# Risk and Return in Networked Village Economies

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PRELIMINARY

**Abstract** We apply the Consumption-based Asset Pricing Model (CCAPM) of the finance literature to study the risk and return of household business assets in developing economies. Using monthly panel data from a household survey in rural Thailand, we find that higher exposure to aggregate, non-diversifiable risk, as measured by household beta or the co-movement of the return of the individual household enterprise with the aggregate return, is associated with higher expected return on household business assets. The primary specification is township level, with four village connected through family ties, but the results are robust at the individual village level, and kinship related dynasties within villages. The main prediction is also robust to allowing for human capital and time-varying stochastic discount factors. However, contrary to the model, the more the households are exposed to idiosyncratic risks, the higher also is the expected rate of return. We find that exposure to both aggregate and idiosyncratic risks of the household is positively associated with the education of household head and negatively associated with the initial wealth of the household. We then use the estimates from the model to compute the risk-adjusted rate of return for each household. This residual varies negatively with the age of household head.

Keywords: Risk, Return, Village Economy, Asset Pricing, CAPM, Productivity, Risk Premium

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## 1. Introduction

As argued in Samphantharak and Townsend (2010), many households in developing countries are not simply consumers supplying factor inputs and purchasing and consuming outputs. They are also engaged in production in both farm and non-farm activities. As a result, measuring the risk and return of these household enterprises is important as it helps us understand the productivity and vulnerability of the households and their business enterprises. In order to study risk and return, however, we need an appropriate framework. This paper presents a model that draws on insights from the Consumption-based Capital Asset Pricing Model (CCAPM) to the study of risk and return [1]

Although the relationship between risk and return derived in this paper is analogous to the one in the traditional finance literature, the economic environment behind the model assumptions is different. In particular, the complete market assumption in the benchmark models of the traditional asset pricing literature is generally from the tradability of the assets and the market access of participants. Our paper presents an alternative interpretation of the complete market assumption based on formal and informal arrangements that result in a full risk-sharing allocation of consumption. Although the complete market assumption in the finance literature is more likely to hold in an advanced economy with formal modern financial markets, the complete market environment in our paper is more likely to be achieved in a rural poor village economy where social networks are strong and informal financial arrangement on risk sharing is common.

We apply our model to the study of risk and return of financial assets and real fixed productive assets (such as machinery) as well as those assets in between (such as inventories). Although the returns to tradable liquid financial assets are from interests, dividends, or capital gains, the returns to relatively illiquid real productive assets are mainly from the outputs they produce but also relatively infrequent capital gains. Finally, the consumption-based finance literature typically relies on countrywide aggregate consumption to explain asset risk and return of financial assets, as accessed by a limited number of market participants, potentially leading to anomalies in financial research.[2] Studying risk and return of household enterprises in village economies based on detailed household-level surveys allows researchers to link asset return of the households with consumption panel data.

This paper also contributes to development economics literature. There is a literature on the return on assets and how it is directly related to the productivity and income of households and enterprises. Another literature studies risk and volatility and how they

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[1] 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.

[2] See Vissing-Jorgensen (2002) for the limited market participation argument in the U.S. context.

determine the vulnerability of poor households. Yet, to the best of our best knowledge, there is little literature in development economics linking these two concepts.[3] A higher (average) return on assets of a household may not imply that the household is more able or more productive than others. The higher return could well reflect the fact that the household is engaged in more risky production activities, not simply idiosyncratic risk, if at all, but rather market, aggregate risk. Related, although the literature on consumption risk sharing clearly distinguishes between aggregate risks that are not diversifiable and idiosyncratic risks that could be shared, we go further here and study how these risks are priced and compensated in the form of higher returns.[4]

In a nutshell, this paper defines and measures risk in a way consistent with both economics and finance theories, and provides a practical computation of risk-adjusted returns as a measure of productivity. Specifically, under certain assumptions for the environment, our model postulates that only the aggregate risks are priced, while the idiosyncratic risks are diversified away. Again this insight is equivalent to what is suggested by the traditional Capital Asset Pricing Model (CAPM) of the finance literature. Based on the model, the measure of risk for each the collection of productive assets managed by a household, termed its asset portfolio beta, is the co-movement of the household return on asset (ROA) and the market or aggregate ROA. We use the data from household financial accounts to answer the key questions: Do households with higher aggregate risks (higher beta) tend to have higher expected ROA? Are the returns also correlated positively with idiosyncratic risks? Finally, adjusted for risks, do the returns depend on anything else? If so, what?

In the empirical sections, we apply the model to the monthly panel data from the Townsend Thai Survey, an integrated household survey conducted in rural and semi-urban villages in Thailand. We emphasize the importance of such high-frequency long-running household surveys that allows researchers to compute the co-movement of returns, something that could not be done in a one-shot survey or short duration survey. We rely on derived household financial accounts (income statements and balance sheets) constructed in Samphantharak and Townsend (2010). We consider a township as our definition or extent of the aggregate economy or the market as almost everyone in the four sampled villages of each township are connected through family ties.

We find that a higher exposure to aggregate, non-diversifiable risk is related to a higher expected return on assets of the households, largely consistent with a prediction from the model presented in this paper, which is in turn consistent to the prediction from the

[3] 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.

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

conventional CAPM. This finding is robust to the use a village or a network with a village, as our alternative definitions of the aggregate economy. The main result is also robust to extended specifications where we include household human capital and allow for time-varying stochastic discount factors. But contrary to a prediction from the complete market setup, we find that idiosyncratic risks also have positive price in our data, i.e. the more the households are exposed to idiosyncratic risks, the higher the expected rate of return. We find that exposure to both aggregate and idiosyncratic risks of the household is positively associated with the education of household head and negatively associated with the initial wealth of the household. This is a reminiscent result of Calvet, Campbell, and Sodini (2010) that higher wealth takes on more risks. Adjusted for risks, the return on household assets is negatively correlated with the average age of the household.

The theoretical framework and the empirical findings in this paper have important policy implications. High rates of return on enterprise assets in developing economies is sometimes viewed by academic scholars and policy makers as an indicator of financial constraints, that is, households could not acquire additional finance to invest, and expand. This paper shows that a higher return on assets of a given household enterprise may not imply that the household is more able or more productive than others. The higher return could well reflect the fact that the household is engaged in riskier production activities and compensated for the higher risk in the form of higher average return.

The paper proceeds as follows. Section 2 presents the model 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, using a township, a village, and a kinship network as an extent of the aggregate economy. We extend our benchmark model to incorporate human capital, time-varying stochastic discounts, and idiosyncratic risks in Section 5. Section 6 distinguishes the risk premium from the productivity of household enterprises, computing the household's risk-adjusted rate of return and analyzing its determinants. We conclude and discuss further research and policy implications in Section 8.

## 2. A Model

### *2.1 Social Planner's Problem*

We start with an economy that consists of $J$ households, indexed by $j = 1, 2, \ldots J$. There are $I$ production activities, indexed by $i = 1, 2, \ldots I$, that utilize capital as the only input. Each production technology delivers the same consumption goods and is linear in capital, the amount invested. Let $k_j^i$ be the assets assigned to production activity $i$ 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.

At the beginning of each period, the economy consisting of a set of nearby villages starts with aggregate assets on the balance sheet, $W$. This consists of the assets or projects (namely, "the trees") held from the previous period plus their returns.[5] Since we assume a linear production technology with capital as the only input, the net income generated by all of the assets held by household *j* (namely, "the fruit") is therefore $\sum_{i=1}^{I} r_j^i k_j^i$. Crucial, however, the household does not eat simply eat these returns, but rather can receive or pay gifts and transfers, as in a risk-sharing syndicate. The social planner chooses these current transfers to each household *j*, $\tau_j$, so that the current period consumption of household *j* is $c_j = \sum_{i=1}^{I} r_j^i k_j^i + \tau_j$. One could interpret these gifts and transfers as insurance indemnities or premia, or the return on Arrow-Debreu contingent securities, although we not need this interpretation and we do not require that Arrow Debreu securities be traded. We certainly are not pricing any such securities per se.

The social planner also chooses the assets to be allocated to each activity run by the household in the following period, $k_j^{i/}$. Therefore, the value function of the social planner is

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

subject to aggregate resource constraint

$$\sum_{j=1}^{J} \left( \sum_{i=1}^{I} r_i^j k_i^j + \tau^j \right) + \sum_{j=1}^{J} \sum_{i=1}^{I} k_i^{j/} = W, \tag{1}$$

where $\phi$ is the discount factor, $\lambda_j$ is the Pareto weight for household *j*, $u_j(\cdot)$ is the period utility function of household *j*, and $W$ is the aggregate wealth of the whole economy at the beginning of the current period, i.e.

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

[5] The way this is written, it appears that the economy is closed, where aggregate assets are therefore identical to aggregate wealth. The model is however easily extended and reinterpreted to allow external borrowing and lending, simply by subtracting any economy-wide debt, *D*, with interest from the previous period, and adding potential new borrowing (to be paid back next period). External borrowing can be negative, hence 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.

Therefore, the value function can be rewritten as

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

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),

$$\sum_{j=1}^{J}\tau_j+\sum_{j=1}^{J}\sum_{i=1}^{I}k_j^{i\prime}=\sum_{j=1}^{J}\sum_{i=1}^{I}k_j^i. \tag{3}$$

In other words, the positive aggregate transfer to households is financed by the decumulation of economywide stock of capital while the negative aggregate transfer to households (i.e. positive taxes) contributes to the economy-wide accumulation of capital stock.

