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Spring, 2020

Risk Sharing: Without Obstacles as Key Benchmark, How Close to Data. Building from below – risk sharing and networks

(Lecture 5)

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Lecture 5: Building from Below, Risk Sharing without Obstacles as Key Benchmark and Networks (3/10)

Basic Risk-Sharing

*Townsend, Robert M. "Risk and Insurance in Village India." Econometrica 62, no. 3 (1994): 539-91. doi:10.2307/2951659. •

*Krislert Samphantharak & Robert M. Townsend, 2018. "Risk and Return in Village Economies," American Economic Journal: Microeconomics, American Economic Association, vol. 10(1), pages 1-40, February.

*Cynthia Kinnan, Krislert Samphantharak, Robert Townsend, and Diego Vera-Cossio. "Risk-sharing, economic networks and the transmission of shocks." Working Paper (2019).

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

Advani, Arun. "Insurance Networks and Poverty Traps." Working Paper (2019). https://arunadvani.github.io/papers/Advani2018_InsuranceNetworksAndPovertyTraps.pdf

Parit Sripakdeevong and Robert Townsend. "The Village Money Market Revealed: Credit Chains and Shadow Banking." Working Paper (2017). http://www.robertmtownsend.net/sites/default/files/files/papers/working_papers/The_Village_Money_Market_Revealed_-111919.pdf

In the US

Schulhofer-Wohl, Sam. "Heterogeneity and tests of risk sharing." *Journal of Political Economy* 119.5 (2011): 925-958.

Zorzi, Nathan, "Investment Dynamics and Cyclical Redistribution." Working Paper (2019). https://economics.mit.edu/files/18667

Patterson, Christina, "The Matching Multiplier and the Amplification of Recessions," Mimeo, MIT 2019.

Networks and Supply Chains in the US and other Economies

Bernard, Andrew B., Andreas Moxnes, and Yukiko U. Saito. "Production networks, geography, and firm performance." *Journal of Political Economy* 127.2 (2019): 639-688.

Bernard, Andrew B., and Andreas Moxnes. "Networks and trade." *Annual Review of Economics* 10 (2018): 65-85.

Wu, Di. "Shock spillover and financial response in supply chain networks: Evidence from firm-level data." *Unpublished working paper* (2016). https://pdfs.semanticscholar.org/9bf3/9f16bf5aa2f663ff196dfeae6a5a8848af3c.pdf?_ga=2.130953862.86924 0609.1580312341-1559509627.1576540538

Acemoglu, Daron, Ufuk Akcigit, and William Kerr. "Networks and the macroeconomy: An empirical exploration." *NBER Macroeconomics Annual* 30.1 (2016): 273-335.

Liu, Ernest. "Industrial policies in production networks." *The Quarterly Journal of Economics* 134.4 (2019): 1883-1948.

Huneeus, Federico. "Production network dynamics and the propagation of shocks." Working Paper (2018). https://static1.squarespace.com/static/5bc932127fdcb8476acace36/t/5c2c542c0ebbe85745fc7502/154640902 8785/JMP_FHL.pdf

Reischer, Margit. "Finance-thy-neighbor: trade credit origins of aggregate fluctuations." Working Paper (2018). https://margitreischer.files.wordpress.com/2019/11/reischer_tcwp110219_m.pdf

Risk Sharing in the US

Asdruball, P. B. E. Sorensen, and O. Yosha (1996): "Channels of interstate risk sharing: United States 1963-1990," The Quarterly Journal of Economics, 1081–1110.

Atkeson, A. and T. Bayoumi (1993): "Do private capital markets insure regional risk? Evidence from the United States and Europe," Open Economies Review, 4, 303–324.

Kalemli-Ozcan, S. B.E. Sorensen, and O. Yosha (2003): "Risk sharing and industrial specialization: Regional and international evidence," The American Economic Review, 93, 903–918.

Luistig, H. and S. Van Nieuwerburgh (2010): "How much does household collateral constrain regional risk sharing?" Review of Economic Dynamics, 13, 265–294

The Theory

It is important to distinguish a particular *state* s_t from a *history* s_t. A history s_t is a particular sequence of states up to time t, i.e.

$$s^t = (s_1, s_2, \ldots, s_t)$$

The Endowment Economy

In its most basic form, the problem of risk-sharing occurs in an economy, where individual endowments are exogenous. In particular, we suppose that there are I agents, which receive an endowment $y^i(s^t) \in \mathcal{Y}(s^t)$ in history s^t. The utility function of individual i is given by

$$U^i = \sum_{t=1}^{\infty} \sum_{s^t \in S^{t-1}} \beta^t u^i(c^i(s^t)) Pr(s^t).$$

For simplicity we will also write this as $U^i = \sum_{t,s^t} \beta^t u^i(c^i(s^t)) Pr(s^t)$. We will also assume that u^i satisfies the usual assumptions if not otherwise stated.[1]

Given this environment, the Pareto problem is given by

$$\max_{\{[c^i(s^t)]_{s^t}\}_i} \sum_{i=1}^{I} \lambda^i \left(\sum_{t,s^t} \beta^t u^i(c^i(s^t)) Pr(s^t) \right) \tag{1}$$

$$\text{s.t. } \sum_{i=1}^{I} c^i(s^t) = \sum_{i=1}^{I} y^i(s^t) \text{ for all } s^t \in S^t,$$

where λ^i denotes the Pareto weight of individual i. The object of choice $\{[c^i(s^t)]_{s^t}\}_i$ are the consumption allocations in each state of the world, i.e. the conditional distribution of consumption for all individuals (where the appropriate distribution is of course just $Pr(s^t)$). From a conceptual point of view it is interesting to rewrite (8) as a static maximization problem, i.e. to solve it "pointwise" for each t. Doing so and defining aggregate income

$$Y(s^t) = \sum_{i=1}^{I} y(s^t) \text{ for all } s^t \in S^t$$

yields

$$\sum_{t,s^t} \beta^t Pr\left(s^t\right) \max_{\left\{[c^i(s^t)]_{s^t}\right\}_i, i=1}^{I} \sum_{i=1}^{I} \lambda^i u^i \left(c^i\left(s^t\right)\right)$$

$$\text{s.t. } \sum_{i=1}^{I} c^i\left(s^t\right) = Y\left(s^t\right) \text{ for all } s^t \in S^t.$$

