MIT Libraries | DSpace@MIT

MIT Open Access Articles

Risk and Return in Village Economies

The MIT Faculty has made this article openly available. ***Please share*** how this access benefits you. Your story matters.

Citation: Samphantharak, Krislert, and Robert M. Townsend. "Risk and Return in Village Economies." American Economic Journal: Microeconomics 10, no. 1 (February 2018): 1–40. © 2018 American Economic Association

As Published: http://dx.doi.org/10.1257/mic.20160125

Publisher: American Economic Association

Persistent URL: http://hdl.handle.net/1721.1/114164

Version: Final published version: final published article, as it appeared in a journal, conference proceedings, or other formally published context

Terms of Use: Article is made available in accordance with the publisher's policy and may be subject to US copyright law. Please refer to the publisher's site for terms of use.

Massachusetts Institute of Technology

American Economic Journal: Microeconomics 2018, 10(1): 1–40
https://doi.org/10.1257/mic.20160125

Risk and Return in Village Economies†

By Krislert Samphantharak and Robert M. Townsend*

This paper provides a theory-based empirical framework for understanding the risk and return on productive capital assets and their allocation across activities in an economy characterized by idiosyncratic and aggregate risk and thin formal markets for real and financial assets. We apply our framework to households running business enterprises in Thai villages with extensive networks, taking advantage of panel data: income, assets, consumption, gifts, and loans. We decompose risk and estimate the risk premia faced by households, distinguishing aggregate risk from idiosyncratic, potentially diversifiable risk. This distinction matters for estimating measures of underlying productivity and has important policy implications. (*JEL* D12, D22, D24, D81, O12, O14, O18)

This paper provides a theoretical framework for understanding the allocation, risk, and return on productive real capital assets across activities and sectors in an economy characterized by idiosyncratic and aggregate risk and thin formal markets for real and financial assets. We apply our framework to households running farm and nonfarm business enterprises in rural and semi-urban Thai villages with extensive family networks, taking advantage of unusual panel data, a monthly household survey over 156 months that measures income, assets, consumption, gifts, and loans.

Our framework allows us to quantify and decompose the risk faced by households running these business enterprises into two components: aggregate, non-diversifiable risk, and idiosyncratic, potentially diversifiable risk. In particular, we are able to estimate the risk premia for the aggregate and the idiosyncratic risk components separately. We find that these two risk premia are quite different from each other, specifically, much higher for the aggregate risk than for the idiosyncratic

* Samphantharak: School of Global Policy and Strategy, University of California, San Diego, 9500 Gilman Drive #0519, La Jolla, CA 92093 (email: krislert@ucsd.edu); Townsend: Department of Economics, Massachusetts Institute of Technology, 77 Massachusetts Avenue, E52–538, Cambridge, MA 02139 (email: rtownsen@mit.edu).
We would like to thank Giacomo De Giorgi, Lars Hansen, John Heaton, Ethan Ligon, Juhani Linnainmaa, Albert Park, Michael Peters, Scott Rozelle, Yasuyuki Sawada, Christopher Udry, seminar participants at various conferences and workshops, and anonymous reviewers. Research support from the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) (grant number R01 HD027638), the research initiative 'Private Enterprise Development in Low-Income Countries' [(PEDL), a programme funded jointly by the Centre for Economic Policy Research (CEPR) and the Department for International Development (DFID), contract reference MRG002_1255], the John Templeton Foundation (grant number 12470), the Consortium on Financial Systems and Poverty at the University of Chicago (funded by Bill and Melinda Gates Foundation under grant number 51935), the Thailand Research Fund (TRF), and the Bank of Thailand are gratefully acknowledged. The views expressed are not necessarily those of CEPR or DFID.

† Go to https://doi.org/10.1257/mic.20160125 to visit the article page for additional materials and author disclosure statement(s) or to comment in the online discussion forum.

risk. The distinction thus matters for backing out accurate measures of underlying productivity, risk-adjusted net returns, i.e., what remains after subtracting risk premia from expected, average returns.

Many households in our data face relatively more idiosyncratic risk but this risk carries a low-risk premium. For these households, although the quantity of idiosyncratic risk can be high, not much of it is borne by the household as it is diversified away to a considerable degree. Thus, these households have low risk premia and, with not much to subtract, net returns are relatively close to unadjusted returns. In contrast, other households in the data bear considerably more aggregate risk than idiosyncratic risk. As this aggregate risk cannot be diversified away, it bears a high risk premium. Thus, unadjusted returns for such households can seem quite high, but the net returns after subtracting the risk premia, i.e., the measures of their latent productivity, are low.

This in turn has important policy implications. To the extent that a community faces aggregate risk, there is little that could be done within the community itself to alleviate that risk. Aggregate risk is not entirely exogenous, however. Under our framework, aggregate risk is chosen optimally as sectors and activities within and across households, but beyond that there is little the community can do ex post. On the other hand, idiosyncratic risk is in principle diversifiable, hence one can think about potential policy improvements, e.g., improved ex ante insurance products within the community or ex post government transfers. Therefore, the distinction between aggregate and idiosyncratic risk is important for policies that are geared toward risk sharing.

Other policies addressing credit constraints, financial access, and occupation choice also hang on the distinction between aggregate and idiosyncratic risk. The relatively poor households in the village economies of our sample are engaged in production activities with high expected returns. Thus, they might appear to be credit constrained in the usual, stereotypical sense. But these poor households face high aggregate risk, and also idiosyncratic risk. Adjusting for each of these risks appropriately, with differential risk premia, we find that poor households in the more developed region of the country have net returns that are actually lower than the relatively wealthy in that region. So poor households in the developed region seem constrained after all but in a different sense: they are not constrained within their chosen sectors and activities, but rather are constrained away from the activities with the highest returns net of risk premia that are available for richer households. Further, the returns of the relatively poor in the less developed, agrarian region are not different from those of the relatively wealthy in that region, after adjusting for risk premia. Thus, poor households are not credit constrained in the usual sense, either.

Our framework and the results are made clear by a comparison of two extreme benchmarks. A full risk-sharing benchmark, not with ex ante asset trades but with ex post transfers of consumption goods contingent on output, delivers the prediction that only aggregate covariate risk contributes to the risk premium. In contrast, an autarky benchmark would predict that aggregate and idiosyncratic risks should enter the risk premium with the same weight because total risk faced by the household business is simply the sum of the risk from each component. In the data, the risk-sharing benchmark picks up a large part, though not all, of the variation in risk

premia. There is a residual, smaller part due to idiosyncratic risk, but otherwise it is substantially diversified away. More specifically, a financial autarky model that would simply adjust for total risk, that is, with equal weight on aggregate and idiosyncratic risk factors, is rejected in the data. Intermediate models which allow substantial though less than perfect risk sharing fit the data best.

This finding, derived entirely from production and rate of return data, is highly reminiscent of findings in the literature on risk sharing using consumption and income data (Townsend 1994). The full risk-sharing benchmark is typically rejected, and so are the borrowing-lending or buffer stock financial regimes. The best fitting models typically lie between these extremes, sometimes closer to the former than the latter. Here we take a direct look at this issue: we use the consumption as well as gifts and lending data from the same sample of households and establish a consistent picture of what we are seeing on production and consumption sides. Positive idiosyncratic shocks to rates of return are positively correlated with outflows of gifts and lending as the full insurance benchmark would suggest. Still, in consumption risk sharing regressions, these same idiosyncratic shocks do nevertheless move consumption, with positive but quantitatively small coefficients. So indeed households do bear some of the idiosyncratic risk and that is why there remains risk premium for idiosyncratic risk. Yet, the idiosyncratic risk premium is small relative to risk premium associated with aggregate shocks, which in the data move both production and consumption. To the best of our knowledge, little previous work has analyzed risk sharing of the same households in the same sample using data from both consumption and production sides.

What we study in this paper is related to recent, important literatures in development, macroeconomics, and finance that focus on rates of return. In development economics, there is relatively sparse cross-referencing between risk and return concepts. Although there is literature on risk and the vulnerability of poor households as well as studies on returns on household enterprises as a source of household income, many of them do not explicitly consider risk premium as a part of the return. For example, there is existing literature showing that the impact on revenue of additional investments can be high, particularly with respect to small investments (for example, De Mel, McKenzie, and Woodruff 2008; Evenson and Gollin 2003; McKenzie and Woodruff 2008; and Udry and Anagol 2006). In a recent paper, Beaman et al. (2015) demonstrate that the return to agricultural investment varies across farmers, farmers are aware of this heterogeneity, and farmers with particularly high returns self-select into borrowing. Related, the evidence from traditional microcredit, targeting microenterprises, is mixed: some studies with randomized control trials find an increase in investment in self-employment activity, while others do not.[1] In this paper, we add to this list an important consideration that measured rates of return may reflect a risk premium. We find that poor households, usually a natural target for policy intervention as they have high return and low investment, seem to engage in riskier production activities. Therefore, targeting without information on risk could be naïve, taking an average over individuals who vary in true underlying productivity (some are constrained and

[1] For a summary of recent randomized interventions on microcredit, see Banerjee, Karlan, and Zinman (2015).

productive while others are not). Put differently, to the extent we can identify subgroups and their exposure to different kinds of risk, we would be better able to target the ones with genuinely high returns. In this respect, our study is among few existing studies that explicitly connect risk and return together. Rosenzweig and Binswanger (1993) test for the existence of a positive association between the average returns to individual production assets and their sensitivity to weather variability. Morduch (1995) finds that poor households in villages in India have limited ability to smooth consumption ex post and tend to choose production activities with lower yields to give them smoother ex ante income. Our study, in contrast, finds that Thai households with lower initial wealth are more involved with risky activities, both aggregate and idiosyncratic, and for that reason have higher average returns. More recently, Karlan et al. (2013) argue that risk is a constraint to agricultural investment in Ghana.

Likewise, in macroeconomics, Hsieh and Klenow (2009); Restuccia and Rogerson (2008); and Bartelsman, Haltiwanger, and Scarpetta (2013) study misallocation of resources. The essential idea is that an optimal allocation of capital (and other factor inputs) requires the equalization of marginal products. Deviations from this outcome represent a misallocation of resources and translate into suboptimal aggregate outcomes. Typically, however, the literature does not examine the underlying causes. An important recent exception is David, Hopenhayn, and Venkateswaran (2016) in which firm's informational frictions drive capital decisions. Similarly, Midrigan and Xu (2014); Moll (2014); Buera and Shin (2013); and Asker, Collard-Wexler, and De Loecker (2014) study the role of financial frictions and capital adjustment costs, respectively. However, studies often take risk and return on the production side of the economy as exogenous. We add to these studies the role of risk aversion, the various types of risk faced by firms, and evidence that people can and do choose among potential projects based on a risk-return trade-off. For us, the market is crucial, but in our case informal markets are the mechanism allowing mitigation of much of the idiosyncratic risk. In turn, adjustments of the measured rates of return to get at underlying productivity require different risk premium, varying with idiosyncratic versus aggregate risk.

Our study also contributes to the standard empirical consumption-based asset pricing in macroeconomics and finance literature that typically relies on country-wide aggregate consumption to explain asset risk and return of financial assets. Our study is applied locally to collections of closely connected villages in which almost everyone is in a family network, allowing us to link asset returns of the households with panel data of relevant market participants, including household specific data on consumption, gifts, and loans.[2] In addition, households in our sampled villages infrequently trade their fixed business assets (machinery, livestock, and land).[3] However, they have extensive family networks and engage actively in gifts and

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

[3] The returns to the relatively illiquid real productive assets are mainly from the output they produce. There are a few financial assets (such as deposits at financial institutions). The returns to these tradable liquid financial assets are from interest, dividends, or capital gains (and losses), but these assets and their returns are small in the data and are not driving the conclusion.

loans. This makes the economic mechanism in these village economies with informal markets and institutions close to complete market mechanism in the standard capital asset pricing model, resulting in identical predicted outcome despite different institutional settings. Finally, there are studies of risk and return to private enterprises in the finance literature, but these are mainly in developed country contexts. For example, Moskowitz and Vissing-Jorgensen (2002) and Kartashova (2014) analyze private equity premium by comparing the rates of return on private equity in the United States with the returns to public equity, arguing that private firms are seemingly more poorly diversified. Heaton and Lucas (2000) show that entrepreneurial risk is important for portfolio choice. In our village economies, at least, the limits to diversification at the household level are mitigated by risk sharing through informal networks of family in the community. Though it may be a stretch to imagine this is happening in advanced economies, the point remains that in any given setting informal networks could potentially rationalize apparent risk return anomalies.

The paper proceeds as follows. Section I presents the two benchmarks, the endpoints as it were, that we use to study risk and return in village economies. The more realistic intermediate case lies between these two extremes. Section II describes the data from the Townsend Thai Monthly Survey that we use in our empirical work. Section III presents the first set of our main empirical results on the relationship between expected return and aggregate risk. As robustness checks, we extend our analysis to incorporate human capital, time-varying risks, and time-varying stochastic discount factors. We find that expected returns are positively associated with aggregate risks in our village economies. Section IV quantifies idiosyncratic risk and analyzes its effect on risk premium and expected returns, as well. The main point is that the contributions of the aggregate and the idiosyncratic risk premia to the total risk premia are distinct from the contributions of aggregate risk and idiosyncratic risk to total risk. This is the second set of empirical results. Section V presents our third set of empirical results by demonstrating that the empirical findings from the production and asset return data in this paper are consistent with those from the consumption and income data, as in earlier literature, by directly analyzing our panel data where both production and consumption are measured. Section VI distinguishes the risk premium from the productivity of household enterprises, computing the household's rate of return net of the risk premium. Section VII presents our fourth and final set of empirical findings that there is heterogeneity across households in their exposure to aggregate and idiosyncratic risks. Section VIII concludes and discuss policy implications.