The first-order conditions imply

$$\begin{aligned}
&[\tau_j]:\lambda_j u_{jc}(c_j)=\mu && \text{for all } j\\
&[k_j^{i\prime}]:\phi E\left[V_W\left(W^{\prime}\right)\left(1+r_j^{i\prime}\right)\right]=\mu && \text{for all } i \text{ and all } j,
\end{aligned} \tag{4}$$

where $\mu$ is the shadow price of consumption in the current period, the Lagrange multiplier on (3). Finally, for each $i$ and $j$, we get

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

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

$$m^{\prime}=\frac{\phi V_W\left(W^{\prime}\right)}{\mu}. \tag{6}$$

Equation (5) has some important properties. First, $m^{\prime}$ is a stochastic discount factor, which is common across households and assets. Second, the model implies that equation (5) holds for each of the assets allocated to production activity $i$ and run by household $j$, for all $i$ and all $j$ ,. This equation is equivalent to the "pricing equation" derived in the consumption-based asset pricing model in finance literature.[6] Of course it has a parallel in the traditional capital asset pricing model (CAPM) literature as well, but here we do not require households in the regional economy to buy and sell assets and we do not use

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

observed market prices of assets.[7] There is a rate of return on an asset, but it is simply the real yield from holding it, namely net profits from it divided by capital invested. We do talk about "prices" below as if they were from this traditional CAPM literature but, again, these are variables from the consumption-based model and not observed prices on markets.[8]

Equation (5) also holds for any of the portfolios constructed by any combinations of the assets $k_j^{il}$ for all $i$ and all $j$. This is because the production technology is linear in capital. Specifically, if we consider a household as our unit of observation, equation (5) implies that $1 = E\left[m^l R_j^l\right]$, where $R_j^l$ is the weighted average return to the portfolio of the assets operated by household $j$, where the weights are the fraction of each asset in household $j$'s portfolio. This allows us to study the risk and return of household portfolio of assets instead of the risk and return of each individual asset. This 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 (see Samphantharak and Townsend 2012).

Next, since $E\left[m^l R_j^{il}\right] = E\left[m^l\right] E\left[R_j^{il}\right] + \operatorname{cov}\left(m^l, R_j^{il}\right)$, equation (5) can be rewritten as

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

which implicitly defines the quantity and the price of aggregate risks. Specifically interpret $\beta_{m^l,ij} = -\frac{\operatorname{cov}\left(m^l, R_j^{il}\right)}{\operatorname{var}\left(m^l\right)}$ as the "quantity" of the risk of the assets used in activity $i$ by household $j$ that cannot be diversified. In equilibrium, this risk is 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, $\lambda_{m^l} = \frac{\operatorname{var}\left(m^l\right)}{E\left[m^l\right]}$. Finally, $\gamma^l$ is the risk-free rate or the rate of return on zero-beta assets, as from equation (7), $R_f^l = \gamma^l = \frac{1}{E\left[m^l\right]}$, since $\operatorname{cov}\left(m^l, R_f^l\right) = 0$.

[7] 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.

[8] An exception, for the data in the empirical section, we do have a component for capital gain (or loss), if an asset were sold at a higher (lower) price than purchased, adjusted for depreciation. These transactions are however not common.

*2.2 A Special Case: Quadratic Value Function*

We consider a special case where the value function is quadratic in the total assets of the economy.[9] Specifically, we assume that

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

which implies that at $W^{/}$,

$$V_W\left(W^{/}\right) = -\eta\left(W^{/} - W^*\right) = -\eta\left(\sum_{j=1}^{J}\sum_{i=1}^{I} R_j^{i/} k_j^{i/} - W^*\right) = -\eta\left(R_M^{/} k_M^{/} - W^*\right), \tag{8}$$

where $k_M^{/}$ is the total assets of the economy carried from the previous period (before the returns are realized, and adjusted for debt), and $R_M^{/}$ is the weighted average return on assets of the aggregate economy (or the entire market, *M*):

$$k_M^{/} = \sum_{j=1}^{J}\sum_{i=1}^{I} k_j^{i/},$$

$$R_M^{/} \equiv \frac{\sum_{j=1}^{J}\sum_{i=1}^{I} R_j^{i/} k_j^{i/}}{\sum_{j=1}^{J}\sum_{i=1}^{I} k_j^{i/}} = \frac{\sum_{j=1}^{J}\sum_{i=1}^{I} R_j^{i/} k_j^{i/}}{k_M^{/}}.$$

From equations (6) and (8),

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

Equally,

$$m^{/} = a - bR_M^{/}, \tag{9}$$

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

Next, combining with equation (7) derived earlier,

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[9] This is similar to what is assumed in Fama (1970).

$$E\left[R_j^{i\prime}\right]=\frac{1}{E\left[m'\right]}-\frac{\operatorname{cov}\left(m',R_j^{i\prime}\right)}{\operatorname{var}\left(m'\right)}\frac{\operatorname{var}\left(m'\right)}{E\left[m'\right]} \tag{10}$$

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

$$E\left[R_j^{i\prime}\right]=\gamma'+\frac{\operatorname{cov}\left(R_M',R_j^{i\prime}\right)}{\operatorname{var}\left(R_M'\right)}\left(\frac{b\operatorname{var}\left(R_M'\right)}{a-bE\left[R_M'\right]}\right). \tag{11}$$

Finally, in this case,

$$E\left[R_j^{i\prime}\right]=\gamma'+\beta_{M,ij}\lambda_M\ , \tag{12}$$

which is a linear relationship between the expected return of an asset, $E\left[R_j^{i\prime}\right]$, its 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 aggregate nondiversifiable risk, $\lambda_M=\frac{b\operatorname{var}\left(R_M'\right)}{a-bE\left[R_M'\right]}$. Note that equation (12) holds for any assets or portfolio of assets, including the market portfolio and the risk-free asset. Since $\beta_{M,M}=\frac{\operatorname{cov}\left(R_M',R_M'\right)}{\operatorname{var}\left(R_M'\right)}=1$ and $\beta_{M,f}=\frac{\operatorname{cov}\left(R_f',R_M'\right)}{\operatorname{var}\left(R_M'\right)}=0$, equation (12) also implies that $\gamma'=R_f'$ and $\lambda_M=E\left[R_M'\right]-R_f'$. In other words, the price of the aggregate nondiversifiable risk is equal to the return to market portfolio in excess of the risk-free rate. This condition, presented in equation (12), 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 (12) also holds for any of the portfolios constructed by any combinations of the assets $k_j^{i\prime}$ for all *i* and all *j* because the production technology is assumed to be linear in capital. In other words, for each household *j*, we have

$$E\left[R_j'-R_f'\right]=\beta_j\cdot\left(E\left[R_M'\right]-R_f'\right), \tag{13}$$

where $R_j'$ is the return to household *j*'s portfolio and $\beta_j$ is the beta for household *j*,

$$\beta_j=\frac{\operatorname{cov}\left(R_M',R_j'\right)}{\operatorname{var}\left(R_M'\right)} \tag{14}$$

*2.3 The Mechanisms behind Complete Market Outcomes: Tradable Assets versus Consumption Reallocation*

It is important to reiterate that although our empirical counterpart is similar to what has been derived in the traditional CAPM literature, the transaction mechanisms that deliver the predicted allocation outcomes are different. In asset pricing literature, one of the main assumptions is that households (investors) have access to complete markets that allow them to 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. The mechanism behind the asset allocation in the model presented here is different. In this model households do not necessarily trade their assets ex ante. Given asset holding, complete markets in this economy arise from transfers between households in the economy that result in optimal ex post consumption allocation, i.e. consumption allocation under the full risk-sharing regime. These transfers could be through formal or informal financial markets or through gifts within social networks. Specifically, under preferences with Gorman aggregation and with the full sharing of risk, the Pareto weights disappear, and so the return on assets held by each household must satisfy the Euler equation (5).

In fact, using the same data as in this paper, from the Townsend Thai Monthly Survey, a study by Chiappori, Samphantharak, Schulhofer-Wohl, and Townsend (2011) finds evidence of nearly complete risk sharing for households with relatives living in the same village. Their study rejects full insurance among households that have no relative living in the same village, suggesting strongly that gifts and insurance transfers among family-related households are providing something close to a complete markets allocation. Related, Samphantharak and Townsend (2010, Chapter 6) 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 kinship networks are also important for households' access to financing and ability to smooth consumption. Evidently, informal village institutions in Thailand provide risk sharing similar to what is assumed in the model presented in this paper. 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.[10]

## 3. Data

[10] Empirically, complete market environment in village economies could be achieved through a combination of various mechanisms. Households may buy and sell their assets, including livestocks 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 not focus on these various mechanisms in this paper, but see Samphantharak and Townsend (2010) for quantification. Note that despite these mechanisms, there are still several factors that prevent village economies to achieve complete market outcomes, as discussed later in Section 5.

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 a 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 is inter-marriage among households and though less well measured than within villages, gifts and transfers across these nearby villages. In the northeastern province of Srisaket, nucleated clusters of households in a village are readily recognized, but in Buriram these villages have been subsumed by a growing town. For Lopburi and Chachoengsao in the central region, there are no recognizable village boundaries. Thus the benchmark for empirical analysis in this paper will be a township.[11] 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.[12] Approximately 45 households were then sampled from each village. The survey itself began in August 1998 with a baseline interview on initial conditions of sampled households. The monthly updates started in September 1998 and tracked inputs, outputs, and changing conditions of the same households over time.[13] The analysis presented in this paper is based on 84 months, the entire sample available at the time of the initial writing of the initial draft of this paper, starting from month 5. The 84 months are from January 1999 through December 2005. This 84-month period also coincides with the calendar 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 84 months. Since we compute our returns on assets from net income generated from cultivation, livestock, fish

[11] Although townships are larger than villages or networks, households in the same townships are still located closed to each other geographically. The aggregated townships however have larger number of observations than the less aggregated villages or networks, giving us more degree of freedom in the 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, in addition to those noted earlier, we choose to present the results from most of the analysis using a township as the definition of the aggregate economy. Note that, however, using township level delivers similar conclusions as using village or kinship network levels in the analysis. We show some of these results later in this section.

[12] 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.