Hence for each history $s^t \in S^t$, the solution to the Pareto problem (8) solves

$$\max_{\{c^i\}_i, i=1}^{I} \sum_{i=1}^{I} \lambda^i u^i \left(c^i\right) \quad \text{s.t. } \sum_{i=1}^{I} c^i = Y\left(s^t\right). \tag{2}$$

From this formulation we see already that aggregate income $Y\left(s^t\right)$ encodes the entire information about the history s^t, i.e. if two histories $\hat{s}^t$ and $\tilde{s}^t$ satisfy $Y\left(\hat{s}^t\right) = Y\left(\tilde{s}^t\right)$, the efficient consumption allocation will be the same, i.e.

$$c^i\left(\hat{s}^t\right) = c^i\left(\tilde{s}^t\right) \text{ for all } i.$$

In particular, this consumption allocation is independent of the distribution of s^t (as $Pr\left(s^t\right)$ does not appear in (2)).

To fully characterize the solution $\left\{ \left[c^i \left(s^t \right) \right]_{s^t} \right\}_i$, let us go back to (1). The Lagrangian for this problem is given by

$$\mathcal{L} = \sum_{i=1}^{I} \lambda^i \left(\sum_{t,s^t} \beta^t u^i \left(c^i \left(s^t \right) \right) Pr \left(s^t \right) \right) + \sum_{t,s^t} \theta \left(s^t \right) \left(Y \left(s^t \right) - \sum_i c^i \left(s^t \right) \right),$$

where $\theta \left(s^t \right)$ is the history-dependent multiplier on the resource constraint. The necessary and sufficient FOC are

$$\lambda^i \beta^t \frac{\partial u^i \left(c^i \left(s^t \right) \right)}{\partial c} Pr \left(s^t \right) = \theta \left(s^t \right) \text{ for all } i, s^t \tag{3}$$

$$Y \left(s^t \right) = \sum_i c^i \left(s^t \right) \text{ for all } s^t. \tag{4}$$

Hence, from (3) and (4), the consumption allocation in state s^t is characterized by

$$\lambda^1 \frac{\partial u^1 \left(c^1 \left(s^t \right) \right)}{\partial c} = \lambda^i \frac{\partial u^i \left(c^i \left(s^t \right) \right)}{\partial c} \text{ for all } i \tag{5}$$

$$Y \left(s^t \right) = \sum_i c^i \left(s^t \right). \tag{6}$$

(5) and (6) are I equations in the I unknowns ($\left\{ c^i \left(s^t \right) \right\}_i$), which again shows that $c^i \left(s^t \right)$ can fully be characterized by

$$c^i \left(s^t \right) = g^i \left(Y \left(s^t \right) \right). \tag{7}$$

Clearly, (5) and (6) are just the necessary and sufficient conditions from (2).

(7) contains the main exclusion restriction, which most empirical tests of risk-sharing exploit: individual consumption is just a (individual specific) function of aggregate income. Individual income $y^i(s^t)$ however does not matter once aggregate income is controlled for. Individual preferences (e.g. risk-aversion) however determine g^i.

In the following we will now investigate in how far these insights from the simple endowment economy can be generalized to different environments.

Testing

"Risk and Insurance in Village India" Townsend (1994, *Econometrica*)

Risk and diversification possibilities in agriculture

- Yields are risky. In Aurepalle the coefficients of variations range from 0.5 (sorghum) to 1.01 (castor).
- Diversification across crops is possible as cross-crop correlation ranges from 0.09 to 0.81.
- Soil is also not uniform, so that the CV for castor ranges from 0.7 to 1.01 depending on the type of soil.
- Again: diversification across soil is possible as the correlation is only 0.37.
- But: households do not hold the "market portfolio" of soil-crop combinations

Dynamics of the income process

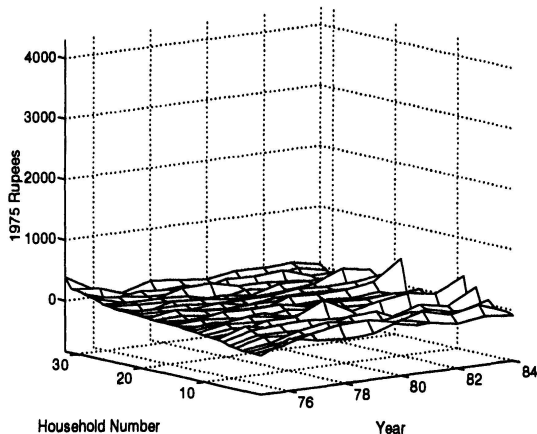Basic picture: Inequality and uncorrelated shocks.
Recall: Households are of very different size.
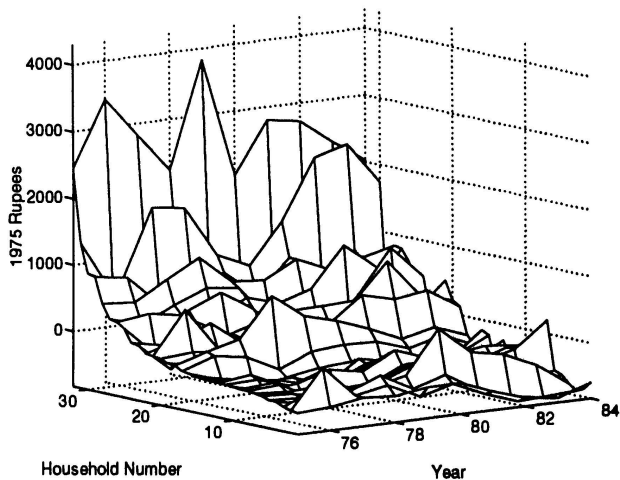
(a) Comovement of household incomes (deviation from village average) Aurepalle.

Dynamics of individual consumption

Basic picture: consumption profiles much smoother than income
process

(a) Comovement of household consumptions (grain only) (deviation from village average) Aurepalle.