I. Theoretical Framework

We start with an economy consisting 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 good. Let $k_{i,j}$ be the assets assigned to production activity i and operated by household j at the end of the previous period. This is one of the key choices, whether chosen as if by the community as a whole, as in the first model below, or done at the household level, as in the second model. The technologies are fixed but the assignment of

capital is endogenous. Let $f_{i,j}(k_{i,j})$ be the output, net of depreciation, realized at the beginning of the current period. The fluctuation and the pairwise comovement of the marginal returns, under a particular capital allocation $k_{i,j}$, is denoted $\frac{df_{i,j}(k_{i,j})}{dk_{i,j}} = f'_{i,j}(k_{i,j})$. Because the returns are random, a variance-covariance matrix represents these marginal returns. We feature endogenous determination of the various portfolios that can be formed by assigning assets to various households and to various activities. Varying the weights of the assets in a portfolio creates a feasible set of all possible returns that could be achieved by available current assets. Note that some of the elements in this set could have zero weight for some of the assets, i.e., it is not necessary to have all of the assets included in a particular portfolio. Also note that this feasibility set is derived from the production technology alone, without any assumptions on preferences or optimization.

We present two polar benchmarks in this section. For expositional clarity, we begin with the first benchmark economy where full risk-sharing delivers Pareto optimal allocations of risk for the community as a whole. We show how technologies introduced in the underlying environment above are linked together when risks are pooled efficiently across all households and production technologies. Then, we discuss the second, opposite benchmark that considers an economy where each household absorbs risk in isolation. The household is still making choices, however, on the composition of its portfolio. Note that the underlying technologies are the same in both benchmarks.[4]

A. *A Full Risk-Sharing Benchmark: A Pareto Optimal Allocation of Risk*

First, we consider a benchmark case in which all households in the economy are able to completely pool and share risk from their production. Let k_M be the total assets of the aggregate economy, M, and F_M be the total output produced from all assets in the aggregate economy. Note that $F_M = F(\mathbf{k}) = \sum_{j=1}^{J}\sum_{i=1}^{I} f_{i,j}(k_{i,j})$, where $\mathbf{k}$ is a vector of capital allocation in the economy, $k_{i,j}$, for all activities i and all households j.

To determine an efficient, Pareto optimal allocation of assets across households and activities, and consumption to the households, we consider a social planning problem that maximizes a Pareto-weighted sum of expected utilities subject to resource constraints. At the beginning of each period, each household j starts with initial resources that consist of two components. The first component is the assets held from the previous period, summing over all production activities, $k_j = \sum_{i=1}^{I} k_{i,j}$. The second component is the sum of the associated outputs (net of depreciation), $\sum_{i=1}^{I} f_{i,j}(k_{i,j})$. The household j may give out or receive gifts and transfers with other households, as in a risk-sharing syndicate.[5] The household then invests a part of this interim wealth in the form of assets carried to the next period. For this social planning problem, the planner retains full control over the projects, assigns them

[4] In the language of the Lucas tree model, households are not endowed with Lucas trees. Instead, the social planner or each household selects a portfolio of activities that maximizes its utility, choosing how many of each type of tree (activity-specific asset) to own and receiving the fruit (return) from that tree.

[5] Generally, households could make state-contingent lending and borrowing contracts, which could be incorporated into the gift term in this setup. For an example of this arrangement, see Udry (1994).

to households, chooses the net current gifts and transfers to each household j, and chooses the assets to be allocated to each activity run by each household in the following period, $k'_{i,j}$. Effectively, the planner determines the current period consumption for each household j, $c_j = \sum_{i=1}^{I}\left(f_{i,j}(k_{i,j}) + k_{i,j}\right) - \sum_{i=1}^{I} k'_{i,j} + \tau_j$.

The value function of the social planning problem is

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

subject to the aggregate resource constraint, i.e., aggregate consumption plus aggregate savings, in the form of next-period capital, equals wealth, $\sum_{j=1}^{J} c_j + \sum_{j=1}^{J} k'_j = W$, and the non-negativity constraint of capital, $k'_{i,j} \geq 0$, that is no project capital can go negative, i.e., households cannot short assets. Current state W denotes the aggregate wealth of the whole economy at the beginning of the current period, that is, $W = \sum_{j=1}^{J}\sum_{i=1}^{I}\left(f_{i,j}(k_{i,j}) + k_{i,j}\right)$. Here the parameter ϕ is a common preference discount factor; the parameter Λ is a time- and state-invariant vector of the Pareto weights for the households, λ_j where $j = 1, 2, \ldots, J$; and the function $u_j(\cdot)$ is the within-period utility function of a risk-averse household j, which is strictly concave, continuously differentiable, increasing without satiation, and with infinite derivative at zero. Note that we are allowing in this general set up differential risk aversion. The solutions to this planning problem for fixed Pareto weights correspond to a particular Pareto optimal allocation, and all of the optima can be traced out as the Pareto weights are varied.

For a given Λ, the first-order conditions are that

$$\left[\tau_j\right]: \quad \lambda_j u_{jc}(c_j) = \mu \quad \text{for all } j,$$

$$\left[k'_{i,j}\right]: \quad -\lambda_j u_{jc}(c_j) + E\left[V_W(W')\left(1 + f'_{i,j}(k'_{i,j})\right)\right] \leq 0 \quad \text{for all } i \text{ and } j,$$

$$\text{with equality for } k'_{i,j} > 0,$$

where μ is the shadow price of consumption in the current period. Note that the first equation, i.e., equalized weighted marginal utilities, is the key equation in the study of consumption risk sharing, and it is an integral part of our framework here. The second equation is a standard Euler equation for investment. Finally, for each $k'_{i,j} > 0$, the technologies actually chosen, the first-order conditions imply

$$(1) \quad 1 = \frac{\phi E\left[V_W(W')\left(1 + f'_{i,j}(k'_{i,j})\right)\right]}{\lambda_j u_{jc}(c_j)} = E\left[\frac{\phi V_W(W')}{\mu}\left(1 + f'_{i,j}(k'_{i,j})\right)\right] = E\left[m' R'_{i,j}\right],$$

where $m' = \frac{\phi V_W(W')}{\mu}$ and $R'_{i,j} = 1 + f'_{i,j}(k'_{i,j})$.

Equation (1) has some important properties. First, m', the stochastic discount factor or the intertemporal marginal rate of substitution, is common across households and across assets. The model also implies that equation (1) holds for each of the

assets actively allocated to production activity i and run by household j, for any i and any j. This equation is equivalent to the pricing equation derived in the Consumption-based Capital Asset Pricing Model (CCAPM) in the finance literature.[6] However, it is important to reiterate that although our empirical counterpart will be similar to what is derived in the capital asset pricing literature, the mechanism that delivers the predicted allocation outcome is different. In the asset pricing literature, households (investors) trade their assets ex ante. Optimally allocated assets deliver the returns that the households in turn use to finance their consumption, or reinvest, ultimately maximizing their utility. Although asset reallocations across households are possible in our model environment, households do not typically trade their assets ex ante in some markets. The rate of return on an asset is simply the real yield from holding it. Given asset holdings and given returns, transfers among households in the economy then give an optimal consumption allocation, i.e., the consumption allocation under the full risk-sharing regime where the marginal rates of intertemporal substitution are equalized across households. These inter-household transfers could be through formal securities or through informal financial markets, namely, gifts and transfers within social networks.[7]

Finally, as in the standard asset pricing literature, we decompose expected return into a risk-free rate and a risk premium. Since $E[m'R'_{i,j}] = E[m']E[R'_{i,j}] + \mathrm{cov}(m', R'_{i,j})$, equation (1) can be rewritten as $E[R'_{i,j}] = \gamma' + \beta_{m',ij}\psi_{m'}$, where $\beta_{m',ij} = -\frac{\mathrm{cov}(m', R'_{i,j})}{\mathrm{var}(m')}$, $\psi_{m'} = \frac{\mathrm{var}(m')}{E[m']}$, and $\gamma' = \frac{1}{E[m']}$. Note that $\beta_{m',ij}$ could be interpreted as the *quantity* of the risk of the assets used in activity i by household j that cannot be diversified, i.e., the risk implied by the comovement of the asset return and the aggregate return. Note that the sign is negative since high returns mean low marginal utility. Since this risk cannot be diversified away, even in the full risk-sharing environment, it must be compensated by a risk premium, which is a product of the quantity of the risk and the price of the risk. The *price* of the risk is in turn equal to the normalized volatility of the aggregate economy, $\psi_{m'}$. Finally, γ' is the risk-free rate, R'_f, since by definition the covariance of the risk-free rate and the aggregate economy return is zero.

The intuition behind this optimal allocation is straightforward. An optimal allocation of assets is a portfolio that delivers an aggregate consumption for the economy that maximizes the Pareto-weighted expected utility of the households. This optimal consumption allocation is stochastic, and its distribution is derived from the distribution of underlying assets in the optimal allocation. Since households are risk averse, the optimal aggregate consumption represents a tradeoff between expected return and risk. In the full risk-sharing environment, idiosyncratic risks

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

[7] The Pareto weights, λ_j, $j = 1, 2, \ldots, J$, are implicit parameters in equation (1) as they are arguments in the value function. Intuitively, the marginal rates of substitution are common across households in any particular optimum but can vary across the many optima, as if moving along a (potentially nonlinear) contract curve. Our general analysis only requires that the risk sharing community be at one fixed social optimum, not at any particular optimal allocation per se. However, when preferences aggregate in a Gorman sense, then the Pareto weights can be dropped from the analysis, and it is as if a social planner were a "stand-in representative consumer" allocating assets among its various "selves."

are diversified away, and this optimal aggregate consumption consists of only the aggregate nondiversifiable component. Note that some of the optimal asset holdings could be zero if they are not needed for the construction of the portfolio that delivers this optimal aggregate consumption. However, for all of the assets that are positively allocated, an optimal allocation implies that the stochastic intertemporal rates of substitution are equalized, i.e., the marginal utility from the expected returns, net of disutility from risk, from the next period are equal across these assets. This equalized intertemporal rate of substitution condition across assets implies that the assets with lower expected return are held in this optimal portfolio because they are less risky than other assets. Since the only remaining risk in the full risk-sharing economy is the covariate risk, an optimal allocation implies the positive relationship between the expected return of the asset and its covariate, nondiversifiable risk, as represented by the asset's beta.[8]

B. *A Financial Autarky Benchmark*

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

$$V_j(W_j) = \max_{k'_{i,j}} \left(u_j \left(\sum_{i=1}^{I} \left(f_{i,j}(k_{i,j}) + k_{i,j} \right) - \sum_{i=1}^{I} k'_{i,j} \right) + \phi E\left[V_j(W'_j) \right] \right),$$

subject to the resource constraint of the household, $W_j = \sum_{i=1}^{I} \left(f_{i,j}(k_{i,j}) + k_{i,j} \right)$, and the nonnegativity constraint of asset holding, $k'_{i,j} \geq 0$.

Operationally, the Euler equation for asset allocation is of the same form as the previous equation (1) for all activities i in which household j chooses to hold and operate. However, in this environment, the stochastic discount factor would be specific to household j and not equalized to m, common across all households in the economy as in the full risk sharing benchmark. Since risk cannot be shared across households, the total fluctuation of the rate of return on asset for each household consists of both the household's idiosyncratic component and the comovement with the economy-wide return, the latter just another source of risk. Alternatively speaking, since there is no risk sharing, each household cannot and

[8] Our prediction from the full-risk sharing benchmark should be viewed as a necessary condition for the full risk sharing, but not a sufficient one. For example, if a household is endowed with a production technology that has returns comoving with the aggregate returns, there will be a positive relationship between expected return and household beta, even when this household is in autarky. However, we have a second necessary condition for optimality: not only is the risk premium determined by comovement with the aggregate, but it is not determined by the idiosyncratic risk as well. This is closely parallel to the consumption risk-sharing literature: not only does consumption move with the aggregate but it also does not move with the idiosyncratic income.

does not need to differentiate its idiosyncratic and aggregate risk, as both components of fluctuation in the rate of return are viewed and treated identically by the household. In financial autarky, their contribution to the household risk premium would be the same.

C. *Intermediate Cases*

Between the full risk-sharing benchmark and financial autarky benchmarks lie various possible intermediate models. These models make clear the ways in which idiosyncratic income could impact consumption and thus how idiosyncratic risk can end up in the risk premium. We do not disown either of the previous two benchmarks above: the full risk sharing benchmarks makes clear the standard ideal while the financial autarky benchmark makes clear that even if a household were acting in isolation there would remain risk premia, and both idiosyncratic and aggregate risk would typically enter into these premia. We view our paper as quantifying how close the villages in our sample are to these extremes, as with the early, seminal work on consumption risk sharing, and we anticipate subsequent efforts to fit structural models.[9]

D. *Empirical Implementation*

For our empirical implementation, we impose two additional assumptions onto the production technology and preferences that deliver a linear relationship between expected return and risk.[10] The first assumption is a linear production technology: $f_{i,j}(k_{i,j}) = r_{i,j}k_{i,j}$, which implies that $f'_{i,j}(k_{i,j}) = r_{i,j}$ and $R_{i,j} = 1 + r_{i,j}$. This assumption can be derived from a more general constant return to scale production function where optimal inputs are chosen sequentially. Following Angeletos (2007) and Moll (2014), capital is predetermined at the beginning of the period. Technologies are then subject to productivity realizations and prices of input and output are determined. Finally households make input (such as labor) decisions and get output. This yields a linear technology mapping predetermined capital into output, an $A_{i,j}k_{i,j}$ model, where productivity shocks and prices are embedded in the technology parameter $A_{i,j}$. It is as if there were a single input, capital, and we focus on this technology henceforth, that is, a single factor production function in capital with random returns. The second assumption is that the value function of the social planning problem can be well approximated as quadratic in the total assets of the

[9] Among these one would include iceberg-like transactions costs on transfer, as in Schulholfer Wohl (2011), where the divergence between the pre-transfer income and the ideal target necessitates a transfer and the constrained optimal allocation reflects both that difference and the transfer costs. Another model would be moral hazard, in which the household puts in unobserved effort in production directly or effort in diverting output for private hidden use, and thus the constrained optimal solution would dictate the household retain some "skin in the game." The magnitude of this exposure to idiosyncratic risk is a function of the cost of effort and the variance of the idiosyncratic component. It can be difficult to derive closed form solutions in these models.