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

and shrimp farming, and non-agricultural business, we also exclude from this study the households whose entire income in every period during the 84 months was from wage earnings. There are 498 households in the sample: 128 from (the sampled township in) Chachoengsao and 139 from Lopburi provinces in the central region, and 98 from Buriram and 133 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 network, all most 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 of production) of the occupations of 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 fish and shrimp farming and non-farm business are prominent in the township in Chachoengsao province. Cultivation (mainly from cash crops) and livestock raising are the main occupations in Lopburi. In the northeastern region, wage earning and non-farm business contribute a large part of provincial revenues in our sample although most households in the northeast are farmers.[14]

[INSERT Table 2]

[14] The reader should be reminded also that our sample does not include the surveyed households whose income was from wage earnings in all months, as mentioned earlier.

Table 3 presents descriptive statistics of the households in our sample. The unit of observation is a household. Median household sizes were similar across the four townships. The township in Chachoengsao province seemed to have the largest household size, despite its higher level of development with the median at 5.0 members, followed by Srisaket at 4.6, Lopburi at 4.3, and Buriram at 4.2. The overall distributions, illustrated by the quartiles, also showed similar rankings. The statistics show that there were slightly more females than males in all of the townships. This pattern was also observed in all quartiles of the distributions. This is probably due to the prevalent migration pattern, in which more males tended to migrate to work or study outside the village than females. In terms of age profiles (at the time of the beginning of the survey in 1998), most of male and female household members were in the range of 15-60 years old, i.e. in the working age. We compute household average age across all. The median of household average age was higher in the central regions (39 years for Chachoengsao and 36 years for Lopburi) relative to Northeastern region (31 years for Buriram and 34 years for Srisaket). Average education was highest in Chachoengsao (almost 5 years for the median household), followed by Srisaket and Lopburi (about 4 years). Households in Buriram had the lowest education attainment (slightly higher than 3 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 1.4 and 1.2 million baht, respectively, at the beginning of the 84-month period in January 1999. The average nominal total assets over 84 months were 1.6 and 1.5 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 compared to the two townships in the central. The median household in the townships in Buriram and Srisaket had only 0.48 and 0.46 million baht of initial total assets, and 0.52 and 0.43 million baht of average assets, 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. The median leverage ratios, i.e. the ratios of total liabilities to total assets, were only 1% in Chachoengsao and 8% in Srisaket. Finally, the monthly average income of households in the sample also shows similar trend. The median households in the central region earn more than three times than those in the northeast (over nine thousands 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 model 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 difficult 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 error that would cause bias in our empirical analysis.[15]

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 that the income was generated. This is the standard way that financial accounting measures performance of productive assets. As a consequence, however, we are ignoring 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 of return, we use the real accrued net income and the real value of household's total fixed assets in the ROA calculation. The real variables were computed using the monthly Consumer Price Index (CPI) at the national level from the Bank of Thailand. Although we realize that the inflation in each township could be different from the national rate, at the time of writing this paper we still do not have a reliable measure of the price index at the village level and have to rely on the national statistics.[16]

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. The calculation also takes into account the fact that household selected themselves into different occupations.[17]

[INSERT Table 4]

[15] For similar reasons, we do not distinguish well the use of assets for production activity versus consumption activity. This could downwardly bias 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.

[16] 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.

[17] See Samphantharak and Townsend (2012) and Townsend and Yamada (2008) for detailed discussion on how to impute wages from non-market production activities.

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 of the unadjusted and adjusted ROA by province. The table also presents statistics for the *Sharpe ratio* of household total assets. The Sharpe ratio measures the expected excess return in relative to the volatility of the return. 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 coefficient of variation of the excess return on assets. In this paper, we assume that the real risk-free rate is zero for all of the periods and for all of the townships, based on the following assumptions: (1) the households in our sample have access to a storage technology; (2) the capital gain, net of depreciation, of the stored goods change at the same rate as inflation; and (3) there is no other risk of holding this good except for inflation. In this case, the stored goods could be viewed as an asset indexed to inflation and have zero real rate of return. As a result, we compute the simple Sharpe ratio as the absolute value of household's monthly average ROA divided by the standard deviation of the ROA, i.e. the inverse coefficient of variation of ROA. The results in Table 4 show that medians of annualized average adjusted ROA were 0.68% for Chachoengsao and 3.31% for Lopburi in the central region, and 0.31% for Buriram, and 1.47% for Srisaket in the northeast. The fluctuations of adjusted ROA as measured by the standard deviation show that adjusted ROA for the township in Chachoengsao fluctuated the least among the four townships while adjusted ROA of the township in Srisaket fluctuated most. Also, the median Sharpe ratios were again lower for the two townships in the northeast, specifically 0.17 for Buriram and 0.19 for Srisaket. The ratios were higher for the two townships in the central, 0.35 for Chachoengsao and 0.424 for Lopburi. For comparison, we also present the counterpart statistics for household unadjusted ROA, which show a similar pattern.

## 4. Risk and Return in Village Economy

### *4.1 Household Beta as a Measure of Nondiversifiable Risk*

We apply the traditional cross-sectional test in CAPM literature to our model. The test contains two stages. In the first stage, we compute the asset beta of a household's portfolio of assets from a time-series regression. We do this to get household's $\beta_j$ for all household *j*.

We define a township as the market or aggregate economy and use township average returns on assets as market return $R_M^l$. Market 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. Again, the market return is computed as the real rate of return, using the same price index as the calculation of the rates of return on household assets. Finally, from equation (14) we compute an asset beta of household *j*, $\beta_j$ , which is identical to a regression coefficient from running a simple regression of $R^{l}_{j,t}$ on $R^{l}_{M}$. Specifically, the first stage, time-series regression specification is

$$R^{l}_{j,t} = \alpha_j + \beta_j R^{l}_{M,t} + \varepsilon_{j,t}\,. \tag{15}$$

From the theory, the null hypothesis is that $\alpha_j = 0$, for all *j*. We will revisit this implication again in Section 6.

In the second stage, we test the expected return-beta relationship derived earlier in equation (12). We first compute the expected rate of return on assets of household *j*, $E\left[R^{l}_{j}\right]$. Empirically, this expected return is computed as a simple time-series average of monthly rates of return, $\overline{R^{l}_{j}} = \frac{\sum_{t=1}^{T} R^{l}_{j,t}}{T}$. Finally we run a cross-sectional regression of the average return on assets of households in our sample on their beta estimated earlier in equation (15), for each township at a time.

$$\overline{R^{l}_{j}} = \alpha + \lambda \widehat{\beta_j} + \eta_j\,. \tag{16}$$

From the theory, the null hypotheses from the model are that $\lambda = E\left[R^{l}_{M}\right]$, and that the constant term $\alpha$ is zero.

*4.2 Empirical Results*

We present in Table 5 the regressions using township as our definition of aggregate economy. The results show that the regression coefficient of household beta is positive for all of the regressions. We then look at a stronger null hypothesis that $\lambda = E\left[R^{l}_{M}\right]$, comparing the magnitude of the regression coefficient $\lambda$ with the township expected return. Table 5 also provides each township's aggregate expected return, as computed as the time-series average of average return of assets in the township. All of the regression coefficients are statistically different from the township average return, inconsistent with the prediction from our model. The zero constant implication is also harder to achieve.

[INSERT Table 5]

One may argue that kinship networks are local and operate better at the village or network levels than at the township level. Table 6 reports the second-stage regression results when we use villages as markets. Despite 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 15 of the 16 villages in our sample, with the only exception of one village in Buriram province. The result also shows that we cannot reject the null hypothesis that $\lambda = E\left[R^{l}_{M}\right]$ at 10% level of significance for four out of 16 villages in the sample (Villages 4 and 7 in Chachoengsao; Villages 2 in Buriram; and Villages 3 in Lopburi). All of the villages in Srisaket reject this null hypothesis.

[INSERT Table 6]

Finally, we perform 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 where (i.e. 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 familially 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.

[INSERT Figure 1: Example of Network Map]

We present in Table 7 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 7 shows that the regression coefficient of household beta is significantly positive for six of the seven networks in our sample. For all of the networks, we however reject the null hypothesis that the regression coefficient is equal to the network's average return.[18]

[INSERT Table 7]

In sum, the positive $\lambda$ implication from the model is pervasive in the data at virtually all levels of aggregation. The more stringent test of $\lambda = E\left[R_M^j\right]$ is more difficult to satisfy.

[INSERT Figure 2: CAPM]

To illustrate our results graphically, Panel A of Figure 2 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. Panel B uses village as aggregate economy while Panel C uses networks. In general, the figures show a positive relationship between household beta and its expected return. From this result we conclude 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.

[18] Finally, although the result shows that we cannot reject the null hypothesis that the constant term from the cross-sectional regression, $\alpha$, is not significantly different from zero for eight of the 16 villages.

## 5. Critiques and Extensions

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

### *5.1 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 market ROA. This is of course possible in our data since survey data are in general subject to measurement errors. However, the bias from measurement errors may not be severe: First, we use household portfolio as our unit of observation when we compute household beta. Since the value of and income from 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.[19] 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 positive correlation between 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 the direct answers on revenue from those production activities to compute household ROA. Since our empirical results hold for both townships, villages, and networks with and without major revenues from cultivation, and our results are robust, we do not think that this problem is source of the measured correlation.

### *5.2 Change in Household Composition of Assets and Production Activities*

Similar to the traditional CAPM in 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 seven years. It is likely that the composition of household occupation (and hence assets and their associated risks) of some of our sampled households had changed during this period. Similarly, the expected market returns $E\left[R_M^l\right]$ could change over time as well, not least from changes in conditioning factors.

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[19] Empirically, this argument is similar to the idea that was introduced to the empirical CAPM literature by Black, Jensen, and Scholes (1972).

[INSERT Table 8]

We explore this issue by performing our empirical analysis, as presented in Section 4, on the subsamples over four different periods separately, namely, months 5-25, 26-46, 47-67, and 68-88. Table 8 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.