Consumption allocations: Households

- Problem: Data has *household* consumption

$$
(12) \quad \frac{\sum_{k=1}^{N_t^j} c_t^k}{\sum_{k=1}^{N_t^j} A_t^k} = \frac{1}{\sigma_j} \left[\log(\lambda^j) - \frac{\sum_{i=1}^{N} \frac{1}{\sigma_i} \log(\lambda^i)}{\sum_{i=1}^{N} \frac{1}{\sigma_i}} \right]
$$

$$
- \frac{1}{\sigma_j} \left[\frac{\sum_{k=1}^{N_t^j} A_t^k \log(A_t^k)}{\sum_{k=1}^{N_t^j} A_t^k} \right.
$$

$$
\left. - \left(\sum_{i=1}^{N} \frac{1}{\sigma_i} \frac{\sum_{k=1}^{N_t^j} A_t^k \log(A_t^k)}{\sum_{k=1}^{N_t^j} A_t^k} \right) \middle/ \sum_{i=1}^{N} \frac{1}{\sigma_i} \right]
$$

$$
+ \frac{1/\sigma_j}{\sum_{i=1}^{N} 1/\sigma_i} \left[\sum_{i=1}^{N} \left(\frac{\sum_{k=1}^{N_t^j} c_t^k}{\sum_{k=1}^{N_t^j} A_t^k} \right) \right].
$$

- Determinants of consumption: (1) pareto weights (wealth), (2) HH composition, (3) Agg consumption, (4) Relative risk aversion

Exclusion for idiosyncratic income: Panel

<div align="center">

TABLE VIII

a. PANEL ESTIMATES WITH ALL CONSUMPTION[a]

</div>

Village:	Aurepalle			Shirapur			Kanzara		
	(A) Std.	(B) First Diff	(C) 2 IV G – H	(D) Std.	(E) First Diff	(F) 2 IV G – H	(G) Std.	(H) First Diff	(I) 2 IV G – H
Variable	ζ_w	ζ_Δ	ζ	ζ_w	ζ_Δ	ζ	ζ_w	ζ_Δ	ζ
1 All Income	0.0772*	0.0469		0.1169*	0.0592*		−0.0073	0.1233*	0.2177
	(0.0221)	(0.0236)	[0.768]	(0.0277)	[0.0236]	[1.290]	(0.0219)	(0.0227)	[−3.177]
2 Crop Profit	−0.0150	−0.0380		0.0825*	0.0352		0.0513*	0.0677*	−0.2545
	(0.0312)	(0.0299)	[0.380]	(0.0373)	[0.0301]	[0.609]	(0.0286)	(0.0308)	[−2.355]
3 Labor Income	0.0401	0.2597*		0.1127*	0.1925*		0.0198	0.1003*	−0.2545
	(0.0647)	(0.0830)	[−1.543]	(0.0740)	[0.0655]	[−0.271]	(0.0406)	(0.0422)	[−1.058]
4 Profit from Trade and Handicrafts	0.2363*	0.1495*		0.0291	−0.1091		0.1347	0.4057*	
	(0.0352)	(0.0389)	[1.197]	(0.0671)	[0.0757]	[0.742]	(0.0895)	(0.0863)	[−1.312]
5 Profit from Animal Husbandry	0.0485	−0.0276		0.5014*	0.1994*	1.4678	0.0672	0.2252*	
	(0.0676)	(0.0689)	[−0.116]	(0.0789)	[0.0693]	[2.193]	(0.0606)	(0.0715)	[−1.387]
6 Full Income	−0.0123*	0.0016		NA	NA	NA	−0.0081	0.0058	
	(0.0027)	(0.0058)	[−1.412]				(0.0044)	(0.0043)	[−0.012]
7 Wage	−10.269	−7.1232		−41.201*	−47.7768		−116.31*	−11.7713	−297.696
	(8.4114)	(10.2640)	[0.004]	(15.4649)	[31.3120]	[−0.467]	(14.057)	(16.8668)	[−4.161]

Outline

- Risk and Return in Production
- Using data on production and consumption
- Social Network and sharing using measured links

Extensions of the Theory: Project Selection

"Risk and Return in Village Economies" Samphantharak & Townsend (2015)

Main Objectives

- Present a model for a study of risk and return of household's productive assets in developing economies

- Applications:
  - Measure idiosyncratic and aggregate risk premia, and use them to analyze risk exposure of households
  - Measure risk-adjusted return, and use it to analyze productivity of assets of household enterprises

Theoretical Framework

- *J* households, indexed by $j = 1, 2, \ldots J$

- *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

- Portfolio of assets = A collection of assets allocated to various households and activities

  - Asset returns are stochastic and allowed to correlate across activities and households

  - Expected return and variance from all available constructed portfolios implies the mean-variance frontier of the economy

- Aggregate production function:

$$F_M = F(\mathbf{k}) = \sum_{j=1}^{J} \sum_{i=1}^{I} f_{i,j}\left(k_j^i\right),$$

I. Full Risk-Sharing Benchmark - 2

- At the beginning of each period, the economy starts with aggregate wealth, *W*, which consists of:
  - The assets held from the previous period ("the trees")
  - The net income generated by all of the assets held by household *j*, net of depreciation, ("the fruit")

- The social planner then chooses current transfer to each household *j* and assets to be carried to the next period for each activity *i* by household *j*

- The current period consumption of household j is

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

I. Full Risk-Sharing Benchmark - 3

- The value function of the social planner is

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

subject to aggregate resource constraint

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

and

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

- W is the aggregate wealth of the whole economy at the beginning of the current period, i.e.