[10] Note that we can also arrive at a linear relationship between expected return and risk with other sets of assumptions, including those with (1) two-period quadratic utility; (2) two periods, exponential utility and normal returns; (3) infinite horizon, quadratic utility and i.i.d. returns; or (4) log utility. It is also a linear approximation of the models with continuous time limit and normal distributions. See chapter 9 of Cochrane (2001) for detail.

economy, $V(W) = -\frac{\eta}{2}(W - W^*)^2$. The derivation in Appendix Section A shows that under these additional assumptions, our model implies

$$E[R_j'] - R_f' = \beta_j\left(E[R_M'] - R_f'\right), \tag{2}$$

where R_j' is the return to household j's portfolio; $R_M' = \frac{\sum_{j=1}^{J}\sum_{i=1}^{I} R_{i,j}' k_{i,j}'}{k_M'}$, $k_M' = \sum_{j=1}^{J}\sum_{i=1}^{I} k_{i,j}'$; and β_j is the beta for the return on household j's assets with respect to the aggregate market return,

$$\beta_j = \frac{\operatorname{cov}\left(R_M', R_j'\right)}{\operatorname{var}\left(R_M'\right)}. \tag{3}$$

II. Data and the Village Environment

The data used in this study are from the Townsend Thai Monthly Survey, an intensive monthly survey initiated in 1998 in four provinces of Thailand. Chachoengsao and Lopburi provinces are semi-urban provinces in a more developed central region near the capital city, Bangkok. Buriram and Srisaket provinces on the other hand are rural and located in the less developed northeastern region by the border of Cambodia. In each of the four provinces, the survey is conducted in four villages, chosen at random within a given township.[11]

The analysis presented in this paper is based on 156 months from January 1999 (month 5) to December 2011 (month 160), which coincides with 13 calendar years. During this time, there were salient aggregate shocks and a plethora of repeated idiosyncratic shocks in these village economies. For example, seasonal variation in the amount and timing of rainfall and temperature can be crucial in rice cultivation. Shrimp ponds were hit with both diseases as well as restrictions on exports to the European Union. At the micro level, milk cows varied in their productivity, i.e., the flow was quite irregular over time for a given animal and over the heard.

We include in this study only the households that were present in the survey throughout the 156 months. Since we compute our returns on assets from net income generated from cultivation, livestock, fish and shrimp farming, and non-agricultural business, we also include in this study only the households that generated income from farm and nonfarm business activities for at least 10 months during the 156-month period (on average about one month per year). In other words, we drop the households whose income was mainly, exclusively from wage earnings. In the end, there are 541 households in the sample: 129 from (the sampled township in) Chachoengsao and 140 from Lopburi provinces in the central region, and 131 from Buriram and 141 from Srisaket provinces in the northeast. Table A1 in the Appendix presents descriptive statistics of household characteristics. Table A2 shows the revenue (gross of cost of production) of the occupations in the sample.

[11] Given that all four villages in the same province in our data are located in the same township, we use the term province and township interchangeably in this paper. For details on the Townsend Thai Monthly Survey, see Samphantharak and Townsend (2010).

We use a township as the aggregate market for empirical analysis in this paper for two reasons. First, the four villages from the same province in our sample are from the same township and therefore located close to each other. There are likely economic transactions across these villages. Second, one of the salient features of the households in the Townsend Thai Monthly Survey is the pervasive kinship network with extended families. Table A3 in the Appendix shows that almost all households in our sample have at least one relative living in the same township.

We use a household as our unit of analysis and consider the return on the household's total assets instead of the return on specific assets. We consider the total assets as a *portfolio* that is composed of multiple individual asset classes (including both financial and fixed assets), and apply the predictions from our framework to study the risk and return of this portfolio. It is difficult and arbitrary to assign the percentage use of each asset in each distinct activity. Imposing additional assumptions on the data to disaggregate assets into subcategories would likely induce measurement errors that could bias our empirical analysis.[12] The rate of return on assets (ROA) is calculated as household's accrued net income divided by household's total asset (net of liabilities) over the period from which the income was generated, i.e., one month in this paper. This is a conventional financial accounting measure of performance of productive assets. We use the real accrued net income and the real value of household's total assets in the ROA calculation. The real variables were computed using the monthly Consumer Price Index (CPI) at the regional level from the Bank of Thailand. The rate is then annualized (multiplied by 12). We assume that the real risk-free rate is zero for all of the periods and for all of the townships.[13] Table A4 in the Appendix presents descriptive statistics of the ROA. The median of the annualized average ROA was 0.38 percent for Chachoengsao and 1.46 percent for Lopburi in the central region, and 0.28 percent for Buriram, and 1.99 percent for Srisaket in the northeast. Excluding land and building structure from total assets, the median ROA is 1.27 for Chachoengsao and 4.55 for Lopburi in the Central region, and 1.11 for Buriram and 4.23 for Srisaket in the Northeast. Appendix Section C describes detailed definition and construction of income, assets, and rate of return, and provides a discussion on measurement error of the variables.

[12] For example, a household that grows rice and also owns a retail shop could use a pick-up truck for both production activities. Similarly, we do not distinguish well the use of assets for production activity versus consumption activity. This could lead to a downward bias of our estimates on return to assets, as some of the assets that we include in the calculation were not used in production. Samphantharak and Townsend (2012) provide an exercise that classifies total assets into subcategories based on additional assumptions on production and consumption of the households, and analyze the sensitivity of the rate of return. The ROA measure we use here is shown there to be robust.

[13] The rationale for the zero risk-free rate is based on the assumption that households have access to storage technology. If the nominal return on stored inventory is the same as inflation rate (which is likely in the case for food crop storage), then the real rate of return is zero. We also perform a robustness check with different risk-free rates. The overall conclusion does not change, which is what we expect, because the shift in both excess asset return and excess market return does not affect the covariance between these two variables. Note that in the earlier versions 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). Again, the main conclusions did not change. We also used ROA computed from total assets without subtracting liabilities; the overall conclusions were robust (which is sensible, given that liability to asset ratios for most households are relatively small).

III. Aggregate Risk and Return on Assets

A. *Baseline Specification*

In the first stage of our empirical analysis, we compute the asset beta of each household's portfolio of assets to get household beta, β_j, for all household j. We define a township as the aggregate economy and use the township average real return on assets as the aggregate return, $\bar{R}_M$, computed as the total net income in the township divided by the township's total assets. To avoid the effect of each household's return on the township return, for each household we do not include the household's own net income and assets in the calculation of its corresponding township return, i.e., we compute and use instead a leave-out mean. As shown in equation (3), an asset beta of household j is defined as $\beta_j = \frac{\text{cov}(R'_M, R'_j)}{\text{var}(R'_M)}$, which is the key ratio of moments we need. Operationally, it is identical and conveniently computed as a regression coefficient from a simple regression of R'_{jt} on R'_{Mt}. Specifically, in the first stage, for each household j, we estimate β_j from a time-series regression

$$R'_{jt} = \alpha_j + \beta_j R'_{Mt} + \varepsilon_{jt}. \tag{4}$$

In the second stage, we study the expected return and beta relationship derived earlier in equation (2). With the assumption that the real return on risk-free assets is zero, we compute the expected rate of return on assets of household j, $E[R'_j]$. Empirically, the expected return is computed as a simple time-series average of monthly rates of return, $\bar{R}'_j = \frac{\sum_{t=1}^{T} R'_{jt}}{T}$, where T is the number of months (156 months in the baseline specification). We run a cross-sectional regression of household's average asset returns on the betas estimated earlier in equation (4) across all households in each township, one township at a time:

$$\bar{R}'_j = \alpha + \psi \hat{\beta}_j + \eta_j. \tag{5}$$

With the assumption that the real risk-free rate is zero, the null hypotheses from equation (5) are that $\psi = E[R'_M]$ and that the constant term α is zero. Note that we report the regression coefficient with the standard error corrected for generated regressor and heteroskedasticity, following Shanken (1992) and Cochrane (2001).

The results in panel A of Table 1 show that the regression coefficient on households' beta is positive for all of the regressions except for the township in Buriram. We then look at a stronger null hypothesis that $\psi = E[R'_M]$, comparing the magnitude of the estimated regression coefficient $\hat{\psi}$ with the township expected return, estimated by the time-series average $\bar{R}'_M = \frac{\sum_{t=1}^{T} R'_{Mt}}{T}$. The table also provides each township's aggregate expected return. For the two townships in the central region (Chachoengsao and Lopburi), the regression coefficients are not statistically different from the township average return (at 10 percent level of significance), consistent with the prediction from our model. However, the coefficients are different from the township average return for the township in Srisaket. The zero constant implication is also satisfied.

Table 1—Risk and Return Regressions: Township as Market

	Dependent variable: Household's mean return on assets			
Region:	Central		Northeast	
Township (province):	Chachoengsao	Lopburi	Buriram	Srisaket
	(1)	(2)	(3)	(4)
Panel A. Constant beta				
Beta	2.135	2.465	0.432	2.335
	(0.386)	(0.518)	(0.455)	(0.663)
Constant	−0.535	−0.503	−0.122	−0.847
	(0.412)	(0.561)	(0.364)	(0.668)
Observations	129	140	131	141
R^2	0.467	0.210	0.017	0.297
Township returns:				
Monthly average	1.68	2.49	0.15	0.80
Standard deviation	0.07	0.10	0.10	0.10
	(5)	(6)	(7)	(8)
Panel B. Time-varying beta				
Beta	1.250	2.307	0.530	1.888
	(0.169)	(0.326)	(0.265)	(0.48)
Constant	−0.325	−0.631	−0.782	−1.114
	(0.176)	(0.235)	(0.162)	(0.304)
Observations	1,161	1,260	1,179	1,269
R^2	0.330	0.204	0.019	0.260
Township returns:				
Monthly average	1.19	2.40	−0.07	1.04
Standard deviation	0.75	1.47	0.54	0.75

Notes: For panel A, unit of observations is household. Beta is computed from a simple time-series regression of household's adjusted ROA on township's ROA over the 156 months from January 1999 to December 2011. Household's mean adjusted ROA is the time-series average of household adjusted ROA over the same 156 months. For panel B, unit of observation is household-time window. Each time window consists of 60 months. The window shifts 12 months (1 year) at a time. There are nine moving windows in total for each household. Beta is computed from a simple time-series regression of household's adjusted ROA on township's ROA in each corresponding time window. Household's mean adjusted ROA is the time-series average of household adjusted ROA over the corresponding time window. Robust standard errors corrected for generated regressors (Shanken 1992) are reported in parentheses.

Source: Authors' calculations

To illustrate our results graphically, Figure 1 plots the beta of household j on the horizontal axis against the expected return on household j's assets on the vertical axis for each of the four townships. In general, the figures show a positive relationship between households' beta and expected returns. Thus, a major implication of the model is capturing a substantial part of the data. In particular, higher risk, as measured by the co-movement of household ROA and township ROA, is associated with higher average return. The positive ψ implication from the model is pervasive in the data at various levels of aggregation. The more stringent test of $\psi = \bar{R}'_M$ is more difficult to satisfy.[14] Note that this baseline specification is subject to some critiques. We now perform robustness checks that address these issues below.

[14] One may argue that kinship networks are local and operate better at the village or network levels than at the township level. We present a similar analysis at the village and network levels in Appendix Section D, with the

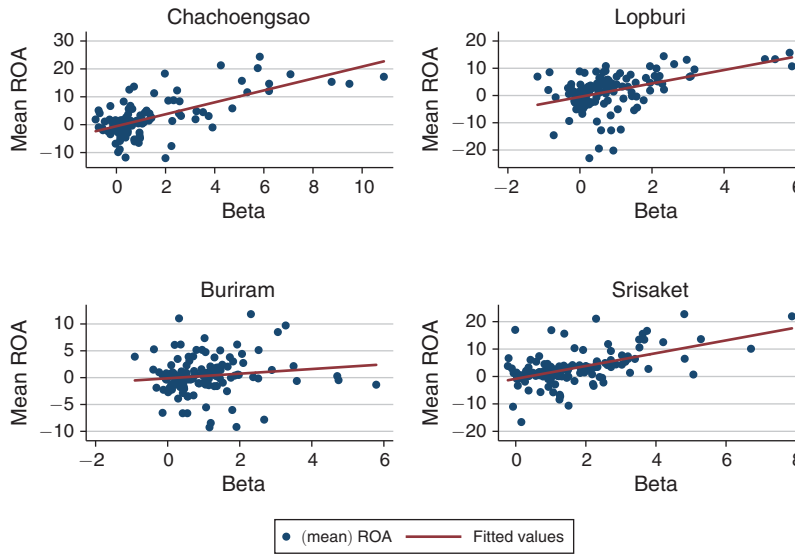

FIGURE 1. RISK AND RETURN: TOWNSHIP AS MARKET

Notes: Unit of observation is household. There are 129 households in Chachoengsao, 140 in Lopburi, 131 in Buriram, and 141 in Srisaket. The fitted lines correspond to regression results presented in columns 1 to 4 in Table 1.

B. *Time-Varying Risk*

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

We explore this issue by conducting our empirical analysis on the subsamples of 60 months (5 years) at a time. Specifically, we first estimate household's β_j and expected return using the time-series data from month 5 to month 64 (years 1–5) for all households. We then perform a similar exercise using the time-series data from month 17 to month 76 (years 2–6), and so on until the five-year window ends in month 160 (years 9–13). With all of the estimated $\hat{\beta}_{js}$ and expected return from all of the nine subperiods s for all households j, we finally estimate equation (2) using the pooled household-subperiod data.[15] Panel B of Table 1 presents the second-stage regression results. The table shows that the main prediction of our model still holds,

results shown in Tables A5 and A6. Overall conclusions remain for most, but not all, of the villages and networks, suggesting that networks may extend beyond the boundary of villages.

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

i.e., higher beta is associated with higher expected (average) return. Note that allowing for time-varying risk (beta), the prediction from the model is also satisfied for Buriram. However, the null hypothesis that the constant term is equal to the risk-free rate (assumed to be zero in this paper) is rejected in all of the four provinces.