*5.3 Human Capital*

The model implies that beta captures all of the aggregate, non-diversifiable risk. It is possible that there is an 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's 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 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 in this subsection by computing an additional household beta with respect to return to aggregate human capital, $R_M^h$, proxied by the change in aggregate labor income of all households in the economy.[20] In particular, the first-stage time-series regression becomes

$$R_{j,t}^{l} = \alpha_j + \beta_j^a R_{M,t}^a + \beta_j^h R_{M,t}^h + \varepsilon_{j,t}$$

and the second-stage cross-sectional regression is

$$\overline{R_j^l} = \alpha + \lambda^a \widehat{\beta_j^a} + \lambda^h \widehat{\beta_j^h} + \eta_j .$$

[INSERT Table 9]

Table 9 shows that the regression coefficient of beta with respect to human capital is not statistically significant in our sample. 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.

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[20] This strategy was used in finance literature by Jagannathan and Wang (1996). Their strategy is based on a simplified ad hoc assumption that per capita 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 therefore 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 of human capital can be proxied by the rate of change of labor income.

*5.4 Time-Varying Stochastic Discount Factor*

Similar to the traditional CAPM in finance literature, our model assumes that parameters that determine stochastic discount factors are time-invariant. For example, the stochastic discount factor, $m^l$, in equation (9) depends on the time-invariant parameters *a* and *b*. Parameters *a* and *b* however are determined by the shadow price of consumption goods, $\mu$, 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 ratio.[21] 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 $\omega$ is the share of physical wealth in total wealth.

Since we do not observe the share of non-human wealth, $\omega$, 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

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

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 we compute beta's with respect to the market return on physical capital, $r_{M,t}^a$; the market return on human capital (as computed in the previous subsection), $r_{M,t}^h$; the predicted value of $\widehat{cay}_t$ computed in the first stage, the interaction between $r_{M,t}^a$ and $\widehat{cay}_t$; and the interaction between $r_{M,t}^h$ and $\widehat{cay}_t$.

$$R_{j,t}^l = \alpha_j + \beta_j^a R_{M,t}^a + \beta_j^h R_{M,t}^h + \beta_j^{cay} \widehat{cay}_t + \beta_j^{cay*a} (\widehat{cay}_t \cdot R_{M,t}^a) + \beta_j^{cay*h} (\widehat{cay}_t \cdot R_{M,t}^h) + \varepsilon_{j,t} \quad (17)$$

---

[21] 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.

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.

$$\overline{R_j^l} = \alpha + \lambda^a \widehat{\beta_j^a} + \lambda^h \widehat{\beta_j^h} + \lambda^{cay} \widehat{\beta_j^{cay}} + \lambda^{cay*a} \widehat{\beta_j^{cay*a}} + \lambda^{cay*h} \widehat{\beta_j^{cay*h}} + \eta_j . \qquad (18)$$

The results shown in Table 9 indicate that the additional factors matter in some of the townships. The coefficient for the interaction between log consumption-wealth ratio and return on township human capital is positively significant in three of the four townships. The coefficient for the interaction with return on township non-human assets is also positively significant for the township in Srisaket. However, the coefficients for the log consumption-wealth ratio and its interaction with the return on township non-human assets are negatively significant. Overall, with the additional factors, the regression coefficients of market physical assets, the main variable from our model, remain positively significant for all of the four townships.

*5.5 Idiosyncratic Risk and Omitted Variable Bias*

Despite several mechanisms described earlier (purchase and sale of inventories, livestocks 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 obstructions that prevent the village economies to achieve complete market outcomes, including full risk sharing. These obstructions include limited commitment, moral hazard, and hidden income.[22] With the departure from complete risk sharing, idiosyncratic risks could have positive price and the expect return on assets may contain a risk premium that compensates for exposure to these risks.[23]

[INSERT Table 10]

In empirical finance literature, monthly idiosyncratic risks are usually computed from the volatility of the return using daily returns during the months (or their lags).[24] Since our data is monthly, we cannot apply such strategy to our model. However, we provide an alternative measure of idiosyncratic risks by computing standard deviation of the residuals from each of the household's time-series regressions in the first step, i.e. the residuals from equation (17). This strategy is similar to what was used by Calvet, Campbell, and Sodini (2007). We consider the standard deviation of the residual,

[22] 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 these three types of models.

[23] 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.

[24] In some studies, the idiosyncratic risks are derived from the standard deviation of the residuals from CAPM regressions using daily returns. In other studies, the volatility is computed from variants of time-series ARCH models. See Ang, Hodrick, Xing, and Zhang (2006) and Fu (2009), for example.

henceforth referred as *household sigma*, as our measure of idiosyncratic risks since it summarizes the volatility of the returns not captured by other factors (market returns on human and non-human assets, consumption-wealth ratio of the aggregate economy, and the interaction terms). We then add this standard deviation as an additional explanatory variable in equation (18). The results in Table 10 show that higher idiosyncratic risks as measure by household sigma is associated with higher average returns in three of the four townships, with the exception of the township in Srisaket. Also, once controlled for our measure idiosyncratic risks, the negative coefficients of the factors in Table 9 become insignificant or less significant. Finally, once household sigma is included in our regression, the coefficients for beta with respect to the market return on non-human assets remain positively significant in three of the four townships, with the exception of the township in Buriram.

It is important to note that household sigma may contain other information in addition to the idiosyncratic risks faced by each household. There may be unobserved factors that matter for the mean and the variation of asset returns but are not included in equation (17). In such case, 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 10.

## 6. Application: Risk Premium versus Productivity

Although empirical tests of conventional Capital Asset Pricing Model (CAPM) using returns on corporate stocks traded on the markets such as New York Stock Exchange yield less than satisfactory results[25], practitioners commonly use CAPM to adjust for risk when they compute the cost of capital for project investment. They also use CAPM to compute risk-adjusted returns that are used to compare the performance of securities or of fund managers. In development economics, the rates of return on assets and equity are usually used as a measure of performance or productivity of a firm or a household enterprise. [26] The simple returns to assets and equity however do not take into account that higher expected returns could be resulted from the compensation for the higher risk in certain production activities. In addition, there has been little attempt in distinguishing risk as measured by the variance of asset returns (total risk, including idiosyncratic risk) versus risk as measured by the covariance between asset returns and market returns (aggregate nondiversificable risk). In order to compare household productivity in a cross section, we need to compute risk-adjusted returns, i.e. the returns not driven by the riskiness of the production technology. The practice in financial industry provides us with an insight that we can apply to the study of productivity of household enterprises in

[25] See a discussion in Fama and French (2004) as an example.

[26] 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.

development economics, using risk-adjusted returns when we compare the productivity of the assets or household enterprises.

*6.1 Household Alpha as a Measure of Risk-Adjusted Return*

The model in Section 2 gives us the null hypothesis that the constant $\alpha^j$ 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 $\beta^j$, determines the excess return of the assets. In reality, however, the $\alpha^j$ 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. In the conventional CAPM context, Jensen (1967) argues that $\alpha^j$ 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 $\alpha^j$ as how well household $j$ manages its assets in generating income in excess of risk premium. We compute household $j$'s alpha, and then use it as our measure of risk-adjusted rate of return. It is important to note that non-zero risk-adjusted returns cannot, in theory, explained by our model since 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. The explanation for risk-adjusted return being different from the risk-free rate must be from some frictions in the economy that prevent it to achieve complete market environment or some estimation problems such as omitted variables.

*6.2 Empirical Results*

We apply the idea of Jensen's alpha to the households in the Townsend Thai Monthly Survey. We present two measures of risk-adjusted returns. The first one is adjusted for aggregate risks based on equation (18) and the right panel of Table 9. The second one is further adjusted for idiosyncratic risks, in addition to aggregate risks, based on the regression results in Table 10. Table 11 presents summary statistics for both measures of risk-adjusted returns, using township as aggregate economy.

[INSERT Table 11]

Note that we should be careful in interpreting the estimate of risk-adjusted returns in the absolute term because they are computed under the assumptions that the risk-free rate was zero. Table 11 also presents rank correlation between the risk-adjusted returns and the simple ROA's that are not adjusted for risks. The results show that we cannot statistically reject that the rank orders or risk-adjusted and unadjusted ROA's are not different. Figure 3 shows a histogram comparing the return on assets that is not adjusted for risks with the return adjusted for both beta and sigma, for each township. The histograms shows that although the adjustment for risk still preserves the rank orders of the rate of return, the distribution and the level of the return evidently change.

*6.3 Household Characteristics, Risks, and Asset Returns*

Finally, we explore whether household rates of return are correlated with observable household characteristics such as demography, initial wealth, and initial leverage. Table 12 presents the results when we use various measures of return on assets as the dependent variable, 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 10.

[INSERT Table 12]

The first column of the table shows that household size, average age, and initial wealth are associated with the accounting ROA, not adjusted for household labor and risks. It is not surprising that once we adjust for household labor, the size of the regression coefficient for household size drops dramatically, as shown in column 2, since household size is highly correlated with household labor supply. Initial wealth still has negative association with asset returns. Education of household head shows up as positively correlated to the return. When we adjust for aggregate risks, only initial wealth still matters. Finally, when idiosyncratic risks are used for adjustment, the return on asset depends only on the average age of the households. Specifically, the younger households seem to have higher average return on assets than the older households (even controlled for the level of education of household head). The last two columns of Table 12 show the relationship between risks, as measured by beta and sigma, and household characteristics. For both types of risks, education of the household head and the initial wealth of the household are associated with risks. The more educated heads tend to be involved in the production activities that are more risky, in both aggregate and idiosyncratic sense. Finally, poorer households as measured by initial wealth tend to face higher risks as well.