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

I. Full Risk-Sharing Benchmark - 4

- The first-order conditions imply

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

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

   where μ is the shadow price of consumption in the current period

- Note that this setup assumes a closed economy
    - We can generalize and allow the economy to have external borrowing and lending, i.e. small-open economy by redefining $\tilde{W} = W - (1+r)D + D'$

I. Full Risk-Sharing Benchmark - 5

- Finally, for each i and j, we get

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

where $R_j^{i\prime} = 1 + f_{i,j}{}'\left(k_j^{i\prime}\right)$ and $\quad m' = \frac{\phi V_W(W')}{\mu}$

Full Risk-Sharing Benchmark - 7

- Next, since $E\left[m'R_j^{i\prime}\right] = E\left[m'\right]E\left[R_j^{i\prime}\right] + \text{cov}\left(m',R_j^{i\prime}\right),$ we have

$$1 = E\left[m'\right]E\left[R_j^{i\prime}\right] + \text{cov}\left(m',R_j^{i\prime}\right)$$

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

$$E\left[R_j^{i\prime}\right] = \gamma' + \beta_{m',ij}\lambda_{m',ij}$$

Empirical Implementation

Assumption 1: Linear production technology

$$f_{i,j}(k_{i,j}) = r_{i,j}k_{i,j}$$
$$f'_{i,j}(k_{i,j}) = r_{i,j}$$
$$R_{i,j} = 1 + r_{i,j}$$

Can be derived from general CRS production function with optimal inputs chosen sequentially

Assumption 2: The value function of the social planning problem can be well approximated as a quadratic function of the total assets of the economy

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

Under the two additional assumptions, the model implies:

$$E[R'_j] - R'_f = \beta_j(E[R'_M] - R'_f)$$

R'_j : the return to household j's portfolio

R'_M: $\dfrac{\sum_{j=1}^{J}\sum_{i=1}^{I} R'_{i,j}k'_{i,j}}{k'_M}$

k'_M: $\sum_{j=1}^{J}\sum_{i=1}^{I} k'_{i,j}$

β_j: the beta for the return on household j's assets with respect to the aggregate market return:

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

In More Detail

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

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

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

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

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

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

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

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

1

Risk and Return: Township as Market - 2

- Step 1: Compute household beta from a simple time-series regression for each HH

$$R^{\prime}_{j,t} = \alpha_j + \beta_j R_{M,t} + \varepsilon_{j,t}$$

- Step 2: Cross-sectional regression for each township, using time-series average $\overline{R^{\prime}_j} = \sum_{t=1}^{T} R^{\prime}_{j,t}$ as proxy for expected return $E(R^j)$

$$\overline{R^{\prime}_j} = \alpha + \lambda \beta_j + \eta_j .$$

- In theory, the null hypotheses from the model are that , $\lambda = E(R_M)$ and that the constant term α is zero

Data - 2

- Overall sample in the survey:
  - Survey started in August 1998 with a baseline survey; monthly updates began in September 1998 (month 1); (currently month 174)
  - About 45 households in each village
- Sample included in this paper:
  - Month 5 to month 160
    - 156 months (13 full years); Jan 1999-Dec 2011
  - Include only households present for the entire 156-month period
  - Exclude households whose earnings were entirely from wage for the entire period
  - Final sample size: 541 households
- Salient feature of households: Pervasive networks of extended families

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.
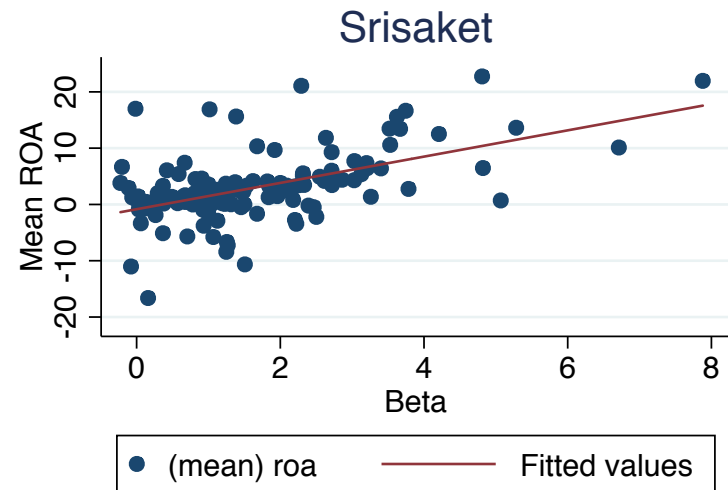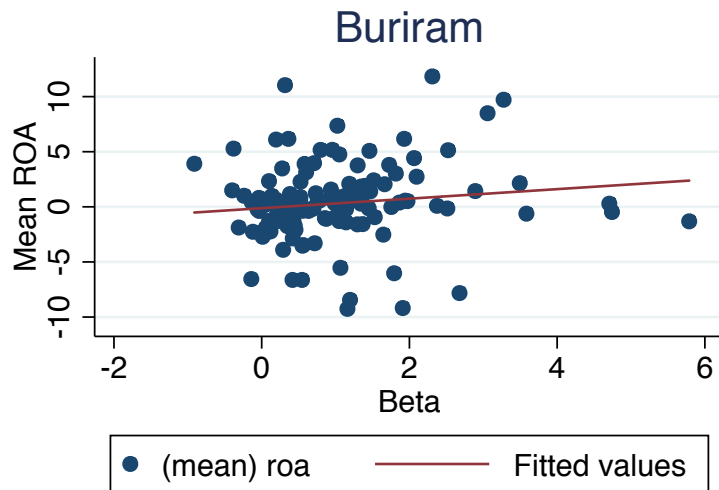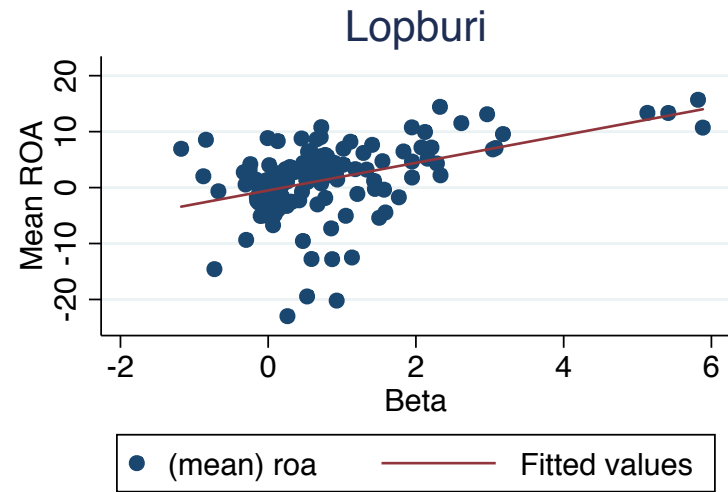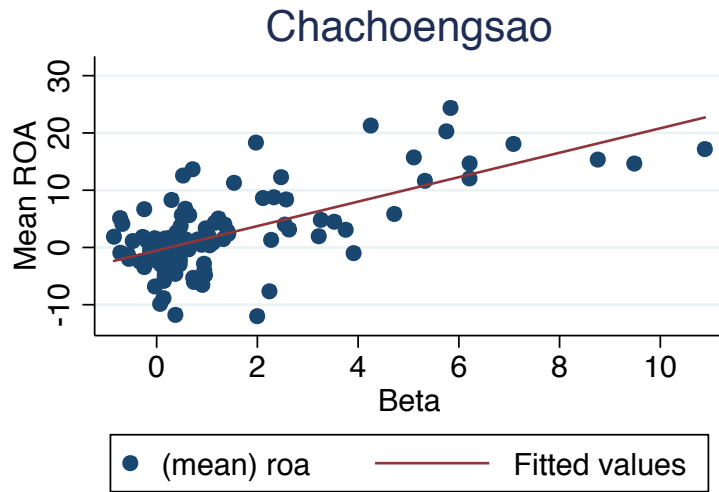
Total Assets: Assets include all assets, i.e., fixed assets, inventories, and financial assets. *Fixed assets* are surveyed in the Agricultural Assets, Business Assets, Livestock, Household Assets, and Land Modules of the survey. In the Agricultural Assets Module, fixed assets include walking tractor, 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]

