients for beta with respect to the market return on physical assets still remain positively significant in three of the townships, with Buriram as the only exception. The finding in Table 8 suggests that it is possible that these economies may not have a complete market environment and idiosyncratic risks are not fully diversified and are therefore compensated accordingly.

[INSERT Table 8]

6. Comparing Aggregate and Idiosyncratic Risk Premium

It is important to note that, although aggregate and idiosyncratic risks are both positively correlated with higher expected return, the *prices* of these two types of risks, that is, their contribution to risk premia, could be different. Thus to investigate whether aggregate and idiosyncratic risks are priced differently, we compute risk premia from aggregate and idiosyncratic risks from the regression presented in Table 8. The risk premia on the right hand side of equation (24), which show up in the expected return on the left hand side of the equation are computed as:

$$\text{Aggregate Risk Premium} = \widehat{\psi^{a}}\widehat{\beta_j^{a}} + \widehat{\psi^{h}}\widehat{\beta_j^{h}} + \widehat{\psi^{cay}}\widehat{\beta_j^{cay}} + \widehat{\psi^{cay*a}}\widehat{\beta_j^{cay*a}} + \widehat{\psi^{cay*h}}\widehat{\beta_j^{cay*h}} \quad (25)$$

$$\text{Idiosyncratic Risk Premium} = \widehat{\psi^{\sigma}}\widehat{\sigma_j^{2}}. \quad (26)$$

Again, in theory the full risk-sharing benchmark presented earlier in this paper implies that the risk premium from idiosyncratic risk should be zero, no matter how volatile is the rate of return. If the volatility is idiosyncratic it should be completely shared and diversified away and should not contribute to the remaining risk premium. In contrast, the autarky benchmark suggests that households would not differentiate the idiosyncratic component and the aggregate component of the total fluctuation of the rate of return. In this case, the risk premium from both components should be proportional to the contribution of each component's contribution to the total fluctuation. Empirically, Panel B of Table 8 presents the decomposition of total risk premium (the sum of the aggregate risk premium and idiosyncratic risk premium). The result shows that, with the exception of Buriram, the contribution of idiosyncratic risk premium to the total risk premium is lower than the contribution of idiosyncratic risk to the total risk (as discussed earlier in Panel A). Specifically, although idiosyncratic risk accounts for 86.5% and 89.1% the total risk of median households in Chachoengsao and Lopburi, it contributes to only 23.6% and 52.9% of the total risk premium. Likewise, for the median household in Srisaket, idiosyncratic risk accounts for 57.2% of total risk while its premium contributes for only 16.7% of the total risk premium. We also perform a nonparametric statistical test for the difference in medians and find that the median percentage contribution of idiosyncratic risk to the total risk is statistically different from the median percentage contribution of idiosyncratic risk premium to the total risk premium at 1% level of significance in all provinces except for Buriram. The pattern for lower and upper quartiles is also similar to the median (findings not shown in the table).[35]

In sum, from the first and the second moments of return distribution, idiosyncratic risk seems to be shared considerably across households in each of these three townships. However, risk sharing is not complete, and the remaining idiosyncratic risk is compensated in the form of positive risk premium. Idiosyncratic risk does not contribute to the risk premium in asset returns in the same (larger) way that aggregate nondiversifiable risk does. One of the important policy implications from this finding is that we cannot identically treat aggregate and idiosyncratic risks when we analyze risks and returns of household enterprises in developing economies. A household with high

[35] There is, however, another possible explanation. If there are other aggregate factors that matter for the mean and the variation of asset returns and they are not included in equation (21), these omitted variables would lead to a positive correlation between average return on the left hand side and the residuals on the right hand side, producing positive coefficients of sigma in Table 8. In such cases, the contribution of idiosyncratic risk premium presented in Table 7 would be overestimated. However, this bias would work against us: the contribution from idiosyncratic risk to the total risk premium is still relatively small.

total risk (high variance) may have lower risk premium than another household if the higher risk is idiosyncratic and diversifiable. Likewise, a household with low total risk (low variance) could require a higher risk premium if most of the risk is covariate and nondiversifiable. The point of course is that the model presented in this paper distinguishes these two types of risks and allows us to compute risk premium for each risk separately.

To illustrate this point, let's consider household A and household B from Lopburi province in our sample. During the period of this study, household A's main occupation was livestock while household B grew beans and sunflowers. Compared to household B, household A's return on assets fluctuated far more. The variance of the rate of return on assets for household A was 1.23 times higher than the variance of household B's return. The coefficient of variation was even higher at 2.72 times. However, 99% of the variance of the rate of return on household A's assets was from the idiosyncratic component while in contrast idiosyncratic risk contributed to only 63% for household B. Consequently, we find that the risk premium for household A was only 0.008 (annualized) percentage point while it was 1.394 for household B, that is, higher, despite household B's less volatile return. With our model, the explanation is intuitive. Most of the fluctuation of household A's returns was diversified and did not need compensation. On the contrary, a large part of household B's (smaller) fluctuation could not be diversified and therefore was compensated in the form of higher risk premium.

7. Risk-Adjusted Return

In development economics, rates of return on assets and equity are usually used as a measure of performance or productivity of a firm or a household enterprise.[36] These returns to assets and equity however do not take into account that different household enterprises are involved in different risks and higher expected returns could result from compensation for the higher risk. A comparison of household C and household D from our sample illustrates this argument. Both households lived in Srisaket province. The main occupation of both households was cultivation although they grew different crops. Household C's main crop was rice while household D grew cassava. During the period of our study, the average annualized monthly real rate of return on assets for household C was 9.06% while the average rate for household D was at 3.93%, i.e., less than half of the rate for household C. However, looking closely, our analysis shows that household C's higher return was largely due to the higher risk and the types of risk it face. First, household C was engaged in production activity whose return fluctuated more than household D. In particular, the variance of the rate of return for household C was 2.26 times higher than that of household D. Second, while 70% of the total risk faced by household C was idiosyncratic and could be (partially) diversified away, this diversifiable

[36] The estimates of return on assets in development economics literature are computed by various methods. For example, Pawasuttipaisit and Townsend (2010) use the rates of return from financial accounts similar to this paper. De Mel, McKenzie, and Woodruff (2008) estimate their rates of return from randomized field experiments. Udry and Anagol (2006) compute their rates of return from production function estimation. However, these measures of returns are generally not adjusted for risk premium.

risk component accounted for a greater percentage, 89%, for household D. As a result, the risk premium of household C was as high as 8.25 percentage points while it was only 1.11 percentage points for household D. In other words, household C's higher average return was mainly the compensation for higher risk exposure that the household faced, both in terms the total and in terms of a greater share of aggregate nondiversifiable risk that was not fully shared. In the end, household C actually had the lower risk adjusted return at 0.81% relative to household D at 2.82%.