## 7. Conclusion

We present a model for the study of risk and return of household assets in village economies. The model yields similar insights and predictions to those derived from the traditional Capital Asset Pricing Model (CAPM) and the Consumption-based Asset Pricing Model (CCAPM) in finance literature. We apply our model to the monthly panel data from a household survey in rural Thailand. We find that a higher exposure to aggregate, non-diversifiable risk is related to a higher expected return on assets of the households, largely consistent with a prediction from the model presented in this paper, which is in turn consistent to the prediction from the conventional CAPM. This finding is robust when we use a village or a network as our alternative definitions of the aggregate economy. The main result is also robust in the extended specifications where we include household human capital and allow for time-varying stochastic discount factors. Contrary to a prediction from the complete market setup, we find that idiosyncratic risks have positive price in our data, i.e. the more the households are exposed to idiosyncratic risks, the higher the expected rate of return. We then use the prediction from the model to compute the risk-adjusted return for each household. We find that exposure to both aggregate and idiosyncratic risks of the household is positively associated with the education of household head and negatively associated with the initial wealth of the household. Adjusted for risks, the return on household assets is negatively correlated with the average age of the household. This finding has an important policy implication on economic development. Higher return on assets of a household may not imply that the household is more able or more productive than others. The higher (average) return could well reflect the fact that the household is engaged in more risky production activities and therefore compensated for the higher risk in the form of higher average return. This implication in turn reinforces the importance of a high-frequency household survey that allows researchers to compute the co-movement of returns, something that could not be done in a one-shot survey.

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**Table 1 Descriptive Statistics of Networks in Village and Township**

| ***Region*** | ***Central*** | | ***Northeast*** | |
|---|---|---|---|---|
| ***Province*** | **Chachoengsao** | **Lopburi** | **Buriram** | **Srisaket** |
| Number of Observations | 128 | 139 | 98 | 133 |
| % of Households with relatives living in the same... | | | | |
| Village | 50.8% | 77.0% | 82.7% | 88.0% |
| Township | 87.8% | 88.4% | 97.1% | 94.0% |

**Remarks** 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.

**Table 2 Revenue from Production Activities (% by Township)**

| *Region:* | *Central* | | *Northeast* | |
|---|---|---|---|---|
| ***Province:*** | ***Chachoengsao*** | ***Lopburi*** | ***Buriram*** | ***Srisaket*** |
| Production Activities | | | | |
| Cultivation | 11.9% | 33.8% | 11.9% | 28.3% |
| Livestock | 14.5% | 28.1% | 1.5% | 1.3% |
| Fish and Shrimp | 26.7% | 0.0% | 0.2% | 1.9% |
| Non-farm Business | 28.3% | 20.9% | 48.5% | 29.0% |
| Wage Earning | 18.2% | 13.9% | 33.9% | 34.6% |
| Number of Sampled Households | 128 | 139 | 98 | 133 |

**Remarks** The unit of observations is township. The revenues are monthly average of village's total revenue in each activity in baht over the 84-month period from January 1999 to December 2005.

**Table 3 Descriptive Statistics of Household Characteristics, By Township**

| | Number of Observations | Percentiles 25th | 50th | 75th | Number of Observations | Percentiles 25th | 50th | 75th |
|---|---|---|---|---|---|---|---|---|
| ***Region*** | ***Central*** | | | | | | | |
| ***Province (Township)*** | ***Chachoengsao*** | | | | ***Lopburi*** | | | |
| *As of December 1998:* | | | | | | | | |
| Household size | 128 | 3.6 | 5.0 | 6.6 | 139 | 3.2 | 4.3 | 5.2 |
| Male | 128 | 1.4 | 2.1 | 3.0 | 139 | 1.0 | 2.0 | 2.8 |
| Female | 128 | 1.9 | 2.8 | 3.9 | 139 | 1.5 | 2.2 | 3.0 |
| Male, age 15-60 | 128 | 0.7 | 1.3 | 2.0 | 139 | 0.5 | 1.0 | 1.8 |
| Female, age 15-60 | 128 | 1.0 | 1.6 | 2.2 | 139 | 1.0 | 1.4 | 2.0 |
| Average age | 128 | 33.8 | 38.9 | 45.8 | 139 | 29.5 | 35.5 | 44.8 |
| Average years of education | 128 | 3.9 | 4.8 | 6.1 | 139 | 3.1 | 3.9 | 5.0 |
| Total Assets (Baht) | 128 | 415,503 | 1,381,069 | 3,383,761 | 139 | 417690 | 1218133 | 2758164 |
| *84-Month Average (January 1999-December 2005):* | | | | | | | | |
| Monthly Income (Baht) | 128 | 4,539 | 11,727 | 19,737 | 139 | 3,804 | 9,178 | 15,956 |
| Total Assets (Baht) | 128 | 657,274 | 1,587,724 | 4,093,211 | 139 | 611,769 | 1,518,350 | 2,836,570 |
| Fixed Assets (% of Total Assets) | 128 | 50% | 71% | 86% | 139 | 56% | 70% | 82% |
| Total Liability (Baht) | 128 | 4,630 | 19,152 | 77,716 | 139 | 26,959 | 82,197 | 177,629 |
| Liability to Asset Ratio | 128 | 0% | 1% | 5% | 139 | 2% | 6% | 11% |
| ***Region*** | ***Northeast*** | | | | | | | |
| ***Province (Township)*** | ***Buriram*** | | | | ***Srisaket*** | | | |
| *As of December 1998:* | | | | | | | | |
| Household size | 98 | 3.2 | 4.2 | 5.4 | 133 | 3.6 | 4.6 | 6.0 |
| Male | 98 | 1.2 | 2.0 | 2.6 | 133 | 1.3 | 2.0 | 2.9 |
| Female | 98 | 1.6 | 2.5 | 3.3 | 133 | 1.7 | 2.5 | 3.2 |
| Male, age 15-60 | 98 | 0.5 | 1.0 | 1.5 | 133 | 0.8 | 1.1 | 1.6 |
| Female, age 15-60 | 98 | 1.0 | 1.2 | 2.0 | 133 | 1.0 | 1.4 | 2.0 |
| Average age | 98 | 26.0 | 31.4 | 38.3 | 133 | 28.6 | 33.6 | 38.7 |
| Average years of education | 98 | 2.2 | 3.2 | 4.3 | 133 | 3.0 | 4.0 | 4.7 |
| Total Assets (Baht) | 98 | 255,214 | 484,365 | 928,049 | 133 | 198,737 | 461,708 | 974,836 |
| *84-Month Average (January 1999-December 2005):* | | | | | | | | |
| Monthly Income (Baht) | 98 | 1,598 | 3,065 | 4,979 | 133 | 1,718 | 2,773 | 4,454 |
| Total Assets (Baht) | 98 | 306,355 | 516,361 | 955,828 | 133 | 239,743 | 528,602 | 1,038,755 |
| Fixed Assets (% of Total Assets) | 98 | 59% | 71% | 81% | 133 | 60% | 74% | 85% |
| Total Liability (Baht) | 98 | 16,223 | 37,096 | 69,342 | 133 | 17,279 | 35,884 | 65,802 |
| Liability to Asset Ratio | 98 | 3% | 6% | 14% | 133 | 3% | 8% | 15% |

**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 | 128 | 2.80 | 7.90 | 17.47 | 139 | 4.26 | 8.60 | 15.69 |
| Standard Deviation | 128 | 4.63 | 12.05 | 27.26 | 139 | 7.67 | 12.84 | 27.83 |
| Sharpe Ratio | 128 | 0.37 | 0.55 | 1.09 | 139 | 0.35 | 0.55 | 0.99 |
| Adjusted ROA | | | | | | | | |
| Mean | 128 | -0.74 | 0.68 | 4.30 | 139 | 0.61 | 3.31 | 7.89 |
| Standard Deviation | 128 | 1.47 | 5.18 | 16.07 | 139 | 4.97 | 8.42 | 14.38 |
| Sharpe Ratio | 128 | 0.20 | 0.35 | 0.62 | 139 | 0.25 | 0.44 | 0.81 |
| ***Region:*** | ***Northeast*** | | | | | | | |
| ***Province (Township):*** | ***Buriram*** | | | | ***Srisaket*** | | | |
| Unadjusted ROA | | | | | | | | |
| Mean | 98 | 2.63 | 7.58 | 12.59 | 133 | 3.39 | 7.65 | 15.63 |
| Standard Deviation | 98 | 9.73 | 20.00 | 38.84 | 133 | 9.18 | 19.20 | 37.25 |
| Sharpe Ratio | 98 | 0.21 | 0.33 | 0.47 | 133 | 0.28 | 0.37 | 0.46 |
| Adjusted ROA | | | | | | | | |
| Mean | 98 | -0.61 | 0.31 | 1.83 | 133 | 0.06 | 1.47 | 3.79 |
| Standard Deviation | 98 | 2.96 | 8.16 | 13.76 | 133 | 5.71 | 11.63 | 20.69 |
| Sharpe Ratio | 98 | 0.09 | 0.17 | 0.31 | 133 | 0.11 | 0.19 | 0.28 |

**Remarks** Unit of observations is households. ROA is return on total assets adjusted for labor income, reported in annualized percentage. Mean ROA is simple average of monthly adjusted ROA for each household over 84 months (January 1999 to December 2005). SD ROA is standard deviation of monthly adjusted ROA over the same period. Sharpe ratio is computed as the standard deviation of ROA divided by absolute value of the mean ROA.