Table 5 Risk and Return Regressions: Township as Market

				Household's Mean ROA		
			Panel A: Constant Beta			
Region:		**Central**		**Northeast**		
Township (Province):		**Chachoengsao**	**Lopburi**	**Buriram**	**Srisaket**	
		(1)	(2)	(3)	(4)	
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-squared		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	

regression of household adjusted ROA on the ROA of the entire sample over the 156 months. Bootstrap standard errors i
total assets over the month. The adjusted ROA is then annualized and presented in percentage points. For columns (1) to (4
e-series regression of household adjusted ROA on provincial ROA over the156 months. For columns (5), Beta is computed from a
ehold adjusted ROA on the ROA of the entire sample over the 156 months. Bootstrap standard errors in parentheses. *** p<0.01,

Idiosyncratic Risk

- Our framework and empirical strategy allow us to decompose total risks faced by the households and their enterprises (variance) into two components: aggregate (nondiversifiable) risk and idiosyncratic (diversifiable) risk

$$R^{/}_{j,t} = X^{/}_{M,t} \beta_j + \varepsilon_{j,t}$$

$$\mathrm{var}\left(R^{/}_j\right) = \mathrm{var}\left(X^{/}_M \beta_j\right) + \mathrm{var}\left(\varepsilon_j\right)$$

- Finding: Large portion of risk is idiosyncratic

This is a risk decomposition for every household. The first term in the RHS of the equation is the aggregate risk portion (the part being explained by market return). The second term Var(epsilon) is the idiosyncratic risk faced by the household. We then divide both side with Var(R_j) to get the percentage portion of the decomposition, i.e. the contribution from each component for each household. Then, we have a whole distribution of the components for all households; we then compute the median across households and report the median in the following table.

Decomposition of risk premium

Next, we run a regression of each household's average return $\overline{R}_j$ on the estimated β_j and $\sigma_j = \text{Var}\left(\epsilon_j\right)$ to obtain the risk premium for each household:

$$\overline{R}_j = \hat{a} + \hat{b}\beta_j + \hat{c}\sigma_j + \epsilon_i$$

Total risk premium for each household j is $(\hat{b}\beta_j + \hat{c}\sigma_j)$, i.e. total mean return above the risk-free rate ($\hat{a}$). Contribution of aggregate risk premium in total risk premium is calculated as $\hat{b}\beta_j / \left(\hat{b}\beta_j + \hat{c}\sigma_j\right)$. We calculate this percentage for each household i at a time. Then, we calculate the median across households and report the median in the table.

Table 3 Contribution of Idiosyncratic Risk to Total Risk and Total Risk Premium

Region:	Central						Northeast					
Township (Province):	Chachoengsao			Lopburi			Buriram			Srisaket		
	p25	p50	p75	p25	p50	p75	p25	p50	p75	p25	p50	p75
Panel A: Baseline Specification												
Contribution to Total Risk (Variance)	93.9%	98.1%	99.7%	92.3%	97.6%	99.5%	84.0%	94.0%	98.2%	43.8%	65.9%	88.9%
Contribution to Total Risk Premium	4.7%	21.6%	45.4%	41.7%	61.5%	88.7%	105.6%	118.7%	152.8%	13.3%	28.8%	53.9%
Percentage of Diversified Idiosyncratic Risk	98.6%	99.6%	100.0%	92.4%	96.3%	99.9%	111.2%	135.2%	172.2%	67.4%	82.0%	90.0%
Panel B: Robustness Specification												
Contribution to Total Risk (Variance)	77.4%	84.9%	89.0%	80.2%	88.0%	91.6%	73.4%	79.7%	87.1%	40.9%	55.0%	68.9%
Contribution to Total Risk Premium	6.3%	32.6%	56.6%	21.2%	54.9%	102.2%	35.4%	88.4%	147.0%	9.1%	19.5%	33.3%
Percentage of Diversified Idiosyncratic Risk	79.4%	93.4%	100.3%	69.6%	94.9%	110.2%	75.5%	112.7%	153.6%	63.4%	79.9%	89.4%
Number of Observations	129	129	129	140	140	140	131	131	131	141	141	141

Remarks 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.