7.1 Household Alpha as a Measure of Risk-Adjusted Return

The framework in Section 2 gives us the null hypothesis that the constant term α_j in equation (22) for the portfolio of assets operated by household *j* be zero for each of the time-series regressions at the household level. Only the exposure of the portfolio of household assets to aggregate risk, or the household beta β_j, should determine the excess return of the assets. In reality, however, α_j is not necessarily zero as there are several factors that make the excess return of the asset higher than what is predicted by the model. Indeed, in the conventional CAPM context, Jensen (1967) argues that α_j could be interpreted as the abnormal or risk-adjusted return of an asset. In fact, financial practitioners use Jensen's *alpha* as a measure of performance of an asset or a fund manager. We follow this tradition, thinking of α_j as how well household *j* manages its assets in generating income in excess of risk premium. We compute alpha for each household and then use it as our measure of the risk-adjusted rate of return on household enterprise in the Townsend Thai Monthly Survey.[37]

7.2 Empirical Results

Table 9 presents summary statistics for the returns on assets that are not adjusted for any risk (Panel A) and two measures of risk-adjusted returns, using township as the aggregate economy: The first one (Panel B) is adjusted for aggregate risks based on equation (25). The second one (Panel C) is further adjusted for idiosyncratic risks, in addition to aggregate risks, based on equation (26), using empirical results reported in Table 8.

[INSERT Table 9]

The results show that we cannot statistically reject that the rank orders of risk-adjusted and unadjusted ROA's are not different. However, the distributions of the rate of return do change when we adjust for risks, as evident from the differences in the skewness and the kurtosis of the returns. These findings are illustrated in Figure 2, which shows the histograms comparing the return on assets that is not adjusted for risks with the return adjusted for both aggregate and idiosyncratic. Though risk adjusted returns are shifted to the left, the modes received high mass consistently in the risk-adjusted returns. Further in

[37] It is important to note, however, that a non-zero risk-adjusted returns cannot be explained by our model, as one of the main predictions from the benchmark model is that once adjusted for risks, the expected return should be equal to the risk-free rate and independent of any other observables.

two provinces the adjusted returns have more mass in the left tail, and in the other two provinces, in the right tail.

[INSERT Figure 2]

8. Household Characteristics and Risk Exposure

Empirical results in the previous sections show that idiosyncratic risk accounts for a large share of the total risk faced by household business enterprises in our sample although there is still nontrivial aggregate risk. Also, unlike the full risk sharing benchmark, we find that idiosyncratic risk does influence the risk premium of asset returns. We also learn that households in our sample are diverse, and exposure to aggregate and idiosyncratic risks is different across households. This finding is illustrated in Figure 3, which presents a scatter plot between aggregate risk premium and idiosyncratic risk premium.

[INSERT Figure 3]

As can be seen from Figure 3, some households in our sample were exposed to both high aggregate and idiosyncratic risks (those in the upper-right corner) while many faced little of both risks (those in the lower-left corner). Still, there are a large number of households that were mainly exposed to one type of risk, but not the other (those in the upper-left and in the lower-right corners). In this section, we explore this heterogeneity of risk exposure across households.[38]

Specifically, we study whether household rates of return are correlated with observable household characteristics such as demography, initial wealth, and initial leverage. Table 10 presents the results when we use four measures of return on assets as the dependent variable. Table 10 shows as well as the two measures of risks, namely household beta (with respect to the market return on physical assets) and household sigma. The risks and risk-adjusted returns are computed from regression results presented earlier in Table 8.

[INSERT Table 10]

The first two columns of Table 10 highlight the heterogeneity in risk exposure of households in our sample. Households with a younger head and poorer households (lower initial wealth) tend to get involved with more risky activities, both aggregate and idiosyncratic, and therefore are compensated for higher average returns. In contrast, household with older head and households with higher initial wealth have less risky production activities, again, both aggregate and idiosyncratic, hence resulting in lower

[38] Figure 3 also presents two salient findings from our sample. First, there is a positive correlation between aggregate risk premium and idiosyncratic risk premium (the correlation coefficient is 0.49 and statistically significant at 1%). Second, there is a large portion of our sampled households with low risk (those near the origin in Figure 3). The majority of risk faced by households in our sample is idiosyncratic so the aggregate risk component is relatively small, hence a lower aggregate risk premium. In particular, there is variation in aggregate risk premium while the idiosyncratic part is near zero. This produces a cluster of points on the x-axis.

risk premia. The last two columns also show that household heads with lower education and households with male head tend to have production activities that have higher aggregate risks. Finally, households with higher initial leverage tend to have more to idiosyncratic risk.

With different risk exposures, various types of households have different risk-adjusted rates of return on assets of households. To illustrate, we start with Columns 3 and 4, where we consider just a simple accounting rate of return without and with adjustment for household's own labor, respectively. First, the result in Column 3 shows that age of the household head, education of household head, and initial wealth are negatively associated with the simple accounting definition the rate of return, not adjusted for household labor and risks. However, once we adjust for household labor, the magnitude of the regression coefficient for education of household head drops, although still statistically negatively significant, as shown in Column 4. Both age of household head and initial wealth are no longer statistically correlated with the rate of return.[39]

To take into account of heterogeneity in risk exposure that we discuss earlier in the first two columns, we begin to further adjust for aggregate risk only. The result in Column 5 shows that, after adjusting for aggregate risks, only the education of household head still matters but it becomes statistically weaker. Finally, when idiosyncratic risks are used for adjustment, Column 6 shows that the return on asset is negatively associated with the household size and positively correlated with initial wealth. Specifically, larger households tend to have lower risk-adjusted returns while household with higher initial wealth seemed to have higher risk-adjusted return.

Though beyond the theory here, the result shows how easily one could misinterpret data, if one did not adjust for risk. One might have the impression that relatively poor households have high returns on assets, as shown in Columns 3 and 4, and suffer from constraints. The results here show the opposite, namely, it's the relatively the rich who have abnormally high returns. The reason why the poor have higher simple rate of return to household enterprises is from the fact that they take more risk in their production activities, and get compensated accordingly. Controlling for risks, household enterprises of the poor underperform those of the rich. Likewise, household size does not show up in the usual adjustments, but smaller households seem to have higher return on assets after adjusting for the risk that the household size takes on. The results for other variables are also worth mentioning, despite being statistically insignificant at traditional levels. In general the coefficients on a particular variable tend to move monotonically, in one direction the other, as we move across the columns. Specifically, adjusting for aggregate and idiosyncratic risks, the regression coefficient for age of household head flips from

[39] Similarly, we also explore whether various occupations (as measured by shares of household's total revenue) have difference exposure to aggregate and idiosyncratic risks. We find that cultivation and business are statistically associated with higher risk, both aggregate and idiosyncratic. Fish and shrimp farming is correlated with higher aggregate risk while livestock activity tends to have lower aggregate risk. However, both fish and shrimp farming and livestock are not statistically associated with household's exposure to idiosyncratic risk. (The results are not shown here. See also Samphantharak and Townsend 2013).

being negative to positive while the coefficients for household head being male and initial leverage change from being positive to negative.