**Table 5 Risk and Return Regressions: Township as Market**

| ***Dependent Variable:*** | ***Household's Mean Adjusted ROA*** | | | |
|---|---|---|---|---|
| ***Region:*** | ***Central*** | | ***Northeast*** | |
| ***Province:*** | ***Chachoengsao*** | ***Lopburi*** | ***Buriram*** | ***Srisaket*** |
| Beta | 1.569*** | 2.999*** | 1.859*** | 1.991*** |
| | (0.127) | (0.524) | (0.236) | (0.178) |
| Constant | 0.606* | -0.132 | 2.795*** | -0.703** |
| | (0.318) | (0.304) | (0.480) | (0.322) |
| Observations | 128 | 98 | 139 | 133 |
| R-squared | 0.737 | 0.396 | 0.307 | 0.644 |
| *Township Returns:* | | | | |
| Monthly Average | 1.95 | 4.37 | -0.03 | 0.76 |
| Standard Deviation | 1.93 | 3.84 | 3.15 | 4.95 |

**Remarks** Unit of observations is household. Household's mean adjusted ROA is the average of household adjusted ROA over the 84 months from January 1999 to December 2005. Adjusted 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. The adjusted ROA is then annualized and presented in percentage points. For columns (1) to (4), beta is computed from a simple time-series regression of household adjusted ROA on provincial ROA over 84 months. For columns (5), Beta is computed from a simple time-series regression of household adjusted ROA on the ROA of the entire sample over 84 months. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

**Table 6 Risk and Return Regressions: Village as Market**

| ***Dependent Variable:*** | ***Household's Mean Adjusted ROA*** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Province:*** | ***Chachoengsao*** | | | | ***Lopburi*** | | | |
| ***Village:*** | ***02*** | ***04*** | ***07*** | ***08*** | ***01*** | ***03*** | ***04*** | ***06*** |
| Beta | 2.583*** | 3.694*** | 2.852*** | 1.149*** | 1.761*** | 3.695*** | 1.469* | 2.644*** |
| | (0.181) | (0.408) | (0.957) | (0.210) | (0.633) | (1.268) | (0.733) | (0.544) |
| Constant | 1.299 | 0.295 | 0.252 | 0.332 | 1.210 | 1.946* | 3.126*** | 4.843*** |
| | (0.941) | (0.442) | (0.744) | (0.449) | (1.079) | (1.094) | (1.047) | (0.934) |
| Observations | 35 | 36 | 26 | 31 | 34 | 26 | 38 | 41 |
| R-squared | 0.715 | 0.854 | 0.262 | 0.463 | 0.295 | 0.237 | 0.162 | 0.375 |
| *Village Returns:* | | | | | | | | |
| Monthly Average | 2.24 | 2.79 | 3.22 | 0.88 | 2.40 | 5.33 | 2.90 | 7.02 |
| Standard Deviation | 3.18 | 4.38 | 3.30 | 1.44 | 2.77 | 3.45 | 3.45 | 7.95 |

| ***Province:*** | ***Buriram*** | | | | ***Srisaket*** | | | |
|---|---|---|---|---|---|---|---|---|
| ***Village:*** | ***02*** | ***10*** | ***13*** | ***14*** | ***01*** | ***06*** | ***09*** | ***10*** |
| Beta | 0.699 | 2.988** | 1.657*** | 14.02*** | 1.443*** | 6.893*** | 3.340*** | 0.772*** |
| | (0.544) | (1.039) | (0.313) | (4.821) | (0.137) | (0.528) | (0.412) | (0.0740) |
| Constant | 0.212 | -1.051 | -0.460 | 0.371 | -1.299*** | -0.155 | -1.512** | -1.521 |
| | (0.392) | (0.698) | (0.358) | (0.961) | (0.469) | (0.337) | (0.601) | (1.140) |
| Observations | 32 | 14 | 23 | 29 | 37 | 41 | 34 | 21 |
| R-squared | 0.043 | 0.507 | 0.631 | 0.404 | 0.760 | 0.871 | 0.643 | 0.537 |
| *Village Returns:* | | | | | | | | |
| Monthly Average | -0.51 | 0.64 | 0.03 | 0.73 | 0.20 | 2.13 | 0.08 | 0.22 |
| Standard Deviation | 3.87 | 5.67 | 3.49 | 7.36 | 4.72 | 7.49 | 5.90 | 3.18 |

**Remarks** Unit of observations is household. Each column reports a regression result for each village in the four province. Household's mean adjusted ROA is the average of household adjusted ROA over the 84 months from January 1999 to December 2005. Adjusted 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. The adjusted ROA is then annualized and presented in percentage points. Beta is computed from a simple time-series regression of household adjusted ROA on village ROA over 84 months. Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

**Table 7 Risk and Return Regressions: Network as Market**

| ***Dependent Variable:*** | ***Household's Mean Adjusted ROA*** | | | |
|---|---|---|---|---|
| ***Region:*** | ***Central*** | | | |
| ***Province:*** | ***Lopburi*** | | | |
| ***Village:*** | ***01*** | ***03*** | ***04*** | ***06*** |
| ***Network:*** | ***03*** | ***03*** | ***06*** | ***01*** |
| Beta | 2.782*** | 9.256*** | 0.451 | 2.770*** |
| | (0.326) | (1.822) | (1.341) | (0.618) |
| Constant | -0.437 | 2.260 | 3.755** | 5.070*** |
| | (0.713) | (1.482) | (1.392) | (1.059) |
| Observations | 18 | 16 | 20 | 34 |
| R-squared | 0.809 | 0.300 | 0.014 | 0.374 |
| *Network Returns:* | | | | |
| Monthly Average | 2.06 | 6.82 | 1.85 | 7.20 |
| Standard Deviation | 3.11 | 4.39 | 3.28 | 8.75 |

| ***Region:*** | ***Northeast*** | | | | |
|---|---|---|---|---|---|
| ***Province:*** | ***Buriram*** | | ***Srisaket*** | | |
| ***Village:*** | ***13*** | ***14*** | ***01*** | ***06*** | ***09*** |
| ***Network:*** | ***03*** | ***03*** | ***03*** | ***02*** | ***02*** |
| Beta | 0.561** | 20.88*** | 1.548*** | 7.834*** | 2.940*** |
| | (0.244) | (3.025) | (0.185) | (0.634) | (0.385) |
| Constant | -0.451 | -0.455 | -1.366** | -0.155 | -1.503** |
| | (0.365) | (0.542) | (0.614) | (0.379) | (0.620) |
| Observations | 16 | 22 | 22 | 36 | 33 |
| R-squared | 0.238 | 0.740 | 0.767 | 0.894 | 0.632 |
| *Network Returns:* | | | | | |
| Monthly Average | -0.56 | 0.88 | 0.85 | 2.12 | 0.06 |
| Standard Deviation | 2.29 | 6.01 | 6.24 | 7.34 | 5.88 |

**Remarks** Unit of observations is household. Each column reports a regression result for each network group. Only network groups with more than 15 households are included. Household's mean adjusted ROA is the average of household adjusted ROA over the 84 months from January 1999 to December 2005. Adjusted 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. The adjusted ROA is then annualized and presented in percentage points. Beta is computed from a simple time-series regression of household adjusted ROA on network ROA over 84 months. Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

**Table 8 Risk and Return Regressions, Allowing for Change in Beta: Township as Market**

| *Dependent Variable* | *Household's Mean Adjusted ROA* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Period* | *Period 1: Months 5-25* | | | | *Period 2: Months 26-46* | | | |
| *Region* | *Central* | | *Northeast* | | *Central* | | *Northeast* | |
| *Province* | *Chachoengsao* | *Lopburi* | *Buriram* | *Srisaket* | *Chachoengsao* | *Lopburi* | *Buriram* | *Srisaket* |
| Beta | 1.123*** | 1.083*** | 0.469*** | 0.785*** | 1.132*** | 1.404*** | 0.438* | 2.142*** |
| | (0.234) | (0.226) | (0.166) | (0.105) | (0.163) | (0.246) | (0.254) | (0.243) |
| Constant | 1.166*** | 3.516*** | 0.540* | 0.392 | 1.349*** | 3.172*** | 0.532 | 0.103 |
| | (0.435) | (0.454) | (0.273) | (0.318) | (0.428) | (0.488) | (0.443) | (0.328) |
| Observations | 128 | 139 | 98 | 133 | 128 | 139 | 98 | 133 |
| R-squared | 0.530 | 0.206 | 0.168 | 0.539 | 0.479 | 0.228 | 0.192 | 0.571 |

| *Period* | *Period 3: Months 47-67* | | | | *Period 4: Months 67-88* | | | |
|---|---|---|---|---|---|---|---|---|
| *Region* | *Central* | | *Northeast* | | *Central* | | *Northeast* | |
| *Province* | *Chachoengsao* | *Lopburi* | *Buriram* | *Srisaket* | *Chachoengsao* | *Lopburi* | *Buriram* | *Srisaket* |
| Beta | 0.589*** | 1.523*** | 3.715*** | 1.094*** | 0.698*** | 1.368*** | 0.452 | 1.581*** |
| | (0.0821) | (0.244) | (1.371) | (0.131) | (0.0957) | (0.244) | (0.368) | (0.314) |
| Constant | 1.653*** | 3.158*** | 0.730** | -0.0376 | 2.105*** | 3.194*** | 0.597 | -0.306 |
| | (0.448) | (0.497) | (0.299) | (0.319) | (0.535) | (0.475) | (0.506) | (0.422) |
| Observations | 128 | 139 | 98 | 133 | 128 | 139 | 98 | 133 |
| R-squared | 0.490 | 0.236 | 0.180 | 0.568 | 0.254 | 0.244 | 0.121 | 0.329 |

**Table 9 Risk and Return Regressions with Human Capital and Time-Varying Stochastic Discount Factor: Township as Market**

| *Dependent Variable:* | *Household's Mean Adjusted ROA* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Region:* | *Central* | | *Northeast* | | *Central* | | *Northeast* | |
| *Province:* | *Chachoengsao* | *Lopburi* | *Buriram* | *Srisaket* | *Chachoengsao* | *Lopburi* | *Buriram* | *Srisaket* |
| Beta with respect to | 1.479*** | 1.953*** | 3.221*** | 1.950*** | 1.505*** | 1.769*** | 2.753*** | 3.622*** |
| return on market physical capital (ra) | (0.132) | (0.239) | (0.500) | (0.219) | (0.0902) | (0.302) | (0.579) | (0.861) |
| Beta with respect to | -0.000460 | -0.0138 | 0.156 | -0.0234 | -0.107 | -0.00175 | -0.321** | -0.0384 |
| return on market human capital (rh) | (0.0635) | (0.143) | (0.156) | (0.127) | (0.0755) | (0.238) | (0.127) | (0.0699) |
| Beta with respect to | | | | | -0.0926*** | -0.0271 | 0.0379 | -0.0188 |
| residual log consumption (cay) | | | | | (0.0222) | (0.0293) | (0.0290) | (0.0702) |
| Beta with respect to | | | | | -0.00131*** | -0.00194 | 0.00180 | 0.00657** |
| the interaction cay*ra | | | | | (0.000297) | (0.00120) | (0.00304) | (0.00328) |
| Beta with respect to | | | | | 0.000288*** | -7.76e-05 | 0.000347* | 0.000710** |
| the interaction cay*rh | | | | | (0.000104) | (0.000164) | (0.000181) | (0.000295) |
| Constant | 0.802** | 2.745*** | -0.119 | -0.760** | 0.684** | 2.823*** | -0.180 | -0.830** |
| | (0.328) | (0.488) | (0.294) | (0.366) | (0.303) | (0.488) | (0.349) | (0.329) |
| Observations | 128 | 139 | 98 | 133 | 128 | 139 | 98 | 133 |
| R-squared | 0.697 | 0.319 | 0.425 | 0.645 | 0.774 | 0.320 | 0.519 | 0.684 |