The Role of Gifts

- We revisit our assumption that gifts and transfers within a township are a mechanism that makes these village economies close to an as-if-complete-markets environment

- In particular, for each observation we compute a correlation coefficient between gifts received by the household and the residual of ROA during the same month (our measure of idiosyncratic component of ROA)

- We find that the correlations are statistically negative (at 1% level of significance) for all provinces except Buriram

  - This finding suggests that households with positive idiosyncratic return tend to provide gifts to others

  - Likewise, households that face negative idiosyncratic return are likely to receive gifts during that period

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-squared	0.011	0.009	0.009	0.014
Number of Households	541	541	541	541

Remarks: 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. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Interpretation

❖ Table 5 shows 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

❖ Risk sharing is thus 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% of idiosyncratic shocks to rate of return are covered by gifts and net lending, with the residual onto consumption. Thus the results are quite consistent with earlier Table 3.

Summary

❖ Risk sharing to be a strong factor

➢ See literature review for other related contributions

❖ Next up: risk sharing and networks

❖ Also in the literature review for propagation and supply chains

Conceptual framework

The conceptual framework guiding our empirical analysis draws on various distinct contributions to the literature. First, we consider a time line for production is as in Moll (2014) or Samphantharak and Townsend (2018), given previously accumulated capital k and current productivity shocks z, a household running a firm decides on hiring labor and purchasing intermediate inputs to produce output at the end of the period, subject to a collateral constraint on financing. This gives within period profits and, if there are constant returns to scale, maximized profits are linear in k. Alternatively, the household can decide to be a wage laborer, as is standard in the endogenous occupation choice of the literature (Lloyd-Ellis and Bernhardt, 2000; Buera et al., 2011). One can refer to profits or wage earnings as (endogenous) income.

The set of people a household-as-firm can transact with in the local markets could be determined by exogenous shocks, with market clearing prices determined by the resulting set of participants (or some kind of Nash bargaining). In addition, supply-chain network decisions are also an endogenous choice that entails a fixed cost if interacting with new firms.[1] Thus, supply-chain networks could be thin and persistent. Likewise, for wage labor, we have in mind there is a cost to new employment contracts. Both these types of costs either subtract from economy resources or could be non-pecuniary. Finally, we can add that there is another production sector a household can choose selling at small economy fixed (given) prices, though this might have lower returns.

The across-period problem considers capital accumulation, with say k' different from k, and financial assets, a. However, unlike Bewley (1981) or Aiyagari (1994), risk-sharing transfers can take place to hedge ex ante random returns z, that is, transfers are determined as a solution to full risk-sharing problem of a "planner". We add on top of this at least exogenous and random participation in insurance networks—i.e., gift giving networks, as in Chandrasekhar et al. (2018). This also allows endogenous participation with further constraints on the planner problem, e.g., with moral hazard if there is an effort cost to joining and/or costly participation under noisy ex ante signals of within-period income. We go a bit further here and conceptualized this as a multi-period problem with correlated costs.

Community solutions to such planner's problem can be termed constrained-optimal as they consider these constraints. Although potential spillovers or externalities are internalized in the planner's problem, there may be still scope for policy improvements. The various costs outlined above could be brought down by broader participation in cross-village insurance and systematic matching platforms.

Households health shocks:
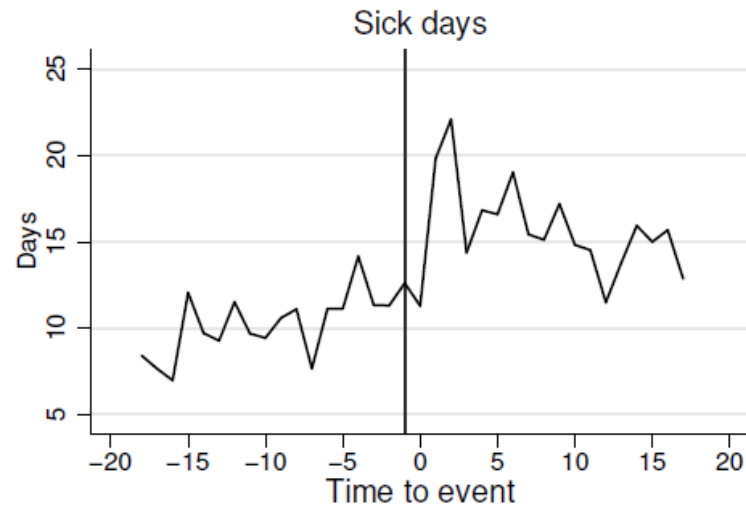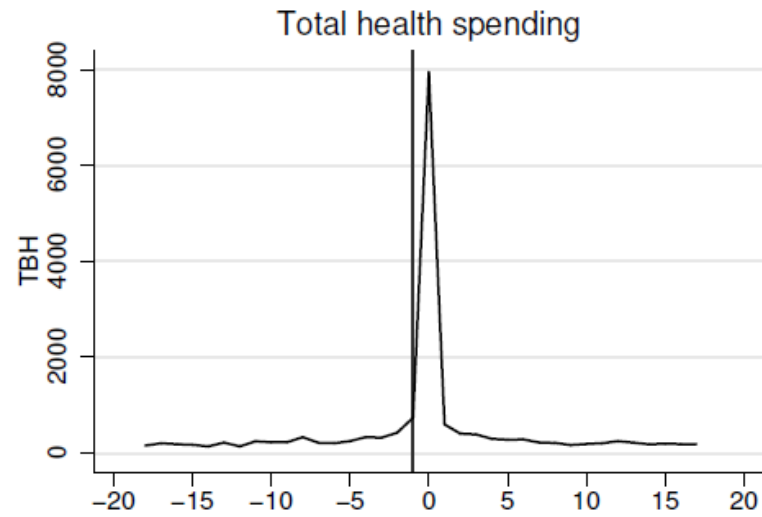
Do households receive more transfers in the aftermath of the shock?
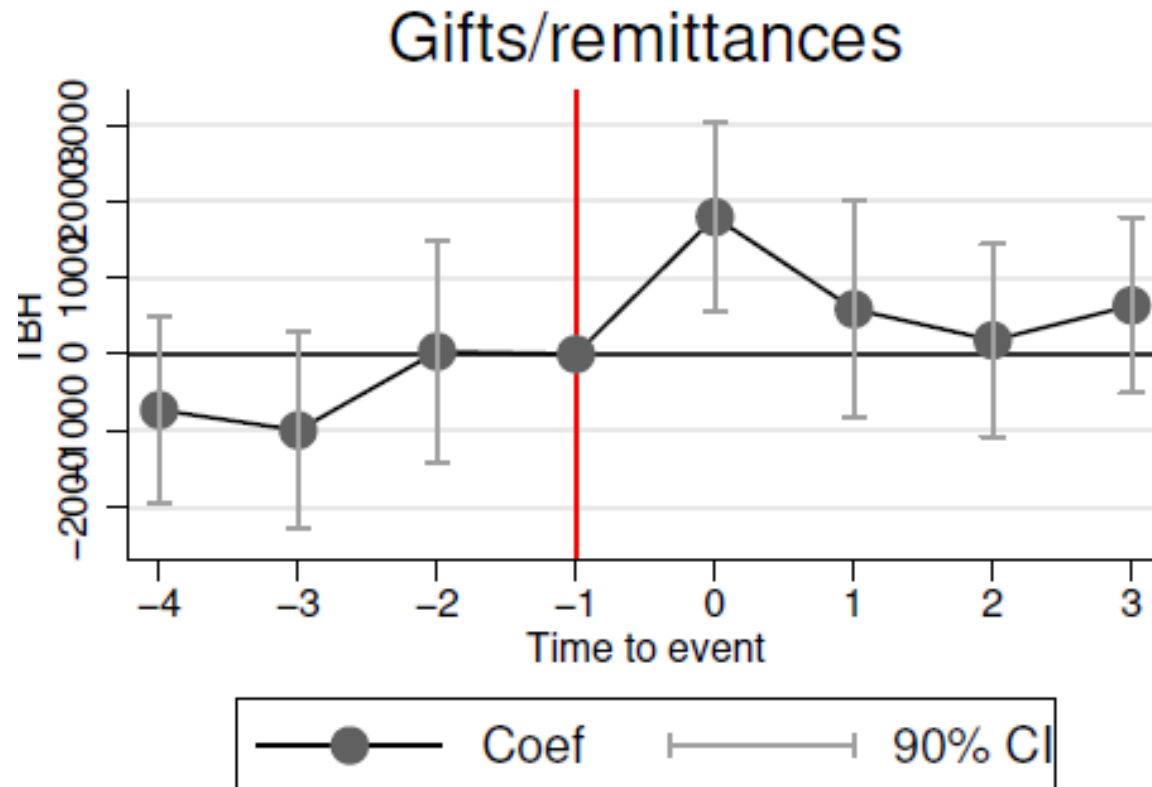
❖ We report estimates of the transmission of the shocks to other households through the sales network for the subsample of households that do not experience a health shock during any of the 24 months following the shocks to other households. Relative to businesses that were unconnected to shocked households, inventory turnover decreased by 6 percentage points in the case of businesses with direct links and by 2.8 percentage points in the case of businesses with indirect ties to shocked businesses. This pattern also holds in the case of the number of sales to local costumers and inventories.