C. *Aggregate Human Capital*

The model presented earlier in this paper implies that a household's beta captures all of the aggregate, non-diversifiable risk faced by the household. It is possible that there is omitted variable bias in the estimation of beta if the average return on township total assets is not the only determinant of the aggregate risk. Aggregate wealth, W, in the economy-wide resource constraint likely comes from other assets in addition to tangible capital held by the households in the economy. As shown in Appendix Table A2, labor income contributes a large share to household income in our sample. Omitting human capital from the resource constraint implies that the economy-wide average return on physical assets (both financial and nonfinancial) might not capture the aggregate non-diversifiable risk of the economy. We address this issue by performing a robustness check. Specifically, we compute an additional household beta with respect to return to aggregate human capital, proxied by the change in aggregate labor income of all households in the economy.[16] In particular, the first-stage time-series regression becomes

$$R'_{jt} = \alpha_j + \beta_j^a R_{Mt}^{a'} + \beta_j^y R_{Mt}^{y'} + \varepsilon_{jt},$$

where $R_{Mt}^{a'}$ represents the return to aggregate physical (nonhuman) asset and $R_{Mt}^{y'}$ is the return to aggregate human capital. The second-stage cross-sectional regression is

$$\bar{R}'_j = \alpha + \psi^a \hat{\beta}_j^a + \psi^y \hat{\beta}_j^y + \eta_j.$$

We then extend our previous empirical analysis to include human capital. The first four columns of Table 2 show 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 positive and significant in all of the four townships.[17]

[16] This approximation strategy is used in the finance literature by Jagannathan and Wang (1996). Their strategy is based on a simplified ad hoc assumption that labor income, L, follows an autoregressive process $L_t = (1 - g) \times L_{t-1} + \varepsilon_t$. Therefore, human capital, H, defined as the discounted present value of the labor income stream, is approximated by $H_t = \frac{L_t}{r-g}$, where r is the discount rate on human capital, and both r and g are taken as constants. In this case, the realized capital gain part of the rate of return on human capital (not corrected for additional investment in human capital made during the period) will be the growth of the stock of human capital, which is also the realized growth rate in per capita labor income.

[17] The coefficients on human capital are not significant. This could be due to human capital being measured imprecisely.

Table 2—Risk and Return Regressions with Human Capital and Time-Varying Stochastic Discount Factor: Township as Market

	Dependent variable: Household's mean return on assets			
Region:	Central		Northeast	
Township (province):	Chachoengsao	Lopburi	Buriram	Srisaket
	(1)	(2)	(3)	(4)
Panel A. Human capital				
Beta with respect to return on market physical capital (*ra*)	1.242	2.233	0.564	1.813
	(0.163)	(0.329)	(0.271)	(0.49)
Beta with respect to return on market human capital (*ry*)	0.00177	0.0217	−0.0524	0.149
	(0.056)	(0.187)	(0.181)	(0.363)
Constant	−0.307	−0.584	−0.757	−1.080
	(0.176)	(0.232)	(0.164)	(0.310)
Observations	1,161	1,260	1,179	1,269
R^2	0.329	0.203	0.021	0.270
	(5)	(6)	(7)	(8)
Panel B. Time-varying stochastic discount factor				
Beta with respect to return on market physical capital (*ra*)	1.094	2.005	0.392	1.893
	(0.148)	(0.334)	(0.242)	(0.45)
Beta with respect to return on market human capital (*ry*)	−0.00542	0.0375	−0.0310	0.179
	(0.061)	(0.185)	(0.171)	(0.354)
Beta with respect to residual log consumption (*cay*)	−0.00441	0.00246	0.0333	0.0789
	(0.055)	(0.17)	(0.149)	(0.324)
Beta with respect to the interaction $cay \times ra$	−0.00533	−0.0304	−0.131	−0.101
	(0.065)	(0.216)	(0.168)	(0.351)
Beta with respect to the interaction $cay \times ry$	0.00134	−0.000574	0.0109	−0.0130
	(0.035)	(0.162)	(0.142)	(0.315)
Constant	−0.156	−0.464	−0.589	−1.164
	(0.178)	(0.223)	(0.162)	(0.268)
Observations	1,161	1,260	1,179	1,269
R^2	0.315	0.203	0.049	0.306

Notes: Unit of observation is household-time window. For panel A, betas are computed from a multivariate time-series regression of household's monthly adjusted ROA on township's monthly return on market physical capital (*ra*) and township's return on human capital (*ry*), which is proxied by the monthly growth rate of township's total labor income. Regressions are performed on moving windows of 60 months. The window then shifts 12 months (1 year) at a time and there are 9 moving windows in total for each household. Household's mean adjusted ROA is the time-series average of household adjusted ROA over the corresponding time window. For panel B, similar analysis is performed, with additional explanatory variables. Residual log consumption is the residual computed from time-series regression of township's monthly log food consumption on township's total physical asset at the beginning of the month and township's total labor income during that month. Interaction terms are then defined accordingly. Robust standard errors corrected for generated regressors (Shanken 1992) are reported in parentheses.

Source: Authors' calculations

D. *Time-Varying Stochastic Discount Factor*

Similar to the traditional CAPM in the finance literature, parameters that determine stochastic discount factors are assumed to be time-invariant when we take the full risk-sharing benchmark to the empirical analysis. In theory, however, they are determined by the shadow price of consumption goods, which likely moves over

time as the aggregate consumption of the economy changes. In order to capture this time-varying stochastic discount factor, we provide a further robustness check following a strategy introduced by Lettau and Ludvigson (2001a, b) who show that these time-varying parameters are functions of the aggregate consumption-wealth ratio. The log consumption-wealth ratio, *cay*, in turn depends on three observable variables, namely log consumption, c; log physical (nonhuman) wealth, a; and log labor earnings, y. For each household, we compute five betas with respect to: (1) the aggregate return on tangible capital, $R_{Mt}^{a'}$; (2) the aggregate return on human capital (as computed in the previous analysis), $R_{Mt}^{y'}$; (3) the predicted value of $\widehat{cay}_t$; (4) the interaction between $R_{Mt}^{a'}$ and $\widehat{cay}_t$; and (5) the interaction between $R_{Mt}^{y'}$ and $\widehat{cay}_t$:[18]

$$(6) \qquad R_{jt}' = \alpha_j + \beta_j^a R_{Mt}^{a'} + \beta_j^y R_{Mt}^{y'} + \beta_j^{cay} \widehat{cay}_t + \beta_j^{cay,a}\left(\widehat{cay}_t \cdot R_{Mt}^{a'}\right) + \beta_j^{cay,y}\left(\widehat{cay}_t \cdot R_{Mt}^{y'}\right) + \varepsilon_{jt}.$$

In the final stage we run a cross-sectional regression of households' average return on the five betas estimated in equation (6). Namely,

$$(7) \qquad \bar{R}_j' = \alpha + \psi^a \hat{\beta}_j^a + \psi^y \hat{\beta}_j^y + \psi^{cay} \hat{\beta}_j^{cay} + \psi^{cay,a} \hat{\beta}_j^{cay,a} + \psi^{cay,y} \hat{\beta}_j^{cay,y} + \eta_j.$$

The results are shown in the last four columns of Table 2. Overall, with the additional factors in this robustness check, the regression coefficient of market nonhuman, physical assets, the main variable from our model, remains positive and significant for all of the four townships.

IV. Idiosyncratic Risk and Return on Assets

The empirical work thus far has abstracted from the presence of idiosyncratic risk and focused on the implications from the full risk-sharing benchmark. However, there are reasons why idiosyncratic risk may matter. With any of the departures from complete risk sharing, the expected return on assets may contain a risk premium that compensates for residual exposure to idiosyncratic risk.[19] We wish to know if this is true for the households in our sample, and if so, how large that residual exposure is, quantitatively. In addition, as mentioned earlier, households may be endowed with production technology that generates the positive relationship between expected return and beta, even in autarky without risk sharing. We seek to disentangle this by first estimating idiosyncratic risk in equations (4) and (6) presented earlier and then

[18] Appendix Section E provides more information on the estimation procedure of log consumption-wealth ratio.

[19] In finance literature, Merton (1987) shows 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 significant and positive relation between the estimated conditional idiosyncratic volatilities and expected returns.

quantifying the contribution of idiosyncratic risk to the total return in equations (9) to (11) below.

We follow Fama and Macbeth (1973) and compute idiosyncratic risk from the variance of the residuals from each of the household's time-series regressions in the first step, i.e., the residuals from equation (4).[20] This strategy is consistent with the decomposition of total risk, as measured by the variance of the return on assets, into aggregate (non-diversifiable) and idiosyncratic (diversifiable) components. Since equations (4) could be rewritten in a matrix form as $R'_{jt} = \mathbf{X}'_{Mt}\beta_j + \varepsilon_{jt}$, we have

$$\text{var}(R'_j) = E[\beta'_j \Omega_M \beta_j] + \text{var}(\varepsilon_j), \tag{8}$$

where Ω_M is the variance-covariance matrix of the aggregate variables and β_j is a vector of the regression coefficients from equation (4). The first term of the right-hand side of equation (8) is therefore the aggregate risk, while the second term is the variance of the residual. We denote this variance of the residual, σ_j^2, henceforth simply referred to as household sigma, as our measure of household specific idiosyncratic risk because it summarizes the volatility of the returns that is not captured by aggregate factor (aggregate return on assets). We emphasize that this is a household-by-household calculation.

Table 3 presents the decomposition of the total risk faced by the median household in each of the provinces in our sample, based on equation (8). Panel A presents the contribution of idiosyncratic risk to the total risk and the total risk premium, using the beta estimated earlier from the simple specification in equation (4). Similarly, panel B uses the betas from the robustness specification in equation (6). The results show that a large part of the volatility of the return to enterprise assets comes from the idiosyncratic component, in all four townships. The orders of magnitude are large, with the idiosyncratic component capturing at least 80–90 percent of the risk decomposition of the median households in three out of four provinces (the exception being Srisaket). Likewise, the aggregate component can be as low as 2 percent to 20 percent in these 3 provinces. Of course, this finding per se is not inconsistent with the model, which allows for idiosyncratic risk in the technologies. Indeed it is good in the sense that it allows us to study the impact of aggregate risk, which one might presume from these numbers to be small, and of idiosyncratic risk, which one might presume to be large. Note that we can quantify the magnitude of idiosyncratic risk that was diversified from our estimates of risk and risk premium decomposition. Table 3 also shows that median households in all provinces except for Srisaket diversified over 90 percent of their idiosyncratic risk, while in Srisaket the median household was still able to share almost 80 percent of their idiosyncratic risk. These decompositions are for each and every household and we thus also report the interquartile range in each line.[21]

[20] In addition to Fama and MacBeth (1973), a recent study by Calvet, Campbell, and Sodini (2007) also uses the same risk decomposition strategy as the one in this paper.

[21] There are some households that appear to be overcompensated for either idiosyncratic or aggregate risk and have a contribution of either risk above 100 percent of the total risk premia.

Table 3—Contribution of Idiosyncratic Risk to Total Risk and Total Risk Premium (*percent*)

Panel A. Baseline specification						
Region:	Central					
Township (province):	Chachoengsao			Lopburi		
	p25	p50	p75	p25	p50	p75
Contribution to total risk (variance)	93.9	98.1	99.7	92.3	97.6	99.5
Contribution to total risk premium	4.7	21.6	45.4	41.7	61.5	88.7
Percentage of diversified idiosyncratic risk	98.6	99.6	100.0	92.4	96.3	99.9
Region:	Northeast					
Township (province):	Buriram			Srisaket		
	p25	p50	p75	p25	p50	p75
Contribution to total risk (variance)	84.0	94.0	98.2	43.8	65.9	88.9
Contribution to total risk premium	105.6	118.7	152.8	13.3	28.8	53.9
Percentage of diversified idiosyncratic risk	111.2	135.2	172.2	67.4	82.0	90.0
Panel B. Robustness specification						
Region:	Central					
Township (province):	Chachoengsao			Lopburi		
	p25	p50	p75	p25	p50	p75
Contribution to total risk (variance)	77.4	84.9	89.0	80.2	88.0	91.6
Contribution to total risk premium	6.3	32.6	56.6	21.2	54.9	102.2
Percentage of diversified idiosyncratic risk	79.4	93.4	100.3	69.6	94.9	110.2
Region:	Northeast					
Township (province):	Buriram			Srisaket		
	p25	p50	p75	p25	p50	p75
Contribution to total risk (variance)	73.4	79.7	87.1	40.9	55.0	68.9
Contribution to total risk premium	35.4	88.4	147.0	9.1	19.5	33.3
Percentage of diversified idiosyncratic risk	75.5	112.7	153.6	63.4	79.9	89.4

Notes: Unit of observation is household. Panel A presents the results from a baseline specification, as shown in equation (4), using the empirical results from columns 1–4 of Table 1. Panel B presents the results from a full robustness specification, as shown in equation (6), using the empirical results from columns 5–8 of Table 2. The numbers for each household are the average across estimates from nine different time-shifting windows.

Source: Authors' calculations

We take the first step and add household sigma computed from regressions (4) and (6), $\hat{\sigma}_j^2$, as an additional explanatory variable to equations (5) and (7), respectively:

$$\bar{R}_j' = \alpha + \psi^a \hat{\beta}_j^a + \psi^\sigma \hat{\sigma}_j^2 + \eta_j, \tag{9a}$$

$$\bar{R}_j' = \alpha + \psi^a \hat{\beta}_j^a + \psi^y \hat{\beta}_j^y + \psi^{cay} \hat{\beta}_j^{cay} + \psi^{cay,a} \hat{\beta}_j^{cay,a} + \psi^{cay,y} \hat{\beta}_j^{cay,y} + \psi^\sigma \hat{\sigma}_j^2 + \eta_j. \tag{9b}$$

The results in Table 4 show that, in both baseline and robustness specifications, higher idiosyncratic risks as measured by household sigma are associated with higher average returns in all of the four townships.[22] Note, however, that the coefficients

[22] Though this violates the exclusion restriction of the full risk-sharing benchmark, we are now in a position to compute risk premium for each type of risk and compare.