**Table 10 Aggregate Risk, Idiosyncratic Risk, and Rate of Return: Township as Market**

| ***Dependent Variable:*** | ***Household's Mean Adjusted ROA*** | | | |
|---|---|---|---|---|
| ***Region:*** | ***Central*** | | ***Northeast*** | |
| ***Province:*** | ***Chachoengsao*** | ***Lopburi*** | ***Buriram*** | ***Srisaket*** |
| Beta with respect to | 0.775*** | 1.184*** | 0.816 | 3.748*** |
| return on market physical capital (ra) | (0.157) | (0.404) | (0.749) | (0.932) |
| Beta with respect to | -0.109* | 0.142 | 0.0880 | -0.0342 |
| return on market human capital (rh) | (0.0588) | (0.248) | (0.138) | (0.0751) |
| Beta with respect to | -0.0150 | 0.00892 | 0.0187 | 0.00297 |
| residual log consumption (cay) | (0.0283) | (0.0390) | (0.0237) | (0.0573) |
| Beta with respect to | -0.000441 | -0.000534 | -0.000547 | 0.00632** |
| the interaction cay*ra | (0.000309) | (0.00138) | (0.00173) | (0.00280) |
| Beta with respect to | 9.94e-05* | -9.60e-05 | 0.000144 | 0.000668*** |
| the interaction cay*rh | (5.61e-05) | (0.000163) | (0.000146) | (0.000237) |
| Sigma | 0.209*** | 0.178* | 0.137*** | -0.0519 |
| | (0.0336) | (0.0969) | (0.0336) | (0.0706) |
| Constant | -0.501* | 1.651*** | -1.122*** | -0.562 |
| | (0.269) | (0.618) | (0.213) | (0.366) |
| Observations | 128 | 139 | 98 | 133 |
| R-squared | 0.844 | 0.370 | 0.694 | 0.692 |

**Table 11 Descriptive Statistics of Household Alpha: Township as Market**

| Province | Number of Observations | Percentiles | | | Spearman's Rank Correlation with Simple ROA |
|---|---|---|---|---|---|
| | | 25th | 50th | 75th | |
| | | *Panel A: ROA, Adjusted for Aggregate Risks* | | | |
| *Central* | | | | | |
| Chachoengsao | 126 | -1.74 | -0.27 | 1.00 | 0.3834*** |
| Lopburi | 139 | -1.75 | -0.20 | 2.72 | 0.3774*** |
| *Northeast* | | | | | |
| Buriram | 98 | -0.62 | 0.20 | 2.02 | 0.9678*** |
| Srisaket | 127 | -0.20 | 1.06 | 3.49 | 0.9933*** |
| | | *Panel B: ROA, Adjusted for Aggregate and Idiosyncratic Risks* | | | |
| *Central* | | | | | |
| Chachoengsao | 126 | -1.39 | -0.02 | 1.02 | 0.6358*** |
| Lopburi | 139 | -2.33 | -0.73 | 2.31 | 0.8464*** |
| *Northeast* | | | | | |
| Buriram | 98 | -0.76 | 0.00 | 0.82 | 0.4976*** |
| Srisaket | 127 | -0.99 | 0.08 | 0.82 | 0.5380*** |

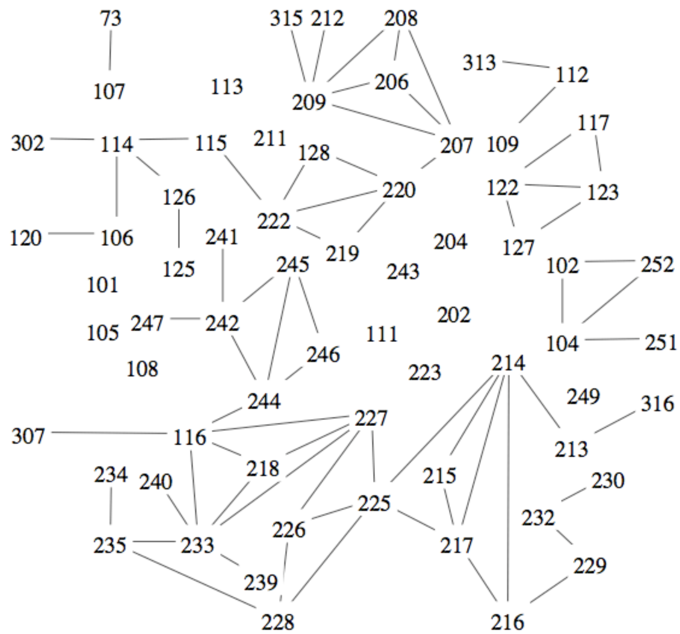
**Remarks** Unit of observations is households. Alpha is a constant from a regression of household's ROA on market's mean ROA (ra), market return on human capital (rh), residual consumption (cay), and their interactions cay*ra and cay*rh over 84 months from January 1999 to December 2005.

**Table 12 Determinants of Rate of Returns and Risks**

| **Dependent Variable:** | **Rate of Return** | | | | **Risk** | |
|---|---|---|---|---|---|---|
| **Adjusted for Household's Own Labor** | **No** | **Yes** | **Yes** | **Yes** | **Beta** | **Sigma** |
| **Adjusted for Aggregate Risk** | **No** | **No** | **Yes** | **Yes** | **(Aggregate Risk)** | **(Idiosyncratic Risk)** |
| **Adjusted for Idiosyncratic Risk** | **No** | **No** | **No** | **Yes** | | |
| Household Size (Aged 15-60) | 0.119*** | 9.13e-05 | 0.000796 | -0.000620 | -0.000797 | 0.00181 |
| | (0.0122) | (0.00162) | (0.00161) | (0.00119) | (0.00374) | (0.00325) |
| Average Age | -6.943*** | -0.519 | -0.324 | -0.359** | -0.728 | -0.899 |
| | (2.523) | (0.317) | (0.277) | (0.171) | (0.870) | (0.676) |
| Education of Household Head | 0.00945 | 0.00220** | 0.000515 | -0.000648 | 0.00855*** | 0.00703*** |
| | (0.0181) | (0.00109) | (0.000424) | (0.000861) | (0.00249) | (0.00166) |
| Initial Wealth (Log) | -0.318*** | -0.00570*** | -0.00349** | 0.000804 | -0.0195*** | -0.0218*** |
| | (0.0237) | (0.00216) | (0.00177) | (0.00117) | (0.00588) | (0.00425) |
| Initial Leverage | -0.0282 | 0.0377 | -0.00650 | -0.00697 | 0.113* | 0.114* |
| | (0.223) | (0.0250) | (0.0223) | (0.0163) | (0.0629) | (0.0607) |
| Constant | 2.562*** | 4.647*** | 4.622*** | 4.621*** | 2.790*** | 4.720*** |
| | (0.117) | (0.0144) | (0.0137) | (0.00885) | (0.0378) | (0.0300) |
| Township Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 489 | 489 | 489 | 489 | 489 | 489 |
| R-squared | 0.605 | 0.108 | 0.042 | 0.012 | 0.104 | 0.130 |

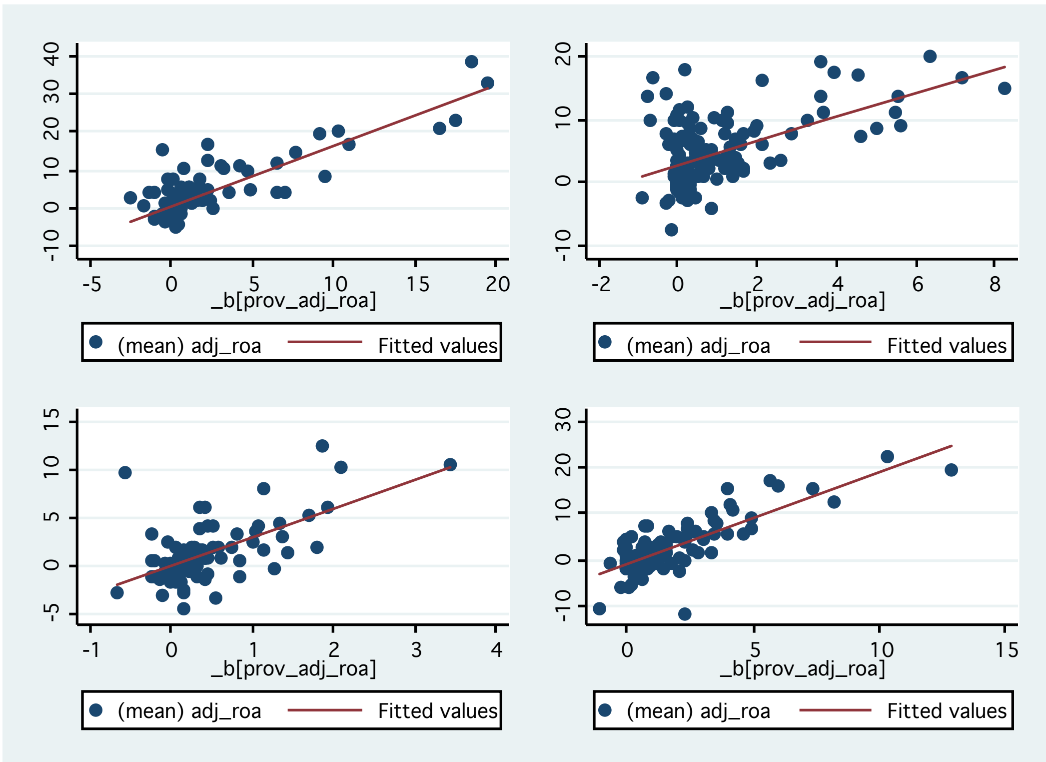
**Remarks** Risks and returns are in logs. Beta is with respect to aggregate return on physical assets. Average age and education are in thousand years. Initial wealth is in million baht. Initial leverage is initial total liabilities divided by initial total assets.