❖ We report estimates of the transmission of the shocks to other house-holds through the labor network. Relative to households that were unconnected to shocked households, the probability of working for other households in the village reduced by 2.2 percentage points in the case of households previously traded labor with shocked households (one link away), and by 1.9 percentage points in the case of households with indirect ties to shocked businesses (two or more links away)

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Table 7: Propagation of shocks to other households - Pooled difference-in-differences method

Panel A : All shocks to households participating in local markets

VARIABLES	(1) # of sales	(2) # of sales	(3) Inventories	(4) Inventories	(5) ITR	(6) ITR
Post X Closeness (Market for goods)	-0.049*	-0.054	20,257.290***	38,299.546***	-0.037***	-0.071***
	(0.026)	(0.038)	(4,945.136)	(10,956.552)	(0.009)	(0.016)
Observations	421,224	421,224	421,224	421,224	421,224	421,224
R-squared	0.726	0.721	0.860	0.811	0.594	0.516
Weights	No	Yes	No	Yes	No	Yes
Number of events	287	287	287	287	287	287

Panel B: Large shocks (Avg. Health Spending¿Avg. per-capita food consumption)

VARIABLES	(1) # of sales	(2) # of sales	(3) Inventories	(4) Inventories	(5) ITR	(6) ITR
Post X Closeness (Market for goods)	-0.154***	-0.166**	25,417.903**	29,346.678**	-0.073***	-0.082***
	(0.050)	(0.066)	(11,071.123)	(13,812.059)	(0.023)	(0.023)
Observations	79,823	79,823	79,823	79,823	79,823	79,823
R-squared	0.697	0.721	0.863	0.838	0.585	0.543
Weights	No	Yes	No	Yes	No	Yes
Number of events	55	55	55	55	55	55

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

Policy question: can well-intended interventions result in welfare losses - Chiappori et al. (2012)

Measuring heterogeneity in risk preferences:

Under the maintained hypothesis of full insurance, the data must satisfy

$$\ln c_{it} = \frac{\ln \alpha_i}{\gamma_i} + \frac{\ln \beta_i}{\gamma_i} t + \frac{\ln \xi_{i,m(t)}}{\gamma_i} + \frac{1}{\gamma_i}(-\ln \lambda_{j(i),t}) + \epsilon_{it}$$

β_i is the household's rate of time preference.

γ_i is household's coefficient of relative risk aversion.

$\xi_{i,m}$ is the household's relative preference for consuming in month $m \in \{$Jan, Feb, ..., Dec$\}$.

m_t is the month corresponding to date t.

$j(i)$ is household i's village.

α_i is a non-negative Pareto weight.

$\lambda_{j(i),t}$ is the Lagrange multiplier on village j's aggregate resource constraint at date t.