9. Policy Implications

The insights from this paper have important policy implications. On the risk and return side, high rates of return on enterprise assets in developing economies could be viewed incorrectly as an indicator of financial constraints. This paper shows not only that a higher return on assets of a given household enterprise can reflect the fact that a household is engaged in riskier production activities, the paper also quantifies this result, and provides a practical, appropriate procedure to compute risk premia that is consistent to economics and finance literature. This is necessary for the study of big questions in economic development: the study of return to household enterprises, cost of capital, financial constraints, and their productivity. On the risk and vulnerability side, many intervention policies are aimed at providing safety nets to low income populations, given a presumption of exposure to high risk. Our methods allow us to see which segments of the population are exposed to which risk factors, bearing in mind that idiosyncratic risk is likely something mitigated by the households themselves via informal arrangements while the remaining risk could be compensated by risk premia, that is, higher average returns.

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Table 1 Descriptive Statistics of Networks in Village and Township

Region	***Central***		***Northeast***	
Township (Province)	**Chachoengsao**	**Lopburi**	**Buriram**	**Srisaket**
Number of Observations	129	140	131	141
% of Households with relatives living in the same...				
Village	50.4%	76.4%	80.9%	87.9%
Township	87.8%	88.4%	97.1%	94.0%

Remarks The unit of observation is household. Relatives are defined as parents of household head, parents of household head's spouse, siblings of household head or of household head's spouse, or children of household head. Network variables are computed as of August 1998 (the initial baseline survey, i.e. Month 0).

Table 2 Revenue from Production Activities (% by Township)

Region:	***Central***		***Northeast***	
Township (Province):	***Chachoengsao***	***Lopburi***	***Buriram***	***Srisaket***
Production Activities				
Cultivation	13.2%	39.4%	13.5%	33.7%
Livestock	21.0%	22.8%	1.0%	1.1%
Fish and Shrimp	17.6%	0.0%	0.3%	1.6%
Non-farm Business	28.8%	19.7%	59.2%	28.6%
Wage Earning	18.4%	15.2%	22.6%	27.9%
Number of Sampled Households	129	140	131	141

Remarks The unit of observations is township. The percentage of revenue is the revenue of each production activity from all households in our sample divided by the total revenue from all activities in the township. The revenues are computed from all of the 156 months (January 1999 to December 2011).

Table 3 Descriptive Statistics of Household Characteristics

	Number of Observations	Percentiles 25th	50th	75th	Number of Observations	Percentiles 25th	50th	75th
Region	***Central***							
Township (Province)	***Chachoengsao***				***Lopburi***			
As of December 1998:								
Household size	129	3.0	4.0	6.0	140	3.0	4.0	5.0
Male	129	1.0	2.0	3.0	140	1.0	2.0	3.0
Female	129	1.0	2.0	3.0	140	1.0	2.0	3.0
Male, age 15-64	129	1.0	1.0	2.0	140	1.0	1.0	2.0
Female, age 15-64	129	1.0	1.0	2.0	140	1.0	1.0	2.0
Average age	129	29.3	36.3	44.5	140	25.6	32.3	42.0
Maximum years of education	129	6.0	9.0	12.0	140	4.2	6.0	9.0
Total Assets (Baht)	129	380,465	1,109,228	3,636,334	140	336,056	1,074,082	2,387,329
156-Month Average (January 1999-December 2011):								
Monthly Income (Baht)	129	7,561	13,696	23,637	140	5,836	10,486	20,765
Total Assets (Baht)	129	857,892	1,745,109	4,275,229	140	653,339	1,645,757	3,052,390
Fixed Assets (% of Total Assets)	129	37%	61%	80%	140	40%	59%	71%
Total Liability (Baht)	129	8,470	31,455	105,216	140	34,595	121,412	285,300
Liability to Asset Ratio	129	0%	2%	6%	140	4%	8%	16%
Region	***Northeast***							
Township (Province)	***Buriram***				***Srisaket***			
As of December 1998:								
Household size	131	3.0	4.0	5.0	141	4.0	5.0	6.0
Male	131	1.0	2.0	3.0	141	2.0	2.0	3.0
Female	131	1.0	2.0	3.0	141	2.0	2.0	3.0
Male, age 15-64	131	1.0	1.0	2.0	141	1.0	1.0	2.0
Female, age 15-64	131	1.0	1.0	2.0	141	1.0	1.0	2.0
Average age	131	20.9	27.6	39.3	141	25.2	32.0	36.3
Maximum years of education	131	4.0	6.0	8.3	141	5.3	7.0	10.3
Total Assets (Baht)	131	356,201	572,491	947,314	141	156,313	387,634	881,455
156-Month Average (January 1999-December 2011):								
Monthly Income (Baht)	131	2,073	3,677	5,584	141	2,160	3,672	5,276
Total Assets (Baht)	131	503,434	741,882	1,114,981	141	317,444	577,064	1,048,213
Fixed Assets (% of Total Assets)	131	39%	57%	69%	141	35%	63%	75%
Total Liability (Baht)	131	24,316	56,805	109,264	141	23,471	42,932	75,531
Liability to Asset Ratio	131	3%	8%	17%	141	4%	9%	17%

Remarks The unit of observations is household. Average age and maximum years of education across household members within a given household. Assets, liabilities, and income are in nominal value. Fixed assets include equipment, machinery, building, and land.

Table 4 Descriptive Statistics of Return on Assets: Quartiles by Township

	Number of Observations	Percentiles 25th	50th	75th	Number of Observations	Percentiles 25th	50th	75th
Region:	***Central***							
Province (Township):	***Chachoengsao***				***Lopburi***			
Unadjusted ROA								
Mean	129	-0.52	1.81	6.62	140	1.95	5.03	9.98
Standard Deviation	129	3.90	7.48	16.60	140	10.24	16.54	24.75
Coefficient of Variation	129	1.69	2.72	4.23	140	2.00	3.10	5.22
Adjusted ROA								
Mean	129	-1.72	0.38	3.99	140	-1.67	1.46	4.53
Standard Deviation	129	4.38	7.56	16.61	140	10.16	16.51	24.77
Coefficient of Variation	129	2.02	3.14	5.46	140	3.27	4.65	8.85
Region:	***Northeast***							
Province (Township):	***Buriram***				***Srisaket***			
Unadjusted ROA								
Mean	131	0.18	2.02	4.78	141	2.78	5.15	9.58
Standard Deviation	131	8.68	13.98	22.90	141	10.60	17.77	31.20
Coefficient of Variation	131	3.88	6.11	11.13	141	2.45	3.41	4.81
Adjusted ROA								
Mean	131	-1.32	0.28	1.56	141	0.21	1.99	4.29
Standard Deviation	131	8.38	13.92	22.59	141	10.16	16.78	26.87
Coefficient of Variation	131	4.03	8.70	17.48	141	4.03	5.92	11.52