Table 4—Aggregate Risk, Idiosyncratic Risk, and Rate of Return: Township as Market

	Dependent variable: Household's mean return on assets			
Region:	Central		Northeast	
Township (province):	Chachoengsao	Lopburi	Buriram	Srisaket
	(1)	(2)	(3)	(4)
Panel A. Baseline specification				
Beta with respect to return on market physical capital (*ra*)	1.214	1.395	−0.130	1.383
	(0.266)	(0.292)	(0.359)	(0.296)
Sigma	0.00283	0.00407	0.00318	0.00425
	(0.000727)	(0.000606)	(0.00113)	(0.000534)
Constant	−0.606	−1.525	−0.644	−1.312
	(0.393)	(0.552)	(0.368)	(0.575)
Observations	129	140	131	141
R^2	0.536	0.297	0.120	0.513
	(5)	(6)	(7)	(8)
Panel B. Robustness specification				
Beta with respect to return on market physical capital (*ra*)	0.487	1.105	0.0137	1.331
	(0.194)	(0.341)	(0.248)	(0.442)
Beta with respect to return on market human capital (*ry*)	0.00598	0.06	−0.0411	0.0799
	(0.054)	(0.18)	(0.168)	(0.335)
Beta with respect to residual log consumption (*cay*)	−0.0117	−0.00401	0.0106	0.0376
	(0.049)	(0.168)	(0.145)	(0.321)
Beta with respect to the interaction $cay \times ra$	−0.0117	0.0245	−0.0686	−0.0560
	(0.056)	(0.214)	(0.162)	(0.344)
Beta with respect to the interaction $cay \times ry$	−0.00166	−0.000644	0.00392	−0.0127
	(0.034)	(0.162)	(0.141)	(0.314)
Sigma	0.00428	0.00467	0.00389	0.00367
	(0.000689)	(0.000400)	(0.000435)	(0.000296)
Constant	−0.489	−1.535	−1.356	−1.491
	(0.171)	(0.214)	(0.151)	(0.237)
Observations	1,161	1,260	1,179	1,269
R^2	0.433	0.330	0.196	0.446

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

Source: Authors' calculations

for the beta with respect to the market return on physical assets still remain positive and significant in three of the townships, with Buriram as the only exception.

Indeed, though both aggregate and idiosyncratic risk are positively correlated with higher expected return, the "prices" of these risks, i.e., their contribution to risk premia, are now shown to be different. We compute aggregate and idiosyncratic

risk premia from equations (9a) and (9b) as empirically estimated in Table 4. Specifically, for the simple specification, we have

$$\text{Aggregate Risk Premium} = \hat{\psi}^{a}\,\hat{\beta}_j^{a}, \tag{10a}$$

$$\text{Idiosyncratic Risk Premium} = \hat{\psi}^{\sigma}\,\hat{\sigma}_j^{2}, \tag{11a}$$

and for the robustness specification, we have

$$\begin{aligned}\text{Aggregate Risk Premium} = {} & \hat{\psi}^{a}\,\hat{\beta}_j^{a} + \hat{\psi}^{y}\,\hat{\beta}_j^{y} + \hat{\psi}^{cay}\,\hat{\beta}_j^{cay} + \hat{\psi}^{cay,a}\,\hat{\beta}_j^{cay,a} \\ & + \hat{\psi}^{cay,y}\,\hat{\beta}_j^{cay,y},\end{aligned} \tag{10b}$$

$$\text{Idiosyncratic Risk Premium} = \hat{\psi}^{\sigma}\,\hat{\sigma}_j^{2}. \tag{11b}$$

In the financial autarky benchmark, households would not differentiate the idiosyncratic component and the aggregate component of the total fluctuation of the rate of return. In this case, the risk premia from both components should be proportional to the contribution of each component's contribution to the total fluctuation. Table 3 also presents the results from the decomposition of total risk premium of each household (the sum of the aggregate risk premium and idiosyncratic risk premium) for the simple and the robustness specifications, respectively. The results show that, with the exception of Buriram, the contribution of the idiosyncratic risk premia to the total risk premia is lower than the contribution of idiosyncratic risk to the total risk (as discussed earlier in the same table). Specifically, for the robustness specification, although idiosyncratic risk accounts for 86.5 percent and 89.1 percent of the total risk of the median households in Chachoengsao and Lopburi, it contributes to only 23.6 percent and 52.9 percent of the total risk premium. Likewise, for the median household in Srisaket, idiosyncratic risk accounts for 57.2 percent of the total risk while its premium contributes for only 16.7 percent of the total risk premium. We also perform a nonparametric statistical test for the difference in medians and find that the median percentage contribution of idiosyncratic risk to the total risk is statistically different from the median percentage contribution of idiosyncratic risk premium to the total risk premium at 1 percent level of significance in all provinces except for Buriram.[23] The pattern for lower and upper quartiles is also similar to the median. Finally, it is important to note that omitted variables could lead to a positive relationship between expected return and sigma if a component of aggregate risk was mistakenly in sigma. However, this would work against us. Our empirical results suggest the impact of sigma is largely diversified anyway.

In sum, we cannot treat aggregate and idiosyncratic risks identically when we analyze the risk and return of household enterprises in developing economies. A household with high total risk (high variance) may have lower risk premium than

[23] One possible explanation for Buriram is that it is the place with the most transition of occupations (toward higher return) and we have a shorter period in which to use our method. See Pawasutipaisit and Townsend (2011).

another household if the higher risk is idiosyncratic and diversifiable. Likewise, a household with low total risk (low variance) could require a higher risk premium if most of the risk is covariate and nondiversifiable.[24]

V. Risk Sharing: Connecting the Production Approach to the Consumption Approach

Reassuringly, our main findings on the production side are largely consistent with earlier studies on the consumption side that idiosyncratic risk is considerably shared across households in these villages. Using consumption data from the same sample as in this paper, Chiappori et al. (2013 and 2014) use variation in aggregate shocks to estimate the degree of heterogeneity in risk tolerance among the households and find evidence for full risk sharing. Likewise, Karaivanov and Townsend (2014) find that the consumption and income data of those in family networks is consistent with full risk sharing, though tied with moral hazard as best fitting models. Kinnan and Townsend (2012) show that households linked to one another by gifts and loans, and hence indirectly if not directly connected to outside financial institutions, achieve full risk sharing. In contrast, isolated households, especially the poor, are vulnerable to idiosyncratic income risk. Our larger point is that idiosyncratic risk in most of these studies is partially, though not necessarily completely, insured and this is consistent with what we are finding in this paper with the data on risk premia from the production side.

Regarding the actual mechanisms used for smoothing, i.e., financing a deficit or saving a surplus, households may buy and sell their assets (though this is rare) or use crop storage inventory (more common). They can also borrow or lend money formally through financial institutions or informally through village moneylenders, friends, or relatives. Samphantharak and Townsend (2010) provide quantification for these various smoothing mechanisms using the same Thai data and document the role of gifts among social networks.[25] Our conceptual framework in this paper both combines the production and consumption sides, as the first-order conditions have made clear, and features the role of gifts as the primary smoothing mechanism.

We perform further analyses that directly connect production and smoothing mechanisms. For each household, we compute the residual from equation (8) as month-by-month idiosyncratic shocks. Then, as reported in Table 5, we regress household's net gifts (i.e., gift outflows minus gift inflows) on these idiosyncratic

[24] To illustrate this point, let us consider two households, A and B, from Lopburi province in our sample. During the period of this study, A's main occupation was livestock farming, while B grew beans and sunflowers. However, 99 percent of the variance of the rate of return on A's assets was from the idiosyncratic component, while in contrast idiosyncratic risk contributed to only 63 percent for B. Consequently, we find that the risk premium for A, facing mostly diversified risk was only 0.008 (annualized) percentage points, while for B, with more aggregate risk, it was 1.394, despite B's less volatile return. This example, though deliberately dramatic, is not an outlier. Below we return to an analysis of risk premia and associated characteristics of enterprises that deliver statistically significant variation.

[25] The risk-sharing implications of networks have been studied in other economies as well. 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. Recently, Attanasio, Meghir, and Mommaerts (2015) study group risk sharing in extended family networks in the United States. They find that majority of shocks to household income are potentially insurable within family networks but they find, in contrast, little evidence that the extended family provides insurance for such idiosyncratic shocks.

Table 5—Idiosyncratic Income, Consumption, Gift, and Lending

Dependent variable:	Net gift outflow	Net lending	Net gift outflow plus net lending	Consumption
Idiosyncratic income	13.02	27.67	40.66	4.857
	(4.795)	(7.507)	(9.000)	(2.081)
Province-month fixed effects	Yes	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes	Yes
Observations	81,664	81,712	81,664	81,712
R^2	0.011	0.009	0.009	0.014
Number of households	541	541	541	541

Notes: Unit of observation is household-month. Net gift outflow is defined as gift outflow minus gift inflow. Net lending is defined as lending minus borrowing. Robust standard errors are in parentheses.

Source: Authors' calculations

shocks, controlling for common township-time dummies (capturing aggregate shocks) and household fixed effects (capturing diverse Pareto weights). Since gifts could also be disguised in the form of state-contingent loans (as in Udry 1994), we also regress household's net lending (i.e, lending minus borrowing), as well as household's net gifts plus net lending, on the same set of explanatory variables. The coefficients are all statistically significant at the 1 percent level. Finally, we also run the standard risk-sharing regressions with the consumption data (Townsend 1994). Controlling for aggregate shocks and household fixed effects, we regress monthly consumption on the same idiosyncratic shocks and find a low but significant coefficient, significant at 5 percent level.

To summarize, the results in Table 5 show that once we control for province-month fixed effects, which capture the provincial aggregate shocks, household consumption is positively correlated with household-specific, idiosyncratic shocks. Thus, risk sharing is imperfect and households do bear some of their idiosyncratic risk. This is consistent with the fact that idiosyncratic risk is showing up in the idiosyncratic risk premium on the production side. On the other hand, the coefficient is small, and small in comparison with coefficients on the other regressions. Most of the movement in idiosyncratic shocks is absorbed by net gifts and lending across the households. Table 5 can be interpreted to show, via a kind of normalized covariance decomposition, that on average 89 percent of idiosyncratic shocks to rates of return are covered by gifts and net lending, with the residual onto consumption. Thus, the results are quite consistent with the earlier Table 3.

Finally, we note that the consumption, gift, and lending-borrowing data used in the analysis in this section are from different modules of the questionnaire than what we use in the calculation of ROA. Consistency in the empirical findings reassures us that the main conclusions in this paper are unlikely driven by measurement error in the data. Of course, there remains the possibility of measurement error inflating the variance of the idiosyncratic shocks, but attenuation bias would hit all of the regressions. Thus, the relative comparison of coefficients across regressions remains of interest, confirming the role of social networks as a key institution in these villages.

VI. Returns Net of Risk Premia

In the development and macroeconomics literatures mentioned earlier in the introduction, rates of return on assets are usually used as a measure of performance, the productivity of a firm or a household enterprise. These returns to assets, however, typically do not take into account that different household enterprises are involved in different risks, and so higher average returns could result from compensation for higher risk and not productivity.[26]

The framework in this paper gives us a practical way to compute the risk premia that contribute to the return on assets and hence the residual return, after adjusting for the premium, as in the example just given. In the conventional CAPM context, Jensen (1967) argues that intercepts α_j in equation (6) can be interpreted as the abnormal return of an asset, and financial analysts use Jensen's *alpha* as a measure of performance of an asset or a fund manager. We follow this tradition, thinking of α_j as how well household *j* manages its assets in generating income in excess of risk-free rate adjusting for measured risk premia.

Figure 2 shows the histograms comparing the return on assets that is not adjusted for risks with the return adjusted for both aggregate and idiosyncratic risk (based on the robustness specification). Though risk-adjusted returns are naturally shifted to the left, other aspects of the distribution also change. The modes receive high mass consistently in the risk-adjusted returns. Further in two provinces the adjusted returns have more mass in the left tail, and in the other two provinces, in the right tail. The overall point is that the distributions of the rate of return do change when we adjust for risks, as evident from the differences in the skewness and the kurtosis of the returns. Table A7 in the Appendix presents selected descriptive statistics of household alpha.

VII. Household Characteristics Associated with Risk Exposure and Return on Assets

Figure 3 presents a scatter plot displaying for each household its aggregate risk premium and idiosyncratic risk premium. The figure shows that some households in our sample were exposed to both high aggregate and idiosyncratic risk (those in the upper-right corner) while many faced little of both risks (those in the lower-left corner). Still, there are a large number of households that were mainly exposed to one type of risk, but not the other (those in the upper-left and in the lower-right corners).[27]

[26] A comparison of two farming households in Srisaket province, C and D, from our sample illustrates this argument. Their main crops were rice and cassava, respectively. During the period of our study, the average annualized monthly real rate of return on assets for C was 9.06 percent, while it was only at 3.93 percent for D. However, C's higher return was largely due to the higher risk and the types of risk it faced. First, C was engaged in production activity whose return fluctuated more than D: the variance of the rate of return for C was 2.26 times higher than that of D. Second, while 70 percent of the total risk faced by C was idiosyncratic and could be (partially) diversified away, the diversifiable risk component accounted for 89 percent for D. As a result, the risk premium of C was 8.25 percentage points while it was only 1.11 percentage points for D. In the end, C actually had a lower return net of risk, i.e., after subtracting risk premia, a net of 0.81 percent, in comparison to D at 2.82 percent.