Policy question: can well-intended interventions result in welfare losses - Chiappori et al. (2012)

Test of efficient risk sharing:

$$\ln c_{it} = \frac{\ln \alpha_i}{\gamma_i} + \frac{\ln \beta_i}{\gamma_i} t + \frac{\ln \xi_{i,m(t)}}{\gamma_i} + \frac{1}{\gamma_i}(-\ln \lambda_{j(i),t}) + b_j \ln income_{it} + \epsilon_{it}$$

As used in most literature in practice:

$$\ln c_{it} = a_i + d_{j(i),t} + b_j \ln income_{it} + u_{it}$$

Schulhofer-Wohl (2011) "Heterogeneity and tests of risk sharing"

How well do people share risk? Standard risk-sharing regressions assume that any variation in households' risk preferences is uncorrelated with variation in the cyclicality of income. I combine administrative and survey data to show that this assumption is questionable: Risk-tolerant workers hold jobs in which earnings carry more aggregate risk. The correlation makes risk-sharing regressions in the previous literature too pessimistic. I derive techniques that eliminate the bias, apply them to U.S. data, and find that the effect of idiosyncratic income shocks on consumption is practically small and statistically difficult to distinguish from zero.

Patterson (2019) "The Matching Multiplier and the Amplification of Recessions"

Abstract

This paper shows that the unequal incidence of recessions in the labor market amplifies aggregate shocks. I define the *Matching Multiplier* as the increase in the output multiplier originating from the matching of high marginal propensity consume (MPC) workers to highly cyclical jobs. Using administrative data from the United States, I document a positive covariance between worker MPCs and the elasticity of their earnings to GDP that is large enough to increase shock amplification by 40 percent over an equal exposure benchmark. I validate this amplification mechanism by showing that local areas with higher matching multipliers are more cyclical, and that the measured covariance implies strong amplification in a dynamic incomplete markets model.

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Zorzi (2020) "Investment Dynamics and Cyclical Redistribution"

Demand for durable goods and residential investment is strongly pro-cyclical. Workers employed in durable industries are imperfectly insured against these fluctuations, leading to distributional consequences during booms and busts. This paper studies the interaction between cyclical durable demand and redistribution of labor income. I explore this feedback loop within a heterogeneous agent New Keynesian (HANK) model with multiple sectors and lumpy durable adjustment. Crucially, lumpy adjustment at the micro level generates non-linearities at the macro level: the average marginal propensity to spend on durable goods varies with the size of income shocks. As a result, sectoral redistribution of labor incomes has aggregate effects. I find that the interaction between cyclical investment and redistribution amplifies the aggregate response of durable spending during booms and dampens it during recessions. The lumpy nature of durable adjustment entirely accounts for this non-linear effect.

Lecture 5: Building from Below, Risk Sharing without Obstacles as Key Benchmark and Networks (3/10)

Basic Risk-Sharing

*Townsend, Robert M. "Risk and Insurance in Village India." Econometrica 62, no. 3 (1994): 539-91. doi:10.2307/2951659. ●

*Krislert Samphantharak & Robert M. Townsend, 2018. "Risk and Return in Village Economies," American Economic Journal: Microeconomics, American Economic Association, vol. 10(1), pages 1-40, February.

*Cynthia Kinnan, Krislert Samphantharak, Robert Townsend, and Diego Vera-Cossio. "Risk-sharing, economic networks and the transmission of shocks." Working Paper (2019).

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

Advani, Arun. "Insurance Networks and Poverty Traps." Working Paper (2019). https://arunadvani.github.io/papers/Advani2018_InsuranceNetworksAndPovertyTraps.pdf

Parit Sripakdeevong and Robert Townsend. "The Village Money Market Revealed: Credit Chains and Shadow Banking." Working Paper (2017). http://www.robertmtownsend.net/sites/default/files/files/papers/working_papers/The_Village_Money_Market_Revealed_-111919.pdf

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In the US

Schulhofer-Wohl, Sam. "Heterogeneity and tests of risk sharing." *Journal of Political Economy* 119.5 (2011): 925-958.

Zorzi, Nathan, "Investment Dynamics and Cyclical Redistribution." Working Paper (2019). https://economics.mit.edu/files/18667

Patterson, Christina, "The Matching Multiplier and the Amplification of Recessions," Mimeo, MIT 2019.

Networks and Supply Chains in the US and other Economies

Bernard, Andrew B., Andreas Moxnes, and Yukiko U. Saito. "Production networks, geography, and firm performance." *Journal of Political Economy* 127.2 (2019): 639-688.

Bernard, Andrew B., and Andreas Moxnes. "Networks and trade." *Annual Review of Economics* 10 (2018): 65-85.

Wu, Di. "Shock spillover and financial response in supply chain networks: Evidence from firm-level data." *Unpublished working paper* (2016). https://pdfs.semanticscholar.org/9bf3/9f16bf5aa2f663ff196dfeae6a5a8848af3c.pdf?_ga=2.130953862.86924 0609.1580312341-1559509627.1576540538

Acemoglu, Daron, Ufuk Akcigit, and William Kerr. "Networks and the macroeconomy: An empirical exploration." *NBER Macroeconomics Annual* 30.1 (2016): 273-335.

Liu, Ernest. "Industrial policies in production networks." *The Quarterly Journal of Economics* 134.4 (2019): 1883-1948.

Huneeus, Federico. "Production network dynamics and the propagation of shocks." Working Paper (2018). https://static1.squarespace.com/static/5bc932127fdcb8476acace36/t/5c2c542c0ebbe85745fc7502/154640902 8785/JMP_FHL.pdf

Reischer, Margit. "Finance-thy-neighbor: trade credit origins of aggregate fluctuations." Working Paper (2018). https://margitreischer.files.wordpress.com/2019/11/reischer_tcwp110219_m.pdf

Risk Sharing in the US

Asdruball, P. B. E. Sorensen, and O. Yosha (1996): "Channels of interstate risk sharing: United States 1963-1990," The Quarterly Journal of Economics, 1081–1110.

Atkeson, A. and T. Bayoumi (1993): "Do private capital markets insure regional risk? Evidence from the United States and Europe," Open Economies Review, 4, 303–324.

Kalemli-Ozcan, S. B.E. Sorensen, and O. Yosha (2003): "Risk sharing and industrial specialization: Regional and international evidence," The American Economic Review, 93, 903–918.

Luistig, H. and S. Van Nieuwerburgh (2010): "How much does household collateral constrain regional risk sharing?" Review of Economic Dynamics, 13, 265–294

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