Remarks Unit of observations is households. ROA is rate of return on household's total asset, computed by household's net income (net of compensation to household labor) divided by household's average total assets over the month. ROA is real return, adjusted by regional Consumer Price Index from the Bank of Thailand, and reported in annualized percentage. Unadjusted ROA is return on total asset without adjustment for household's own labor that contributes to their own business enterprises. Adjusted ROA is return on total assets, adjusted for household's own labor contribution to their own business enterprises. See Appendix 1 for detailed definition and computation of both unadjusted and adjusted ROA. Mean, standard deviation, and coefficient of variation of ROA are computed from monthly ROA f*or each household* over 156 months (January 1999 to December 2011). The percentiles are *across households* in each township.

Table 5 Risk and Return Regressions: Township as Market

Dependent Variable:	***Household's Mean Return on Assets***							
	Panel A: Constant Beta				***Panel B: Time-Varying Beta***			
Region:	***Central***		***Northeast***		***Central***		***Northeast***	
Township (Province):	***Chachoengsao***	***Lopburi***	***Buriram***	***Srisaket***	***Chachoengsao***	***Lopburi***	***Buriram***	***Srisaket***
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Beta	2.135***	2.465***	0.432	2.335***	1.250***	2.307***	0.530***	1.888***
	(0.227)	(0.287)	(0.321)	(0.352)	(0.0878)	(0.133)	(0.131)	(0.172)
Constant	-0.535	-0.503	-0.122	-0.847	-0.325*	-0.631***	-0.782***	-1.114***
	(0.412)	(0.561)	(0.364)	(0.668)	(0.176)	(0.235)	(0.162)	(0.304)
Observations	129	140	131	141	1,161	1,260	1,179	1,269
R-squared	0.467	0.210	0.017	0.297	0.330	0.204	0.019	0.260
Township Returns:								
Monthly Average	1.68	2.49	0.15	0.80	1.19	2.40	-0.07	1.04
Standard Deviation	0.07	0.10	0.10	0.10	0.75	1.47	0.54	0.75

Remarks For columns (1)-(4), unit of observations is household. Beta is computed from a simple time-series regression of household's adjusted ROA on township's 'sROA over the 156 months from January 1999 to December 2011. Household's mean adjusted ROA is the time-series average of household adjusted ROA over the same 156 months. For columns (5)-(8), unit of observation is household-time window. Each time window consists of 60 months. The window shifts 12 months (1 year) at a time. There are 9 moving windows in total for each household. Beta is computed from a simple time-series regression of household's adjusted ROA on township's ROA in each corresponding time window. Household's mean adjusted ROA is the time-series average of household adjusted ROA over the corresponding time window. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6 Risk and Return Regressions with Human Capital and Time-Varying Stochastic Discount Factor: Township as Market

Dependent Variable:	***Household's Mean Return on Assets***							
Region:	***Central***		***Northeast***		***Central***		***Northeast***	
Township (Province):	***Chachoengsao***	***Lopburi***	***Buriram***	***Srisaket***	***Chachoengsao***	***Lopburi***	***Buriram***	***Srisaket***
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Beta with respect to	1.242***	2.233***	0.564***	1.813***	1.094***	2.005***	0.392***	1.893***
return on market physical capital (ra)	(0.0839)	(0.136)	(0.137)	(0.181)	(0.0744)	(0.140)	(0.108)	(0.142)
Beta with respect to	0.00177	0.0217	-0.0524	0.149***	-0.00542	0.0375*	-0.0310	0.179***
return on market human capital (rh)	(0.0154)	(0.0216)	(0.0466)	(0.0563)	(0.0186)	(0.0200)	(0.0372)	(0.0472)
Beta with respect to					-0.00441	0.00246	0.0333**	0.0789***
residual log consumption (cay)					(0.0146)	(0.00796)	(0.0152)	(0.0173)
Beta with respect to					-0.00533	-0.0304	-0.131***	-0.101**
the interaction cay*ra					(0.0211)	(0.0447)	(0.0342)	(0.0441)
Beta with respect to					0.00134	-0.000574	0.0109	-0.0130
the interaction cay*rh					(0.00177)	(0.00172)	(0.00801)	(0.00864)
Constant	-0.307*	-0.584**	-0.757***	-1.080***	-0.156	-0.464**	-0.589***	-1.164***
	(0.176)	(0.232)	(0.164)	(0.310)	(0.178)	(0.223)	(0.162)	(0.268)
Observations	1,161	1,260	1,179	1,269	1,161	1,260	1,179	1,269
R-squared	0.329	0.203	0.021	0.270	0.315	0.203	0.049	0.306

Remarks Unit of observation is household-time window. For Columns (1)-(4), beta's are computed from a multivariate time-series regression of household's monthly adjusted ROA on township's monthly return on market physical capital (ra) and township's return on human capital (rh), which is proxied by the monthly growth rate of township's total labor income. Regressions are performed on moving windows of 60 months. The window then shifts 12 months (1 year) at a time and there are 9 moving windows in total for each household. Household's mean adjusted ROA is the time-series average of household adjusted ROA over the corresponding time window. For Columns (5)-(8), similar analysis is performed, with additional explanatory variables. Residual log consumption is the residual computed from time-series regression of township's monthly log food consumption on township's total physical asset at the beginning of the month and township's total labor income during that month. Interaction terms are then defined accordingly. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7 Decomposition of Risk and Risk Premium (Median Households by Province)

	Panel A: Decomposition of Risk (Variance)			
Region:	Central		Northeast	
Township (Province):	Chachoengsao	Lopburi	Buriram	Srisaket
Aggregate Risk	15.1%	12.0%	20.3%	45.0%
Idiosyncratic Risk	84.9%	88.0%	79.7%	55.0%

	Panel B: Decomposition of Risk Premium			
Region:	Central		Northeast	
Township (Province):	Chachoengsao	Lopburi	Buriram	Srisaket
Aggregate Risk	67.4%	45.1%	11.6%	80.5%
Idiosyncratic Risk	32.6%	54.9%	88.4%	19.5%
Number of Observations	129	140	131	141

Remarks Unit of observation is household. Panel A decomposes aggregate risk and idiosyncratic risk as defined by equation (23) in the text, using the empirical results from Columns (5)-(8) of Table 6. Panel B decomposes contributions of aggregate risk and idiosyncratic risk to the total risk premium. Aggregate risk premium is defined by equation (24) and idiosyncratic risk premium is defined by equation (25). The numbers for each household are the average across estimates from nine different time-shifting windows.