[27] Figure 3 also presents two salient findings from our sample. First, there is a positive correlation between aggregate risk premium and idiosyncratic risk premium (the correlation coefficient is 0.49 and statistically significant at 1 percent). Second, there is a large portion of our sampled households with low risk (those near the origin in

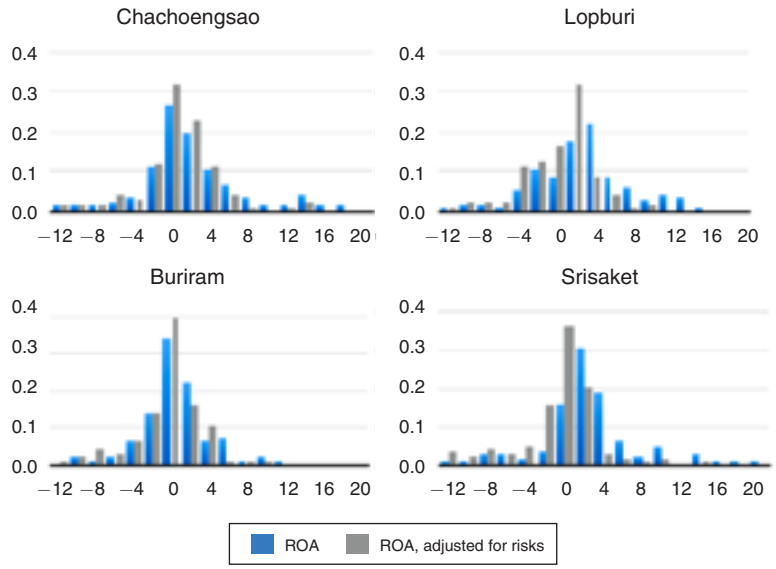

Figure 2. Histograms of Rate of Return on Assets, Unadjusted and Adjusted for Risk

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

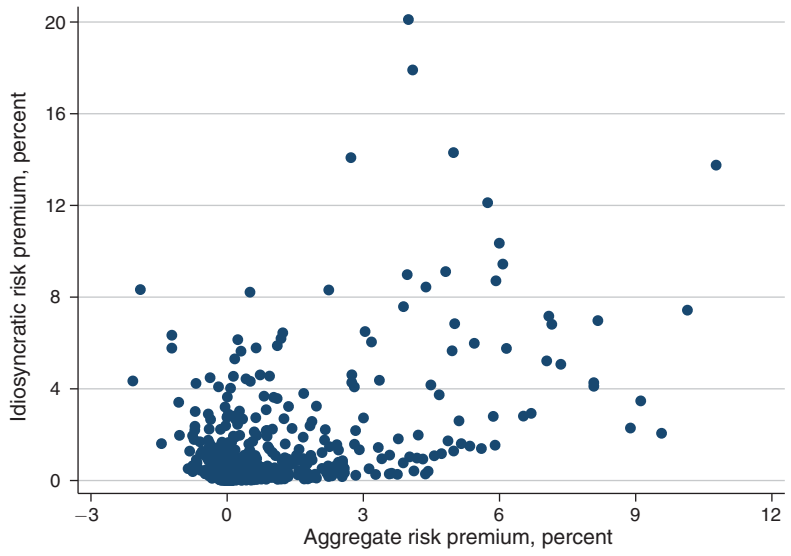

Figure 3. Scatter Plots Aggregate Risk Premium and Idiosyncratic Risk Premium

Notes: Unit of observation is household. The observations are from all four townships. Aggregate risk premium is computed from equation (10b) while idiosyncratic risk premium is computed from equation (11b), both using estimates from Table 4. The premia are presented in annualized monthly percentage return.

Figure 3). In particular, there is variation in aggregate risk premium while the idiosyncratic part is near zero. This produces a cluster of points on the horizon axis.

Table 6—Determinants of Rate of Returns and Risks

Region	Central		Northeast	
Province	Chachoengsao	Lopburi	Buriram	Srisaket
Panel A. Simple rate of return				
Total initial wealth	−0.0140	0.534	−0.594	−2.149
	(0.00694)	(0.0791)	(0.255)	(0.323)
Household size	−0.0868	−0.729	−0.0651	−0.144
	(0.177)	(0.249)	(0.169)	(0.228)
Age of household head	−0.0417	0.00155	0.00627	0.00231
	(0.0201)	(0.0211)	(0.0142)	(0.0209)
Education of household head	−0.115	−0.469	0.128	−0.492
	(0.136)	(0.120)	(0.0823)	(0.133)
Household head gender (Male = 1)	0.590	−0.597	−0.997	1.710
	(0.444)	(0.510)	(0.415)	(0.510)
Constant	4.434	4.472	0.101	4.636
	(1.815)	(1.766)	(1.103)	(1.791)
R^2	0.014	0.078	0.022	0.084
Panel B. Risk-adjusted rate of return				
Total initial wealth	0.0287	0.711	−0.323	−0.109
	(0.00806)	(0.0691)	(0.262)	(0.192)
Household size	0.182	−0.872	−0.239	−0.577
	(0.123)	(0.205)	(0.146)	(0.166)
Age of household head	0.0217	0.0338*	0.0257	0.0550
	(0.0133)	(0.0174)	(0.0125)	(0.0148)
Education of household head	0.209	−0.368	0.0896	−0.252
	(0.108)	(0.106)	(0.0746)	(0.108)
Household head gender (Male = 1)	−1.580	−0.291	−0.685	−0.0355
	(0.345)	(0.369)	(0.386)	(0.401)
Constant	−2.320	−0.815	−1.911	−2.299
	(1.204)	(1.494)	(0.964)	(1.233)
R^2	0.026	0.128	0.027	0.080

(*continued*)

Table 6 presents correlations in the data, with different measures of return and risk of assets as the dependent variable and household's initial wealth and other demographic characteristics on the right-hand side. Specifically, panel A presents regression results when we use the simple measured rate of return on assets (not adjusted for risk) as the dependent variable. In three out of four provinces, we find that poor households (as measured by initial wealth) tend to have higher average returns on assets. This result might prompt us to conclude that households in these provinces are financially constrained. However, the results in panel B reveal a different story. Once adjusted for risk, poorer households in the central region tend to have a lower return on assets, while there is no relationship between wealth and return on assets for the two provinces in the northeast.

The explanation for these findings is shown in panels C and D, where we examine the relationship between household characteristics and household beta (aggregate risk with respect to the market return on physical assets) and household sigma (idiosyncratic risk). The results highlight the heterogeneity in the risk exposure of households in our sample. Controlling for household demography, poorer households tend

Table 6—Determinants of Rate of Returns and Risks (*continued*)

Region	Central		Northeast	
Province	Chachoengsao	Lopburi	Buriram	Srisaket
Panel C. Aggregate risk				
Total initial wealth	−0.0261	−0.00532	−0.178	−0.831
	(0.00397)	(0.0148)	(0.0572)	(0.0935)
Household size	−0.141	0.0543	0.0622	0.224
	(0.0695)	(0.0491)	(0.0444)	(0.0526)
Age of household head	−0.0482	−0.0152	−0.00635	−0.0115
	(0.0108)	(0.00479)	(0.00432)	(0.00540)
Education of household head	−0.266	−0.0172	0.000534	−0.111
	(0.0529)	(0.0158)	(0.0187)	(0.0225)
Household head gender (Male = 1)	1.766	0.0687	0.304	0.789
	(0.212)	(0.122)	(0.0936)	(0.117)
Constant	4.888	1.574	0.847	2.326
	(0.918)	(0.366)	(0.313)	(0.429)
R^2	0.080	0.164	0.043	0.169
Panel D. Idiosyncratic risk				
Total initial wealth	−6.902	−34.73	−68.39	−239.2
	(1.087)	(7.917)	(17.98)	(35.16)
Household size	−51.43	23.16	43.24	27.56
	(19.67)	(17.68)	(18.51)	(26.59)
Age of household head	−9.930	−1.943	−4.848	−9.827
	(2.391)	(1.529)	(1.549)	(2.270)
Education of household head	−49.46	−8.927	9.993	−21.49
	(10.47)	(5.995)	(6.210)	(11.86)
Household head gender (Male = 1)	319.9	−109.6	−63.05	153.8
	(48.73)	(77.08)	(46.39)	(58.81)
Constant	1,081	648.4	505.1	1,038
	(216.8)	(141.2)	(105.9)	(190.6)
R^2	0.072	0.050	0.041	0.109
Observations	1,082	1,195	1,100	1,172

Notes: Unit of observation is household-round (shifting time window). For each household, beta and sigma are estimated from the regression in equation (6). Beta is the regression coefficient with respect to aggregate return on physical assets. Sigma is the variance of the error terms from the regression. Household size is the number of household members aged 15–64. Age of household head was as of the end of December 1998. Initial wealth is in million baht. All regressions include village fixed effects. Robust standard errors are reported in parentheses.

Source: Authors' calculations

to be more involved with risky activities, both aggregate (in 3 out of 4 provinces) and idiosyncratic (in all 4 provinces). We also find that households with younger, less educated, and male heads tend to have more exposure to both aggregate and idiosyncratic risks (although specific results vary across provinces).

One might well ask, what is the mechanism that households choose to make their income smooth or risky? We further explore the sources of this household risk exposure (results not shown here). Using the data on the shares of household total revenue from each production activity as well as the data on each household's main occupation (cultivation, livestock, fish and shrimp farming, and nonfarm business), we find that cultivation is associated with the highest aggregate and idiosyncratic risk (these are statistically significant at 1 percent). Cultivation is common in our

sample (hence aggregate risk), but at the same time there is heterogeneity in the variability of returns within cultivation (hence idiosyncratic risk). Finally, we find that poorer households are more likely to participate in cultivation (again, statistically significant at 1 percent). Note also that this finding is unlikely driven by the difference in risk preferences between rich and poor households, as Chiappori et al. (2013, 2014), using data from the same household survey as this paper, find that risk aversion was not correlated with household wealth. This is related to the underlying force of the full risk sharing benchmark, under which production and consumption activities are separated.

The result shows how easily one could misinterpret data, if one did not adjust for risk. One might have the impression that relatively poor households have high returns on assets (as shown in panel A for all of the provinces except for Lopburi) and thus suffer from financial constraints. The results here show that the reason why these poor households have a higher simple rate of return to their business enterprises is from the fact that they take more risk in their production activities and get compensated accordingly. Controlling for risks, household enterprises of the poor in the northeast are not productively different those of the rich, while the poor in the central region tend to have lower return on assets that the rich. Thus, some poor households in our sample, those of the central region, do seem constrained, but not in the usual, stereotypical sense. Poor households seem limited in their choices of production activities, as if constrained away from the activities that have high return net of risk premia and are available largely for richer households. Our findings suggest that there exist obstacles for the poor to leave their current occupation rather than funding the current one. Our finding is similar to Rampini and Viswanathan (2016), who find that household risk management is incomplete and increasing in household net worth and income.[28] The limitation of poor households to diversify idiosyncratic income risk is in contrast to Morduch (1995), who finds that poor households in villages in India have limited ability to smooth consumption ex post and tend to choose production activities that give them smoother income ex ante.

VIII. Conclusion and Policy Implications

We study the risk and return of farm and nonfarm business enterprises in village economies. Using data from the Townsend Thai Monthly Survey, we find that although idiosyncratic risk is the dominant factor in the total risk, it is diversified away to a large extent, and so bears a low risk premium. In contrast, aggregate risk cannot be diversified away and likewise it captures a much larger share of the total

[28] Our findings do not necessarily contradict existing literature that analyzes the gross rate of return, unadjusted for risk premia, and financial constraints. If all households are in the same occupation or sector that has identical aggregate risk, and if idiosyncratic risk is fully diversified, then actual net returns, adjusted for risk, are simply a downward shifted version of the unadjusted returns. Some on the right tail of this distribution may have high net returns and thus may be constrained. More generally, however, with different occupations and differential exposure to risk, high returns on the right tail of the distribution may be simply the compensation for high risk. Likewise, high rates of growth of net worth for poor households with high rates of return does not necessarily indicate the presence of financial constraints, as those with high expected returns, however risky, will on average as a group, experience high growth.

risk premia. Our results, using data on the rates of return from the production side, are parallel to those in the consumption risk sharing literature that uses income and consumption as key variables. We also provide an analysis that jointly makes use of production and consumption panel data, at the level of individual households over time. Our study has important policy implications: when comparing businesses across sectors or production across different activities, the adjustments for aggregate and idiosyncratic risks can vary and there is potentially little association between high returns and underlying productivity.

Appendix

A. *Derivation of Empirical Specification*

The first assumption on linear production technology implies that equation (1) also holds for any of the portfolios constructed by any combinations of the assets $k'_{i,j}$ for all i and all j. If we consider a household as our unit of observation, equation (1) implies that $1 = E\left[m'R'_j\right]$, where $R'_j = \frac{\sum_{i=1}^{I}\theta'_{i,j}R'_{i,j}}{\sum_{i=1}^{I}\theta'_{i,j}}$. In other words, R'_j is the weighted average return to the portfolio of the assets operated by household j, where the weights are the shares of each asset in household j's portfolio. This insight allows us to study the risk and return of a household's portfolio of assets instead of the risk and return of each individual asset. This implication is especially important in the empirical study where the classification of asset types and the income stream from each asset 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.

The second assumption that the value function of the social planning problem can be well approximated as quadratic in the total assets of the economy implies that at W',

$$\text{(A1)} \qquad V_W(W') = -\eta\left(W' - W^*\right) = -\eta\left(\sum_{j=1}^{J}\sum_{i=1}^{I}R'_{i,j}k'_{i,j} - W^*\right)$$

$$= -\eta\left(R'_M k'_M - W^*\right),$$

where $R'_M = \frac{\sum_{j=1}^{J}\sum_{i=1}^{I}R'_{i,j}k'_{i,j}}{k'_M}$ and $k'_M = \sum_{j=1}^{J}\sum_{i=1}^{I}k'_{i,j}$. The first-order conditions from the value function (A1) imply

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

$$\text{(A2)} \qquad m' = a - bR'_M,$$

where a and b are implicitly defined. Next, combining equation (A2) with the Euler equation derived earlier,

$$E\left[R'_{i,j}\right] = \gamma' - \frac{\operatorname{cov}\left(a - bR'_M, R'_{i,j}\right)}{\operatorname{var}\left(a - bR'_M\right)} \cdot \frac{\operatorname{var}\left(a - bR'_M\right)}{E\left[a - bR'_M\right]},$$

$$E\left[R'_{i,j}\right] = \gamma' + \frac{\operatorname{cov}(R'_M, R'_{i,j})}{\operatorname{var}(R'_M)} \cdot \frac{b \cdot \operatorname{var}(R'_M)}{a - b \cdot E[R'_M]},$$

$$E\left[R'_{i,j}\right] = \gamma' + \beta_{i,j} \cdot \psi, \tag{A3}$$

which is a linear relationship between the expected return of an asset, $E\left[R'_{i,j}\right]$, its nondiversifiable risk as measured by the comovement with the aggregate return, $\beta_{i,j}$, and the price of the nondiversifiable risk, ψ. Note again that equation (A3) holds for any assets or portfolios of assets, including the market portfolio, M, and the risk-free asset, f. Since $\beta_M = 1$ and $\beta_f = 0$, equation (A3) also implies that $\gamma' = R'_f$ and $\psi = E\left[R'_M\right] - R'_{i,j}$. In other words, the price of the aggregate, nondiversifiable risk is equal to the expected return on the market portfolio in excess of the risk-free rate. This condition, presented in equation (A3), 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 (A3) also holds for any of the portfolios constructed by any combinations of the assets for any i and any j because the production technologies are assumed to be linear in capital. In other words, for each household j, we can derive equation (A4) as

$$E\left[R'_j\right] - R'_f = \beta_j \cdot \left(E\left[R'_M\right] - R'_f\right), \tag{A4}$$

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

$$\beta_j = \frac{\operatorname{cov}(R'_M, R'_j)}{\operatorname{var}(R'_M)}. \tag{A5}$$

Also, note that common quadratic utility functions do Gorman aggregate and we can drop the reference to Pareto weights. Also, the quadratic utility function is not the only setting that delivers this result.