**Figure 1 Example of Kinship Network Map from a Village in Buriram Province**




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

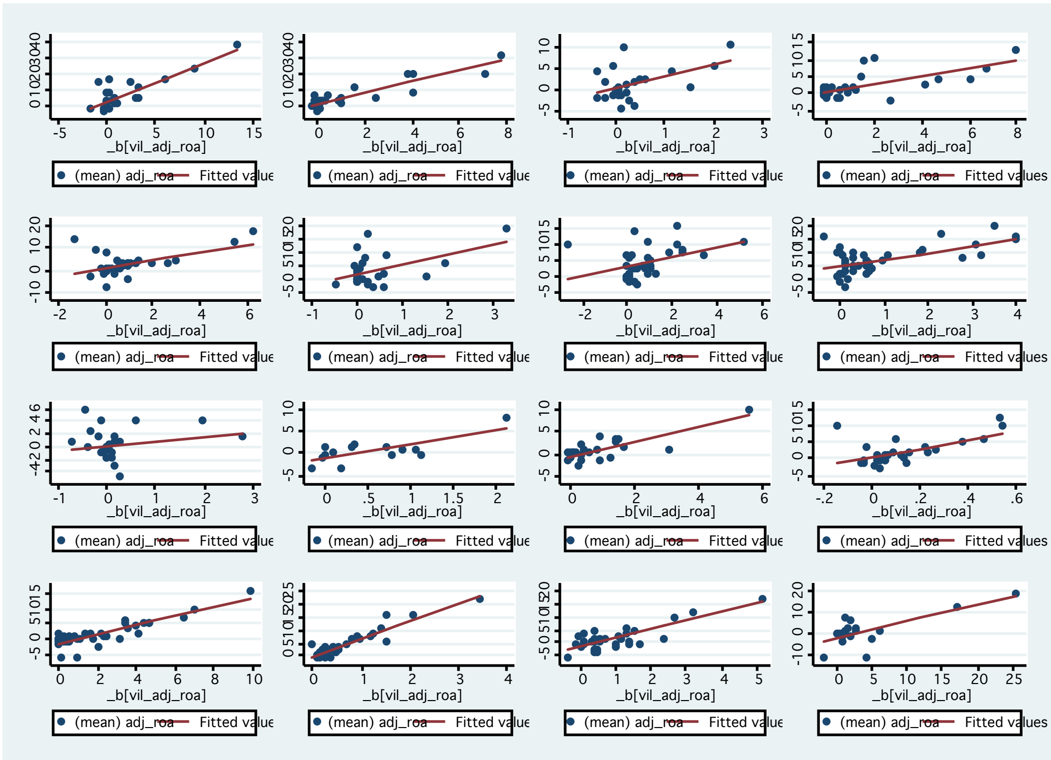
**Figure 2 Risk and Return**




*Panel A: Township as Market*

**Remarks**: Horizontal Axis = Beta; Vertical Axis = Expected Return. Each graph represents each of the four provinces. We treat each province as the market. Top left chart is Chachoengsao; top right is Buriram; bottom left is Lopburi; and bottom right is Srisaket.

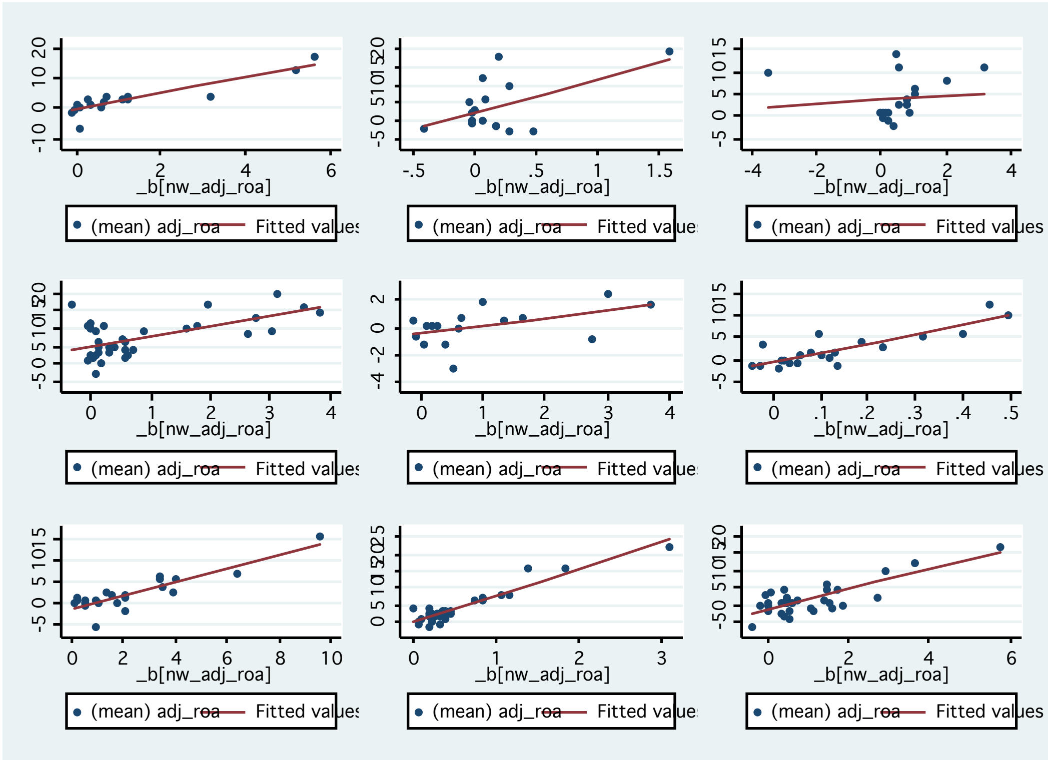
**Figure 2 Risk and Return (Cont.)**



*Panel B: Village as Market*

**Remarks**: Horizontal Axis = Beta; Vertical Axis = Expected Return. Each graph represents each of the 16 villages. We treat each village as the market. First row charts are the four villages in Chachoengsao; second row from Buriram; third row from Lopburi; and last row from Srisaket.

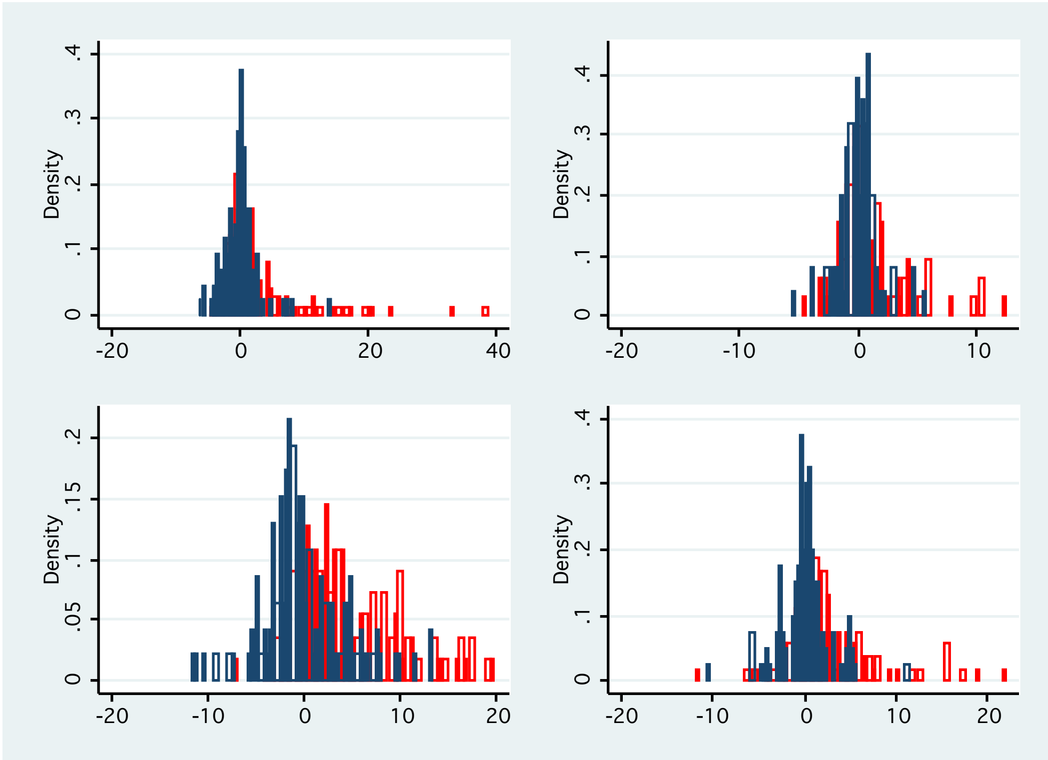
**Figure 2 Risk and Return (Cont.)**




*Panel A: Network as Market*

**Remarks**: Horizontal Axis = Beta; Vertical Axis = Expected Return. Each graph represents each of the networks. We treat each network as the market. From left to right and from top to bottom are networks from Buriram (village 14), Lopburi (villages 1, 4, and 6), and Srisaket (villages 1, 6, and 9).

**Figure 3 Histogram of Return on Assets, Unadjusted and Adjusted for Risk**




**Remarks**: Horizontal Axis = Return on Assets (Red = Unadjusted for risk; Blue = Adjusted for risk).