Table 8 Aggregate Risk, Idiosyncratic Risk, and Rate of Return: Township as Market

Dependent Variable:	***Household's Mean Return on Assets***			
Region:	***Central***		***Northeast***	
Township (Province):	***Chachoengsao***	***Lopburi***	***Buriram***	***Srisaket***
	(1)	(2)	(3)	(4)
Beta with respect to	0.487***	1.105***	0.0137	1.331***
return on market physical capital (ra)	(0.104)	(0.145)	(0.114)	(0.134)
Beta with respect to	0.00598	0.0600***	-0.0411	0.0799***
return on market human capital (rh)	(0.0144)	(0.0158)	(0.0335)	(0.0286)
Beta with respect to	-0.0117	-0.00401	0.0106	0.0376**
residual log consumption (cay)	(0.0108)	(0.00671)	(0.0114)	(0.0149)
Beta with respect to	-0.0117	0.0245	-0.0686**	-0.0560
the interaction cay*ra	(0.0154)	(0.0437)	(0.0277)	(0.0371)
Beta with respect to	-0.00166	-0.000644	0.00392	-0.0127*
the interaction cay*rh	(0.00136)	(0.00134)	(0.00671)	(0.00744)
Sigma	0.00428***	0.00467***	0.00389***	0.00367***
	(0.000689)	(0.000400)	(0.000435)	(0.000296)
Constant	-0.489***	-1.535***	-1.356***	-1.491***
	(0.171)	(0.214)	(0.151)	(0.237)
Observations	1,161	1,260	1,179	1,269
R-squared	0.433	0.330	0.196	0.446

Remarks Unit of observation is household-time window. Beta's are computed from a multivariate time-series regression of household's monthly adjusted ROA on township's monthly return on market physical capital (ra) and township's return on human capital (rh), and township's residual log consumption (cay). Township's return on human capital (rh) is proxied by the monthly growth rate of township's total labor income. Township's residual log consumption is the residual computed from time-series regression of township's monthly log food consumption on township's total physical asset at the beginning of the month and township's total labor income during that month. Interaction terms are then defined accordingly. Sigma is the variance of error terms from regressions used to estimate beta's for each household-time window. Robust standard errors are reported in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 9 Descriptive Statistics of Household Alpha: Township as Market

Province	Number of Observations	Mean	Standard Deviation	Skewness	Kurtosis	Percentiles			Spearman's Rank Correlation with Simple Rate of Return on Assets
						25th	50th	75th	
Panel A: Return on Assets, Not Adjusted for Risks									
Central									
Chachoengsao	129	1.90	6.51	1.14	4.64	-1.72	0.38	3.99	
Lopburi	140	1.37	6.31	-0.93	5.46	-1.67	1.46	3.16	
Northeast									
Buriram	131	0.30	3.49	0.24	4.79	-1.32	0.28	1.39	
Srisaket	141	2.83	5.87	0.75	5.53	0.21	1.99	4.29	
Panel B: Return on Assets, Adjusted for Aggregate Risks									
Central									
Chachoengsao	129	0.68	5.52	0.44	5.17	-1.75	-0.15	2.59	0.96***
Lopburi	140	0.28	5.81	-1.47	7.05	-1.98	1.00	3.16	0.95***
Northeast									
Buriram	131	-0.28	3.60	-0.02	4.54	-1.94	-0.27	1.39	0.92***
Srisaket	141	-0.11	4.84	0.24	5.76	-1.43	-0.08	1.18	0.81***
Panel C: Return on Assets, Adjusted for Aggregate and Idiosyncratic Risks									
Central									
Chachoengsao	129	-0.49	4.52	-0.305	6.09	-2.21	-0.42	1.469	0.86***
Lopburi	140	-1.54	5.27	-1.87	8.12	-3.49	-0.12	1.493	0.73***
Northeast									
Buriram	131	-1.36	3.52	-0.73	4.38	-2.75	-0.75	0.54	0.85***
Srisaket	141	-1.49	4.16	-0.677	5.70	-2.55	-0.72	0.313	0.58***

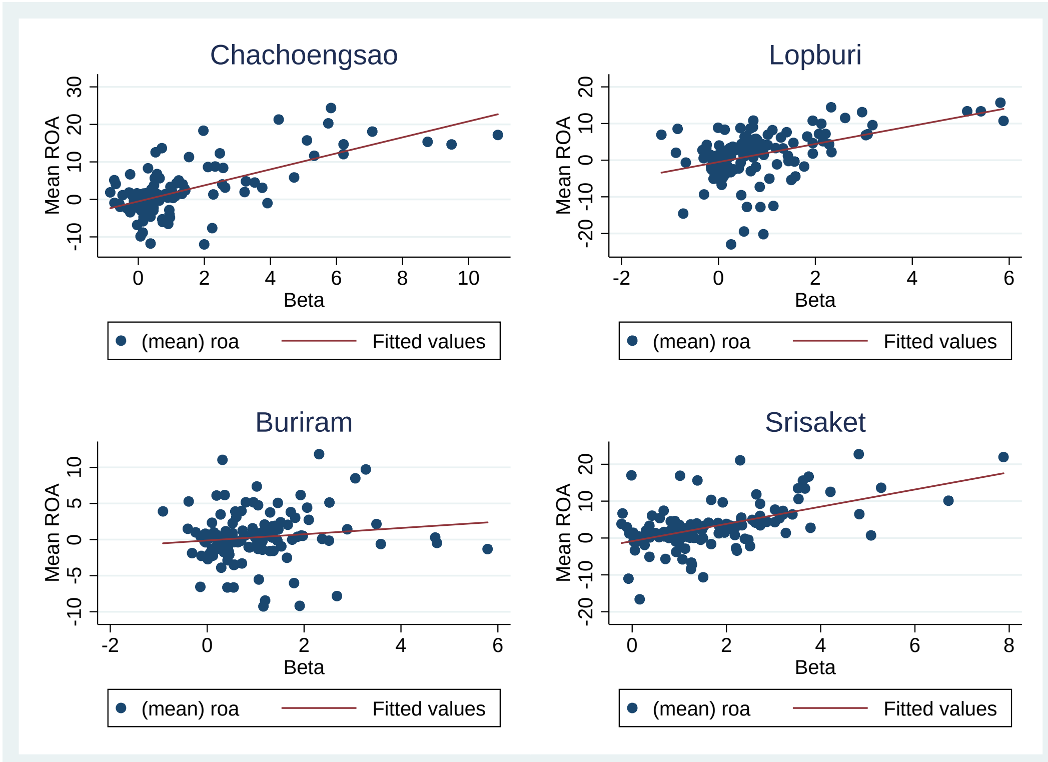
Remarks Unit of observations is households. Panel A reports descriptive statistics of rate of return without adjusting for any risk (but adjusted for household's own labor). Panel B report rate of return adjusted for aggregate risks, where risk premium is computed from market's mean ROA (ra), market return on human capital (rh), residual consumption (cay), and their interactions cay*ra and cay*rh, as defined in equation (24) in the text. Panel C report rate of return adjusted for aggregate risks, where risk premium is computed from market's mean ROA (ra), market return on human capital (rh), residual consumption (cay), and their interactions cay*ra and cay*rh, as defined by equation (24), as well as idiosyncratic risk from sigma, as defined by equation (25) in the text. For each household, the return in Panels B and C is averaged across 9 shifting time windows. *** p<0.01.