B. *Descriptive Statistics*

Table A1—Descriptive Statistics of Household Characteristics

Region	Central							
Township (province)	Chachoengsao				Lopburi			
		Percentiles				Percentiles		
	Observations	25th	50th	75th	Observations	25th	50th	75th
As of December 1998:								
Household size	129	3	4	6	140	3	4	5
Male	129	1	2	3	140	1	2	3
Female	129	1	2	3	140	1	2	3
Male, age 15–64	129	1	1	2	140	1	1	2
Female, age 15–64	129	1	1	2	140	1	1	2
Average age	129	29.3	36.3	44.5	140	25.6	32.3	42.0
Max years of education	129	6	9	12	140	4	6	9
Total assets (thousand baht)	129	380	1,109	3,636	140	336	1,074	2,387
156-month average (January 1999–December 2011):								
Monthly income (baht)	129	7,561	13,696	23,637	140	5,836	10,486	20,765
Total assets (thousand baht)	129	857	1,745	4,275	140	653	1,645	3,052
Fixed asset to total asset ratio	129	0.37	0.61	0.80	140	0.40	0.59	0.71
Total liability (thousand baht)	129	8	31	105	140	34	121	285
Liability to asset ratio	129	0.00	0.02	0.06	140	0.04	0.08	0.16
Region	Northeast							
Township (province)	Buriram				Srisaket			
As of December 1998:								
Household size	131	3	4	5	141	4	5	6
Male	131	1	2	3	141	2	2	3
Female	131	1	2	3	141	2	2	3
Male, age 15–64	131	1	1	2	141	1	1	2
Female, age 15–64	131	1	1	2	141	1	1	2
Average age	131	20.9	27.6	39.3	141	25.2	32.0	36.3
Max years of education	131	4	6	8	141	5	7	10
Total assets (thousand baht)	131	356	572	947	141	156	387	881
156-month average (January 1999–December 2011):								
Monthly income (baht)	131	2,073	3,677	5,584	141	2,160	3,672	5,276
Total assets (thousand baht)	131	503	741	1,114	141	317	577	1,048
Fixed asset to total asset ratio	131	0.39	0.57	0.69	141	0.35	0.63	0.75
Total liability (thousand baht)	131	24	56	109	141	23	42	75
Liability to asset ratio	131	0.03	0.08	0.17	141	0.04	0.09	0.17

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

Source: Authors' calculations

Table A2—Revenue from Production Activities (*percent by township*)

Region:	Central		Northeast	
Township (province):	Chachoengsao	Lopburi	Buriram	Srisaket
Production activities (percent)				
Cultivation	13.2	39.4	13.5	33.7
Livestock	21.0	22.8	1.0	1.1
Fish and shrimp	17.6	0.0	0.3	1.6
Nonfarm business	28.8	19.7	59.2	28.6
Wage earning	18.4	15.2	22.6	27.9
Number of sampled households	129	140	131	141

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

Source: Authors' calculations

Table A3—Descriptive Statistics of Networks in Village and Township

Region:	Central		Northeast	
Township (province):	Chachoengsao	Lopburi	Buriram	Srisaket
Observations	129	140	131	141
Households with relatives living in the same… (percent)				
Village	50.4	76.4	80.9	87.9
Township	87.8	88.4	97.1	94.0

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

Source: Authors' calculations

Table A4—Descriptive Statistics of Return on Assets: Quartiles by Township

		Percentiles				Percentiles		
	Observations	25th	50th	75th	Observations	25th	50th	75th
Region:	Central							
Province (township):	Chachoengsao				Lopburi			
Mean	129	−1.72	0.38	3.99	140	−1.67	1.46	4.53
Standard deviation	129	4.38	7.56	16.61	140	10.16	16.51	24.77
Coef. of variation	129	2.02	3.14	5.46	140	3.27	4.65	8.85
Region:	Northeast							
Province (township):	Buriram				Srisaket			
Mean	131	−1.32	0.28	1.56	141	0.21	1.99	4.29
Standard deviation	131	8.38	13.92	22.59	141	10.16	16.78	26.87
Coef. of variation	131	4.03	8.70	17.48	141	4.03	5.92	11.52

Notes: The unit of observation is household. ROA is rate of return on household's total asset, computed by household's net income (net of compensation to household labor) divided by household's average total assets over the month. ROA is real return, adjusted by regional Consumer Price Index from the Bank of Thailand, and reported in annualized percentage. Mean, standard deviation, and coefficient of variation of ROA are computed from monthly ROA for each household over 156 months (January 1999 to December 2011). The percentiles are across households in each township.

Source: Authors' calculations

C. *Construction of Income, Assets, and Rate of Return*

Net Income: Income is accrued household enterprise income, which is the difference between the enterprise total revenue and the associated cost of inputs used in generating that revenue. Revenue is realized at the time of sale or disposal. Associated cost could be incurred earlier, in the periods before the sale or disposal of outputs. Total revenue includes the value of all outputs the household produces for sale (in cash, in kind, or on credit), own consumption (imputed value), or given away. Revenue also includes rental income from fixed assets. Revenue does not include wages earned outside the household or gifts and transfers received by the household. Cost includes the value of inputs used in the production of the outputs, regardless of the method of their acquisition, i.e., purchase (in cash, in kind, or on credit) or gifts from others or transfers from government. Costs includes the wage paid to labor provided by non-household members as well as imputed compensation to the labor provided by household members.[29] Cost includes all utility expenses of the household regardless of the purposes of their uses and also includes depreciation of fixed assets.

Total Assets: Assets include all assets, i.e., fixed assets, inventories, and financial assets. *Fixed assets* are surveyed in the Agricultural Assets, Business Assets, Livestock, Household Assets, and Land Modules of the survey. In the Agricultural Assets Module, fixed assets include walking tractor, large four-wheel tractor, small four-wheel tractor, aerator, machine to put in seeds and pesticides, machine to mix fertilizer and soil, sprinkler, threshing machine, rice mill, water pump, rice storage building, other crop storage building, large chicken coop, other buildings for livestock, and other buildings. In the Household Assets Module, assets include car, pick-up truck, long-tail boat with motor, large fishing boat, bicycle, air conditioner, regular telephone, cellular telephone, refrigerator, sewing machine, washing machine, electric iron, gas stove, electric cooking pot, sofa, television, stereo, and VCR.[30] Due to the variety in non-agricultural businesses, in the Business Module, we do not list the specific name of the assets, but instead ask the household to report the fixed assets they use in their business enterprises. In the Land Module, assets include land and building at acquisition value, the value of land and building improvement, and the appreciation of land when major events occurred (such as an addition of new public roads). In all of the modules, assets that are not explicitly listed but have a value of more than 2,000 baht are also asked and included. We also adjust the value of fixed assets with monthly depreciation. *Inventories* include raw material, work in progress, finished goods for cultivation, fish and shrimp farming, livestock activities (such as milk and eggs), and manufacturing nonfarm businesses.

[29] For the detailed procedure how we impute the compensation to household's own labor, See Samphantharak and Townsend (2010).

[30] Note that we decide to include all household assets in our calculation. This is mainly because some of these assets were used by the households in their production activities as well and it would be arbitrary to include certain household assets while excluding others. However, the value of these assets was relatively small compared to the value of total assets (which was largely determined by land and other fixed assets). See Samphantharak and Townsend (2012) for the sensitivity analysis of ROA on household assets.

For merchandizing nonfarm businesses, inventories are mainly goods for resale. Animals from the Livestock Inventory Module, which include young meat cow, mature meat cow, young daily cow, mature dairy cow, young buffalo, mature buffalo, young pig, mature pig, chicken, and duck, are accounted as either inventories or fixed assets, based on their nature. *Financial assets* include cash, deposits at financial institutions, other lending, and net ROSCA position. These line items are computed from the Savings Module, the Lending Module, and the ROSCA Module. The stock of cash is not asked directly but can be imputed from questions about each and every transaction that each household had since the last interview. Finally, the total asset used in the calculation of rate of return is *net* of liabilities. We use the information from the Borrowing Module to calculate the household's stock of total liabilities.

Rate of Return: The rate of return on assets (ROA) is defined as household's accrued net income divided by household's average total assets (net of total liabilities) over the period from which that the income was generated, i.e., one month in this paper. The average total asset is the sum of total assets at the beginning of the month and total assets at the end of the month, divided by two.

Discussion on Measurement Errors: For the aggregate risk, the positive relationship between beta and expected (or mean) return could be driven by measurement errors if the measurement errors of household ROAs are positively correlated with the measurement errors of the aggregate ROA. However, for most production activities, we use direct answers on revenue from those production activities from each household to compute that household's ROA. Constructing price indices from these data reveals that prices in a given month can vary considerably over households. This may be due in part to the fact that we did not try to distinguish within village versus farm gate prices, i.e., we have revenue and price at the point of sale, wherever that might be. Actual and imputed wages also vary enormously over households at a point in time. There are also likely measurement errors in idiosyncratic returns but detailed studies of rice production show that yields can be explained beyond rainfall by measured differences in soil moisture, soil type, elevation, and timing of rain, which are all household specific, and hence much of the heterogeneity across households is real and not necessary measurement error (Tazhibayeva and Townsend 2012). Of course, some measurement errors are intrinsic to any survey. However, as we will discuss later in this paper, our findings from the analyses that use the data from the production modules of the survey are largely consistent with the findings from the consumption, gifts, and loan modules of the same survey. This independence across modules reassure us that the main conclusions in this paper are unlikely driven by measurement error in the data.

D. *Alternative Definitions of the Aggregate Economy*

One may argue that kinship networks are local and operate better at the village or network levels than at the township level. Table A5 reports the second-stage regression results when we use villages as aggregates. Despite the smaller number of

Table A5—Risk and Return Regressions: Village as Market

Dependent variable:	Household's mean ROA							
Region:	Central							
Province:	Chachoengsao				Lopburi			
Village:	02	04	07	08	01	03	04	06
Beta	2.473	3.232	6.741	0.720	2.163	3.185	4.399	4.884
	(0.477)	(0.595)	(1.877)	(0.894)	(3.688)	(2.746)	(1.400)	(1.493)
Constant	−1.105	−0.333	−0.739	1.162	−0.827	0.312	0.257	−1.629
	(0.899)	(0.756)	(0.821)	(0.984)	(1.434)	(0.873)	(0.572)	(1.503)
Observations	35	36	27	31	34	29	37	40
R^2	0.449	0.702	0.446	0.036	0.012	0.126	0.472	0.337
Village returns:								
Month average	1.09	1.48	4.13	0.73	2.03	2.49	2.48	2.85
Standard deviation	0.14	0.08	0.50	0.12	0.17	0.34	0.14	0.33
Region:	Northeast							
Province:	Buriram				Srisaket			
Village:	02	10	13	14	01	06	09	10
Beta	0.827	0.547	0.217	0.697	2.759	3.680	1.557	1.902
	(1.470)	(1.566)	(0.823)	(1.298)	(0.746)	(2.015)	(1.326)	(1.101)
Constant	−0.628	0.346	0.684	−0.541	−2.407	−0.558	0.735	−1.748
	(0.417)	(1.197)	(0.831)	(0.688)	(1.172)	(1.661)	(1.001)	(1.907)
Observations	34	28	34	35	38	42	39	22
R^2	0.022	0.010	0.003	0.014	0.510	0.387	0.114	0.149
Village returns:								
Month average	−0.14	1.56	0.36	−0.52	−0.57	1.88	0.87	0.95
Standard deviation	0.11	0.14	0.23	0.17	0.16	0.12	0.13	0.15

Notes: The unit of observation is household. Beta is computed from a simple time-series regression of household adjusted ROA on village ROA over the 156 months from January 1999 to December 2011. Household's mean adjusted ROA is the time-series average of household adjusted ROA over the same 156 months. Standard errors corrected for generated regressors (Shanken 1992) are reported in parentheses.

observations, the results show that the regression coefficient of household beta is significantly positive at 10 percent (or lower) level of significance for 9 of the 16 villages in our sample, with the only exception of all 4 villages in Buriram province, two villages in Lopburi, and one village in Chachoengsao. The result also shows that we cannot reject the null hypothesis that $\psi = \bar{R}_M$ at 10 percent level of significance for 5 out of those 9 villages in the sample (Village 7 in Chachoengsao; Village 4 in Lopburi; and Villages 6, 9, and 10 in Srisaket).

We also perform a similar analysis at the network level. In order to analyze the risk and return at the network level, we construct kinship network maps for the households in the Townsend Thai Monthly Survey. Specifically, for each of the relatives of the household head and the spouse (parents and siblings of the head, parents and siblings of the spouse, and their children) who was still alive and lived within the village, the survey recorded which building structure as recorded in the initial census he or she lived. With this information, we constructed a kinship network map for each village by drawing a link between two households that were family-related. We present in Table A6 the regressions using network as our definition of aggregate

Table A6—Risk and Return Regressions: Network as Market

Dependent variable:	Household's mean ROA				
Region:	Central				
Province:	Lopburi				
Village:	01	03	04	06	
Network:	03	03	06	01	
Beta	−3.088	3.265	7.366	5.189	
	(4.302)	(4.033)	(2.383)	(0.881)	
Constant	0.433	1.523	0.123	−1.655	
	(1.448)	(1.244)	(0.865)	(1.799)	
Observations	16	18	20	33	
R^2	0.012	0.041	0.464	0.345	
Network returns:					
Monthly average	2.03	2.46	2.52	2.85	
Standard deviation	0.20	0.41	0.13	0.35	
Region:	Northeast				
Province:	Buriram		Srisaket		
Village:	13	14	01	06	09
Network:	03	03	03	02	02
Beta	1.373	0.728	2.842	3.832	1.540
	(0.988)	(1.046)	(0.722)	(1.484)	(0.618)
Constant	−0.249	−0.460	−2.205	−0.452	0.554
	(0.694)	(0.794)	(1.226)	(1.845)	(1.025)
Observations	23	27	23	37	36
R^2	0.184	0.015	0.365	0.374	0.134
Network returns:					
Monthly average	0.38	−0.52	−0.58	1.88	0.87
Standard deviation	0.20	0.16	0.14	0.13	0.13

Notes: The unit of observation is household. Beta is computed from a simple time-series regression of household's adjusted ROA on network's ROA over the 156 months from January 1999 to December 2011. Household's mean adjusted ROA is the time-series average of household adjusted ROA over the same 156 months. Standard errors corrected for generated regressors (Shanken 1992) are reported in parentheses.