Table 10 Determinants of Rate of Returns and Risks

Dependent Variable:	**Risk**		**Rate of Return**			
Adjusted for Household's Own Labor	**Beta**	**Sigma**	**No**	**Yes**	**Yes**	**Yes**
Adjusted for Aggregate Risk	**(Aggregate Risk)**	**(Idiosyncratic Risk)**	**No**	**No**	**Yes**	**Yes**
Adjusted for Idiosyncratic Risk			**No**	**No**	**No**	**Yes**
	(1)	(2)	(3)	(4)	(5)	(6)
Household Size	0.0732	23.98	0.344	-0.189	-0.294	-0.394*
	(0.0796)	(27.40)	(0.305)	(0.281)	(0.249)	(0.218)
Age of Household Head	-0.0241***	-5.067**	-0.0985***	-0.0384	-0.0176	0.00267
	(0.00830)	(2.335)	(0.0274)	(0.0261)	(0.0226)	(0.0203)
Education of Household Head	-0.0859***	-9.323	-0.442***	-0.334**	-0.252*	-0.214
	(0.0310)	(8.807)	(0.130)	(0.158)	(0.148)	(0.134)
Household Head Gender (Male=1)	0.713***	80.22	0.947	0.222	-0.262	-0.575
	(0.185)	(67.36)	(0.688)	(0.559)	(0.494)	(0.429)
Total Initial Wealth	-0.231***	-96.98***	-1.036***	-0.132	0.0877	0.487**
	(0.0886)	(28.56)	(0.320)	(0.270)	(0.242)	(0.212)
Initial Leverage	1.377	1,116**	5.602	2.877	1.153	-3.278
	(1.199)	(497.2)	(3.715)	(3.165)	(2.860)	(3.232)
Constant	2.139***	453.9**	11.22***	4.779**	2.907	1.031
	(0.647)	(193.9)	(2.291)	(2.326)	(2.058)	(1.844)
Township Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	483	483	483	483	483	483
R-squared	0.12	0.12	0.16	0.038	0.021	0.053

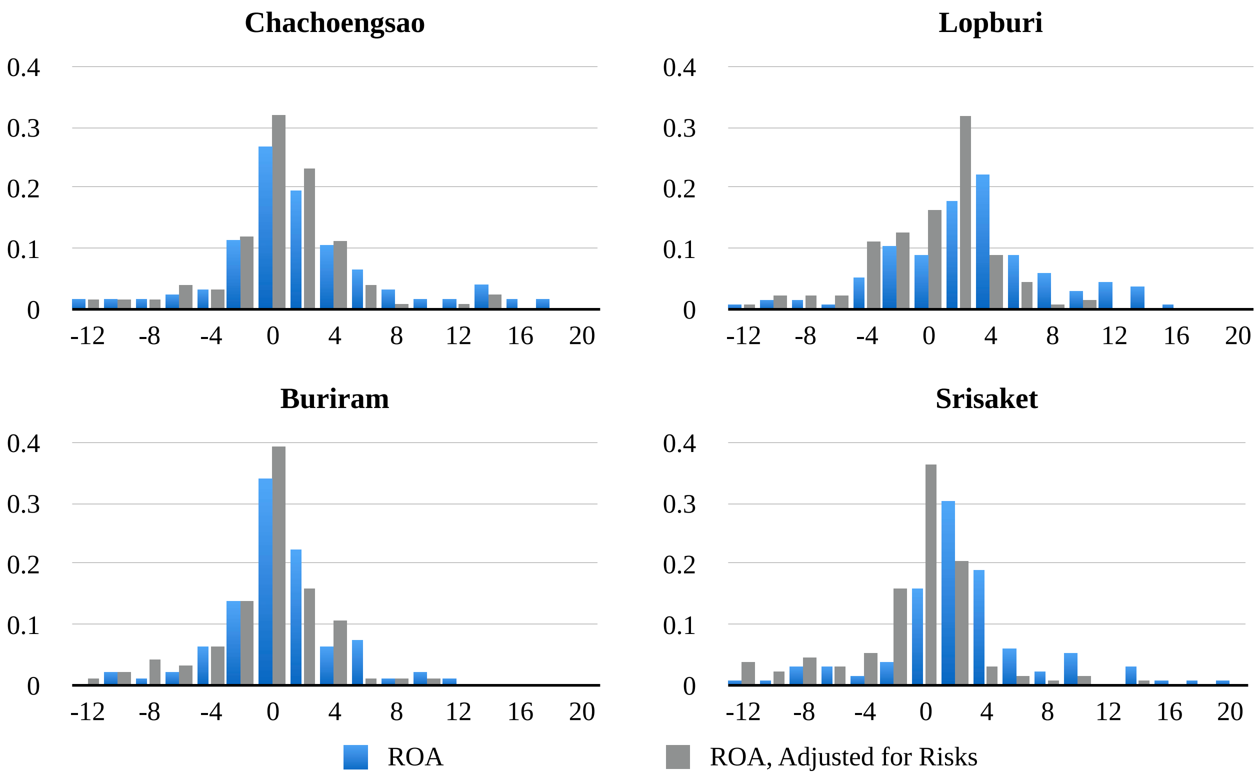
Remarks Unit of observation is household. For each household, beta and sigma are estimated from the regression in equation (21), average across 9 shifting time widows. Beta is the regression coefficient with respect to aggregate return on physical assets (ra). Sigma is the variance of the error terms from the regression. Household size is the number of household members aged 15-64. Age of household head was as of the end of December 1998. Initial wealth is in baht. Initial leverage is initial total liabilities divided by initial total assets. Robust standard errors are reported in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Figure 1 Risk and Return: Township as Market



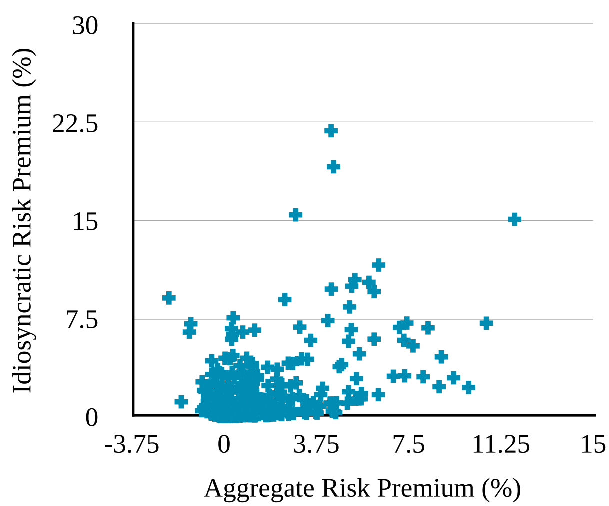
Remarks Unit of observation is household. There are 129 households in Chachoengsao, 140 in Lopburi, 131 in Buriram, and 141 in Srisaket. The fitted lines correspond to regression results presented in Columns (1)-(4) in Table 5.

Figure 2 Histograms of Rate of Return on Assets, Unadjusted and Adjusted for Risk



Remarks Unit of observation is household. ROA is the annualized monthly rate of return on asset in percentage. ROA adjusted for risk is the rate of return adjusted for both aggregate and idiosyncratic components of the total risk faced by the households.

Figure 3 Scatter Plots Aggregate Risk Premium and Idiosyncratic Risk Premium



Remarks Unit of observation is household. The observations are from all of the four townships. Aggregate risk premium is computed from equation (25) while idiosyncratic risk premium is computed from equation (26), both using estimates from Table 8. The premia are presented in annualized monthly percentage return.

Appendix A: Construction of Income, Assets, and Rate of Return Variables

Income: Income is an accrued household enterprise income, which is the difference between the enterprise total revenue and the associated cost of inputs used in generating that revenue. Revenue is realized at the time of sales or disposal. Associated cost could be incurred in the periods different from the sales or disposal of outputs. Total revenue includes the value of all outputs the household produces for sale (in cash, in kind, or on credit), own consumption, or giving away. Revenue also includes rental income from fixed assets. Revenue does not include the wages earned outside the household or gifts and transfers received by the household. Cost includes the value of inputs used in the production of the outputs, regardless of the method of their acquisition, i.e. purchase (in cash, in kind, or on credit), gifts from others or transfers from government. Cost includes the wage paid to labor provided by non-household members as well as (imputed) compensation to the labor provided by household members. Cost includes all utility expenses of the household regardless of the purposes of their uses. Cost also includes depreciation of fixed assets.

In order to impute the cost of the household's own labor, we use the following procedure. First, the procedure is relatively straightforward for a household member who earns labor income from the labor markets virtually every month. In this case, we use the observed hourly wage rate for each of these household members (the total wage bill from a given activity divided by the total number of hours spent on that activity). Together with the survey data regarding time spent on home production activities, we calculate the shadow compensation the household member would have received from providing labor to production activities operated by the household. Second, the procedure becomes more complicated when household members do not work in the labor market every month and we observe their monthly market wage rate only in some months but not others. In this case, we intrapolate the shadow wage rate for each household member based on the member's own observed market wages, and adjust for monthly fluctuations by using monthly deviation from the trend. We then smooth out fluctuated wage rates by 6-month moving average. Finally, the most complicated procedure involves household members who never work in external labor markets throughout the sample period. In this case, we impute the member's shadow wage rate from a traditional Mincer equation, regressing log wage rate on education, experience, and experience squared. The regression is estimated separately for male and female individuals and is controlled for monthly fixed effects. The regression coefficients have expected signs (positive for education and experience, and negative for experience squared) and are all statistically significant at 1%.

Assets: Assets include all assets, i.e., fixed assets, inventories, and financial assets. *Fixed assets* are surveyed in the Agricultural Assets, Business Assets, Livestock, Household Assets, and Land Modules of the Townsend Thai Monthly Survey. In the Agricultural Assets Module, fixed assets include walking tractor, large four-wheel tractor, small four-wheel tractor, aerator, machine to put in seeds and pesticides for preventing grass, machine to mix fertilizer and soil, sprinkler, threshing machine, rice mill, water pump, rice storage building, other crop storage building, large chicken coop, other buildings for livestock, and other buildings. In the Household Assets Module, assets include car, pick-up truck, long-tail boat with motor, large fishing boat, bicycle, air conditioner, regular telephone, cellular telephone, refrigerator, sewing machine, washing machine, electric iron, gas stove, electric cooking pot, sofa, television, stereo, and VCR. Due to the variety in non-agricultural businesses, in the Business Module, we do not list specific name of the assets, but instead ask the household to report the fixed assets they use in their business enterprises. In the Land Module, assets include land (at acquisition value), buildings, the value of land and building improvement, and the appreciation of land when major events occurred (such as an addition of new public roads). In all of the modules, assets that are not explicitly listed but have value more than 2,000 baht are also asked and included. *Inventories* include raw material, work in progress, finished goods for cultivation, fish and shrimp farming, livestock activities (such as milk and eggs), and manufacturing non-farm businesses. For merchandizing non-farm businesses, inventories are mainly goods for resale. Inventories also include animals recorded in the Livestock Inventory Module, which records young meat cow, mature meat cow, young daily cow, mature daily cow, young buffalo, mature buffalo, young pig, mature pig, chicken, and duck. *Financial assets* include cash, deposits at financial institutions, other lending, and net ROSCA position. These line items are computed from the Savings Module, the Lending Module, and the ROSCA module. The stock of cash is not asked directly but can be imputed from questions about each and every transaction that each households had since the last interview. Finally, the total asset used in the calculation of rate of return is *net* of liabilities. We use the information from the Borrowing Module to calculate the household's stock of total liabilities.

Rate of Return: Rate of return on assets (ROA) is defined as household's accrued net income divided by household's average total assets (net of total liabilities) over the period from which that the income was generated, i.e. one month in this paper. The average total asset is the sum of total assets at the beginning of the month and total assets at the end of the month, divided by two. We use the real accrued net income and the real value of household's total assets in the ROA calculation. The real variables were computed using the monthly Consumer Price Index (CPI) at the regional level from the Bank of Thailand. The rate is then annualized (multiplied by twelve) to get the annual percentage rate.

Appendix B: Alternative Definitions of the Aggregate Economy

One may argue that kinship networks are local and operate better at the village or network levels than at the township level. Table A.1 reports the second-stage regression results when we use villages as aggregates. Despite the smaller number of observations, the results show that the regression coefficient of household beta is significantly positive at 10% (or lower) level of significance for 9 of the 16 villages in our sample, with the only exception of all four villages in Buriram province, two villages in Lopburi, and one village in Chachoengsao. The result also shows that we cannot reject the null hypothesis that $\psi = \overline{R'_M}$ at 10% level of significance for 5 out of those 9 villages in the sample (Village 7 in Chachoengsao; Village 4 in Lopburi; and Villages 6, 9, and 10 in Srisaket).