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 A6 shows that the regression coefficient of household beta is significantly positive for five of the nine networks. For 2 of the 9 networks, we however cannot reject the null hypothesis that the regression coefficient is equal to the network's average return (Networks 602 and 902 in Srisaket).

E. *Time-Varying Stochastic Discount Factor*

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 what presented in Section I of this paper, $W_{t+1} = (1 + r_{M,t+1}) \times (W_t - C_t)$, where W_t, C_t, and $r_{M,t}$ are wealth, consumption, and market rate of return

in period t. Following Campbell and Mankiw (1989), the log-linear approximation of this constraint yields $c_t - w_t \approx E_t\left[\sum_{s=1}^{\infty} \rho_w^s (r_{M,t+s} - \Delta c_{t+s})\right]$, where $\rho_w = \frac{W-C}{W}$ or the steady-state investment to wealth ratio. Define $cay_t = c_t - w_t = c_t - \omega a_t - (1-\omega) y_t$, where a is the share of physical wealth in total wealth. Since we do not observe the share of nonhuman wealth, ω, we cannot directly compute the log consumption to wealth ratio, cay_t. Instead, we follow Lettau and Ludvigson (2001a) and obtain the value of cay_t from $\widehat{cay}_t = c_t^* - \hat{\omega} a_t^* - \hat{\theta} y_t^* - \hat{\delta}$, 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 $c_t^* = \delta + \omega a_t^* + \theta y_t^* + \varepsilon_t$.

F. *Risk-Adjusted Return*

Table A7—Descriptive Statistics of Household Alpha: Township as Market

Province	Observations	Mean	SD	Skewness	Kurtosis	Percentiles 25th	50th	75th
Panel A. Return on assets, not adjusted for risks								
Central								
Chachoengsao	129	1.90	6.51	1.14	4.64	−1.72	0.38	3.99
Lopburi	140	1.37	6.31	−0.93	5.46	−1.67	1.46	3.16
Northeast								
Buriram	131	0.30	3.49	0.24	4.79	−1.32	0.28	1.39
Srisaket	141	2.83	5.87	0.75	5.53	0.21	1.99	4.29
Panel B. Return on assets, adjusted for aggregate risks								
Central								
Chachoengsao	129	0.68	5.52	0.44	5.17	−1.75	−0.15	2.59
Lopburi	140	0.28	5.81	−1.47	7.05	−1.98	1.00	3.16
Northeast								
Buriram	131	−0.28	3.60	−0.02	4.54	−1.94	−0.27	1.39
Srisaket	141	−0.11	4.84	0.24	5.76	−1.43	−0.08	1.18
Panel C. Return on assets, adjusted for aggregate and idiosyncratic risks								
Central								
Chachoengsao	129	−0.49	4.52	−0.31	6.09	−2.21	−0.42	1.47
Lopburi	140	−1.54	5.27	−1.87	8.12	−3.49	−0.12	1.49
Northeast								
Buriram	131	−1.36	3.52	−0.73	4.38	−2.75	−0.75	0.54
Srisaket	141	−1.49	4.16	−0.68	5.70	−2.55	−0.72	0.31

Notes: The unit of observation is household. Panel A reports descriptive statistics of rate of return without adjusting for any risk (but adjusted for household's own labor). Panel B reports rate of return adjusted for aggregate risks, where risk premium is computed from market's mean ROA (ra), market return on human capital (ry), residual consumption (cay), and their interactions $cay \times ra$ and $cay \times ry$, as defined in equation (7) in the text. Panel C reports rate of return adjusted for aggregate risks, where risk premium is computed from market's mean ROA (ra), market return on human capital (ry), residual consumption (cay), and their interactions $cay \times ra$ and $cay \times ry$, as well as idiosyncratic risk from sigma, as defined by equation (9b) in the text. For each household, the return in panels B and C is averaged across nine shifting time windows.

Source: Authors' calculations

REFERENCES

Angeletos, George-Marios. 2007. "Uninsured idiosyncratic investment risk and aggregate saving." *Review of Economic Dynamics* 10 (1): 1–30.

Angelucci, Manuela, Giacomo de Giorgi, and Imran Rasul. 2011. "Insurance and Investment within Family Networks." Unpublished.

Asker, John, Allan Collard-Wexler, and Jan De Loecker. 2014. "Dynamic Inputs and (Mis)Allocation." *Journal of Political Economy* 122 (5): 1013–63.

Attanasio, Orazio, Costas Meghir, and Corina Mommaerts. 2015. "Insurance in Extended Family Networks." National Bureau of Economic Research (NBER) Working Paper 21059.

Banerjee, Abhijit, Dean Karlan, and Jonathan Zinman. 2015. "Six Randomized Evaluations of Microcredit: Introduction and Further Steps." *American Economic Journal: Applied Economics* 7 (1): 1–21.

Bartelsman, Eric, John Haltiwanger, and Stefano Scarpetta. 2013. "Cross-Country Differences in Productivity: The Role of Allocation and Selection." *American Economic Review* 103 (1): 305–34.

Beaman, Lori, Dean Karlan, Bram Thuysbaert, and Christopher Udry. 2015. "Selection into Credit Markets: Evidence from Agriculture in Mali." https://www.povertyactionlab.org/sites/default/files/publications/361%20Self%20Selection%20Mali%20May2015.pdf.

Black, Fischer, Michael C. Jensen, and Myron Scholes. 1972. "The Capital Asset Pricing Model: Some Empirical Tests." In *Studies in the Theory of Capital Markets*, edited by Michael C. Jensen, 79–121. New York: Praeger.

Buera, Francisco J., and Yongseok Shin. 2013. "Financial Frictions and the Persistence of History: A Quantitative Exploration." *Journal of Political Economy* 121 (2): 221–72.

Calvet, Laurent E., John Y. Campbell, and Paulo Sodini. 2007. "Down or Out: Assessing the Welfare Costs of Household Investment Mistakes." *Journal of Political Economy* 115 (5): 707–47.

Campbell, John Y. 2003. "Consumption-based asset pricing." In *Handbook of the Economics of Finance*, Vol. 1B, edited by George M. Constantinides, Milton Harris, and Rene M. Stulz, 803–87. Amsterdam: North-Holland.

Campbell, John Y., and N. Gregory Mankiw. 1989. "Consumption, Income, and Interest Rates: Reinterpreting the Time Series Evidence." In *NBER Macroeconomics Annual 1989*, Vol. 4, edited by Olivier Jean Blanchard and Stanley Fischer, 185–246. Cambridge: MIT Press.

Chiappori, Pierre-André, Krislert Samphantharak, Sam Schulhofer-Wohl, and Robert M. Townsend. 2013. "Portfolio Choices and Risk Sharing in Village Economies." Federal Reserve Bank of Minneapolis Research Department Working Paper 706.

Chiappori, Pierre-André, Krislert Samphantharak, Sam Schulhofer-Wohl, and Robert M. Townsend. 2014. "Heterogeneity and Risk Sharing in Village Economies." *Quantitative Economics* 5 (1): 1–27.

Cochrane, John H. 2001. *Asset Pricing*. Princeton: Princeton University Press.

David, Joel M., Hugo A. Hopenhayn, and Venky Venkateswaran. 2016. "Information, Misallocation, and Aggregate Productivity." *Quarterly Journal of Economics* 131 (2): 943–1005.

de Mel, Suresh, David McKenzie, and Christopher Woodruff. 2008. "Returns to Capital in Microenterprises: Evidence from a Field Experiment." *Quarterly Journal of Economics* 123 (4): 1329–72.

Evenson, R. E., and D. Gollin. 2003. "Assessing the Impact of the Green Revolution, 1960 to 2000." *Science* 300 (5620): 758–62.

Fama, Eugene F., and James D. MacBeth. 1973. "Risk, Return, and Equilibrium: Empirical Tests." *Journal of Political Economy* 81 (3): 607–36.

Fu, Fangjian. 2009. "Idiosyncratic risk and the cross-section of expected stock returns." *Journal of Financial Economics* 91 (1): 24–37.

Heaton, John, and Deborah Lucas. 2000. "Portfolio Choice and Asset Prices: The Importance of Entrepreneurial Risk." *Journal of Finance* 55 (3): 1163–98.

Hseih, Chang-Tai, and Peter J. Klenow. 2009. "Misallocation and Manufacturing TFP in China and India." *Quarterly Journal of Economics* 124 (4): 1403–48.

Jagannathan, Ravi, and Zhenyu Wang. 1996. "The Conditional CAPM and the Cross-Section of Expected Returns." *Journal of Finance* 51 (1): 3–53.

Jensen, Michael C. 1967. "The Performance of Mutual Funds in the Period 1945–1964." *Journal of Finance* 23 (2): 389–416.

Karaivanov, Alexander, and Robert M. Townsend. 2014. "Dynamic Financial Constraints: Distinguishing Mechanism Design from Exogenously Incomplete Regimes." *Econometrica* 82 (3): 887–959.

Karlan, Dean, Robert Osei, Isaac Osei-Akoto, and Christopher Udry. 2013. "Agricultural Decisions after Relaxing Credit and Risk Constraints." http://www.econ.yale.edu/~cru2/pdf/eui.pdf.

Kartashova, Katya. 2014. "Private Equity Premium Puzzle Revisited." *American Economic Review* 104 (10): 3297–3334.

Kinnan, Cynthia, and Robert Townsend. 2012. "Kinship and Financial Networks, Formal Financial Access, and Risk Reduction." *American Economic Review* 102 (3): 289–93.

Lettau, Martin, and Sydney Ludvigson. 2001a. "Consumption, Aggregate Wealth, and Expected Stock Returns." *Journal of Finance* 56 (3): 815–49.

Lettau, Martin, and Sydney Ludvigson. 2001b. "Resurrecting the (C)CAPM: A Cross-Sectional Test When Risk Premia Are Time-Varying." *Journal of Political Economy* 109 (6): 1238–87.

Lucas, Robert E., Jr. 1978. "Asset Prices in an Exchange Economy." *Econometrica* 46 (6): 1429–45.

Mankiw, N. Gregory, and Stephen P. Zeldes. 1991. "The consumption of stockholders and nonstockholders." *Journal of Financial Economics* 29 (1): 97–112.

McKenzie, David, and Christopher Woodruff. 2008. "Experimental Evidence on Returns to Capital and Access to Finance in Mexico." *World Bank Economic Review* 22 (3): 457–82.

Merton, Robert C. 1987. "A Simple Model of Capital Market Equilibrium with Incomplete Information." *Journal of Finance* 42 (3): 483–510.

Midrigan, Virgiliu, and Daniel Yi Xu. 2014. "Finance and Misallocation: Evidence from Plant-Level Data." *American Economic Review* 104 (2): 422–58.

Moll, Benjamin. 2014. "Productivity Losses from Financial Frictions: Can Self-Financing Undo Capital Misallocation?" *American Economic Review* 104 (10): 3186–3221.

Morduch, Jonathan. 1995. "Income Smoothing and Consumption Smoothing." *Journal of Economic Perspectives* 9 (3): 103–14.

Moskowitz, Tobias J., and Annette Vissing-Jørgensen. 2002. "The Returns to Entrepreneurial Investment: A Private Equity Premium Puzzle?" *American Economic Review* 92 (4): 745–78.

Pawasutipaisit, Anan, and Robert M. Townsend. 2011. "Wealth accumulation and factors accounting for success." *Journal of Econometrics* 161 (1): 56–81.

Rampini, Adriano A., and S. Viswanathan. 2016. "Household Risk Management." National Bureau of Economic Research (NBER) Working Paper 22293.

Restuccia, Diego, and Richard Rogerson. 2008. "Policy distortions and aggregate productivity with heterogeneous plants." *Review of Economic Dynamics* 11 (4): 707–20.

Rosenzweig, Mark R., and Hans P. Binswanger. 1993. "Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments." *Economic Journal* 103 (416): 56–78.

Samphantharak, Krislert, and Robert M. Townsend. 2010. *Households as Corporate Firms: An Analysis of Household Finance Using Integrated Household Surveys and Corporate Financial Accounting*. Cambridge: Cambridge University Press.

Samphantharak, Krislert, and Robert M. Townsend. 2012. "Measuring return on household enterprises: What matters most for whom?" *Journal of Development Economics* 98 (1): 58–70.

Schulholfer-Wohl, Sam. 2011. "Heterogeneity and Tests of Risk Sharing." *Journal of Political Economy* 119 (5): 925–58.

Shanken, Jay. 1992. "On the Estimation of Beta-Pricing Models." *Review of Financial Studies* 5 (1): 1–33.

Tazhibayeva, Kamilya, and Robert M. Townsend. 2012. "The Impact of Climate Change on Rice Production: Heterogeneity and Uncertainty." Unpublished.

Townsend, Robert M. 1994. "Risk and Insurance in Village India." *Econometrica* 62 (3): 539–91.

Udry, Christopher. 1994. "Risk and Insurance in a Rural Credit Market: An Empirical Investigation in Northern Nigeria." *Review of Economic Studies* 61 (3): 495–526.

Udry, Christopher, and Santosh Anagol. 2006. "The Return to Capital in Ghana." *American Economic Review* 96 (2): 388–93.

Vissing-Jørgensen, Annette. 2002. "Limited Asset Market Participation and the Elasticity of Intertemporal Substitution." *Journal of Political Economy* 110 (4): 825–53

Vissing-Jørgensen, Annette, and Orazio P. Attanasio. 2003. "Stock-Market Participation, Intertemporal Substitution, and Risk-Aversion." *American Economic Review* 93 (2): 383–91.