INSERT Tables A.1]

We also perform a similar analysis at the network level. In order to analyze the risk and return at the network level, we construct kinship network maps for the households in the Townsend Thai Monthly Survey. Specifically, for each of the relatives of the household head and the spouse (parents and siblings of the head, parents and siblings of the spouse, and their children) who was still alive and lived within the village, the survey recorded which building structure as recorded in the initial census he or she lived. With this information, we constructed a kinship network map for each village by drawing a link between two households that were family-related related. Figure 1 shows an example of network map from a village in Buriram. The number at each node in the maps represents a structure number of a household in the village. The link between each two nodes implies that the two households are related by kinship. Figure A.1 shows a network map from one of our sampled villages.

[INSERT Figure A.1]

We present in Table A.2 the regressions using network as our definition of aggregate economy. We present only the results for the networks with more than 15 households. There are nine of them. All are from different villages (four from Lopburi in the central region; two from Buriram and three from Srisaket in the northeast). Table A.2 shows that the regression coefficient of household beta is significantly positive for 5 of the 9 networks. For 2 of the 9 networks, we however cannot reject the null hypothesis that the regression coefficient is equal to the network's average return (Networks 602 and 902 in Srisaket).

[INSERT Tables A.2]

Table A.1 Risk and Return Regressions: Village as Market

Dependent Variable:	*Household's Mean ROA*							
Province:	*Chachoengsao*				*Lopburi*			
Village:	*02*	*04*	*07*	*08*	*01*	*03*	*04*	*06*
Beta	2.473***	3.232***	6.741***	0.720	2.163	3.185	4.399***	4.884***
	(0.370)	(0.433)	(1.065)	(0.695)	(3.099)	(1.956)	(1.003)	(0.772)
Constant	-1.105	-0.333	-0.739	1.162	-0.827	0.312	0.257	-1.629
	(0.899)	(0.756)	(0.821)	(0.984)	(1.434)	(0.873)	(0.572)	(1.503)
Observations	35	36	27	31	34	29	37	40
R-squared	0.449	0.702	0.446	0.036	0.012	0.126	0.472	0.337
Village Returns:								
Monthly Average	1.09	1.48	4.13	0.73	2.03	2.49	2.48	2.85
Standard Deviation	0.14	0.08	0.50	0.12	0.17	0.34	0.14	0.33
Province:	*Buriram*				*Srisaket*			
Village:	*02*	*10*	*13*	*14*	*01*	*06*	*09*	*10*
Beta	0.827	0.547	0.217	0.697	2.759***	3.680***	1.557**	1.902*
	(1.363)	(1.248)	(0.602)	(0.967)	(0.406)	(1.300)	(0.634)	(0.938)
Constant	-0.628	0.346	0.684	-0.541	-2.407**	-0.558	0.735	-1.748
	(0.417)	(1.197)	(0.831)	(0.688)	(1.172)	(1.661)	(1.001)	(1.907)
Observations	34	28	34	35	38	42	39	22
R-squared	0.022	0.010	0.003	0.014	0.510	0.387	0.114	0.149
Village Returns:								
Monthly Average	-0.14	1.56	0.36	-0.52	-0.57	1.88	0.87	0.95
Standard Deviation	0.11	0.14	0.23	0.17	0.16	0.12	0.13	0.15

Remarks Unit of observations is household. Beta is computed from a simple time-series regression of household adjusted ROA on village ROA over the 156 months from January 1999 to December 2011. Household's mean adjusted ROA is the time-series average of household adjusted ROA over the same 156 months. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

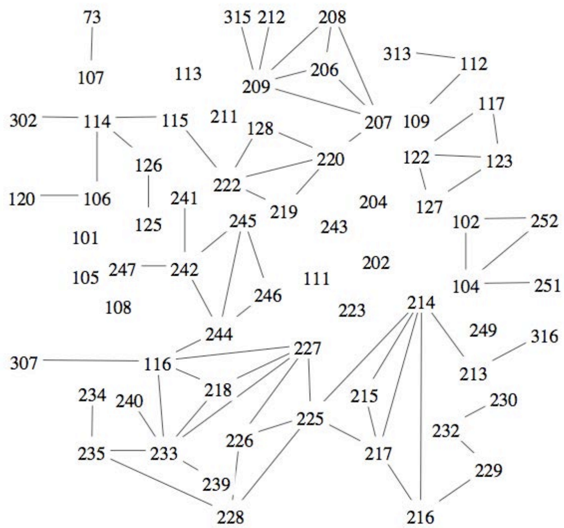
Table A.2 Risk and Return Regressions: Network as Market

Dependent Variable:	***Household's Mean ROA***			
Region:	***Central***			
Province:	***Lopburi***			
Village:	***01***	***03***	***04***	***06***
Network:	***03***	***03***	***06***	***01***
Beta	-3.088	3.265	7.366***	5.189***
	(4.302)	(4.033)	(2.383)	(0.881)
Constant	0.433	1.523	0.123	-1.655
	(1.448)	(1.244)	(0.865)	(1.799)
Observations	16	18	20	33
R-squared	0.012	0.041	0.464	0.345
Network Returns:				
Monthly Average	2.03	2.46	2.52	2.85
Standard Deviation	0.20	0.41	0.13	0.35

Region:	***Northeast***				
Province:	***Buriram***		***Srisaket***		
Village:	***13***	***14***	***01***	***06***	***09***
Network:	***03***	***03***	***03***	***02***	***02***
Beta	1.373	0.728	2.842***	3.832**	1.540**
	(0.988)	(1.046)	(0.722)	(1.484)	(0.618)
Constant	-0.249	-0.460	-2.205*	-0.452	0.554
	(0.694)	(0.794)	(1.226)	(1.845)	(1.025)
Observations	23	27	23	37	36
R-squared	0.184	0.015	0.365	0.374	0.134
Network Returns:					
Monthly Average	0.38	-0.52	-0.58	1.88	0.87
Standard Deviation	0.20	0.16	0.14	0.13	0.13

Remarks Unit of observations is household. Beta is computed from a simple time-series regression of household's adjusted ROA on network's ROA over the 156 months from January 1999 to December 2011. Household's mean adjusted ROA is the time-series average of household adjusted ROA over the same 156 months. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Figure A.1 Example of Kinship Network Map from a Village in the Townsend Thai Monthly Survey



Remarks Numbers denote the structure number in which each household lives. Lines connecting numbers denote kinship relationship between households.