Misallocation due to Incomplete Markets

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Quantifying Misallocation due to Incomplete Markets

- It is well-established that households do not perfectly share risk.
  - Domestically: failure of permanent-income hypothesis.
  - Internationally: violations of Backus-Smith condition.
- Inability to transfer resources efficiently across states & over time is a form of misallocation.
- What is the deadweight loss, or economic waste, from incompleteness of financial markets?
- How to aggregate when households & countries are differently affected by incompleteness?
- Social welfare functions mix efficiency & equity (regardless of Pareto weights).

What We Do

- Quantify losses from incomplete markets using the distance to the frontier:

  If financial markets were completed and everyone was compensated, how much resources would be left over?

  Quantifies efficiency losses separately from inequality concerns.

- Study this question in closed & open economies with incomplete financial markets.
  - Exact formulas & approximations using sufficient statistics w/o fully-specified model.

- Across US households, incomplete risk sharing destroys equiv. of 20% of US consumption.

- Across countries, destroys equiv. of 5% of world consumption over the period 1970-2020.
  - Driven by fast-growing countries, e.g. China/Korea. Lower among only developed countries.

Selection of Related Papers

- **Measuring Aggregate Productivity with Heterogeneous Agents**:

  Coeff. of resource utilization, (Debreu, 1951); Baqaee and Burstein, (2025a,b).

- **Aggregate Welfare in Closed and Open Economies with Incomplete Markets**:

  Imrohoroglu (1989); Heathcote, Storesletten, Violante (2008); Conesa, Kitao, & Krueger (2009); Davila, Hong, Krusell, & R. Rull (2012); Van Wincoop (1994), Tesar (1995), Gourinchas & Jeanne (2006), Fitzgerald (2012, 2025), Heathcote & Perri (2014), Lewis and Liu (2015), Corsetti et al. (2024), Aguiar, Itskhoki & Mukhin (2024).

- **Decompositions of Social Welfare Functions**:

  Bhandari, Evans, Golosov & Sargent (2021); Davila & Schaab (2023, 2024).

- **Efficiency Losses from Incomplete Markets without SWF**:

  Benabou (2002); Floden (2001); Farhi & Werning (2012); Aguiar, Amador, Arellano (2024).

- **Misallocation on the production side**:

  Harberger (1954); Restuccia & Rogerson (2008); Hsieh & Klenow (2009); Baqaee & Farhi (2020).

Agenda

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Measuring Misallocation

Closed Economy with Idiosyncratic Risk

Open Economy with Country-Level Risk

Conclusion

Misallocation with Heterogeneous Agents

- Each agent h has preferences $\succeq_h$ over state-contingent streams of consumption bundles $\boldsymbol{c}_h$.
- Let $\boldsymbol{c}^0 = \{\boldsymbol{c}_h^0\}$ be equilibrium consumption allocation under incomplete markets, and $\mathcal{C}(Z)$ be the Pareto frontier under complete markets, given TFP Z.
- By how much can we reduce Z while keeping everyone indifferent to equilibrium?

$$A \equiv \max\left\{Z > 0 : \text{there is } \boldsymbol{c} \in \mathcal{C}(1/Z) \text{ with } \boldsymbol{c}_h \succeq_h \boldsymbol{c}_h^0 \text{ for every } h\right\}.$$

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- e.g. If $A = 1.1$, it is possible to discard $\approx 10\%$ of every factor and keep everyone indifferent.

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- If $A = 1$, then the equilibrium is Pareto efficient.
- e.g. If $A = 1.1$, it is possible to discard $\approx 10\%$ of every factor and keep everyone indifferent.
- No stance on who gets the extra resources when markets are completed.

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- If $A = 1$, then the equilibrium is Pareto efficient.
- e.g. If $A = 1.1$, it is possible to discard $\approx 10\%$ of every factor and keep everyone indifferent.
- Answer is invariant to monotone transformations of utility.

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Closed Economy

- CRRA preferences over consumption streams with EIS η.

$$u_h(\boldsymbol{c}_h) = \frac{1}{1-\eta^{-1}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t c_{ht}^{1-\frac{1}{\eta}}.$$

- In closed economy, there is a common consumption good, so resource constraint is:

$$\sum_h c_{ht}(s) = Y_t(s).$$

- $Y_t(s)$ produced by perfectly competitive production network subject to productivity shocks.
- Consumption process in equilibrium with incomplete markets is $\{\boldsymbol{c}_h^0\}_h$.
- On Pareto frontier with TFP Z, each agent gets a fixed share of $ZY_t(s)$ in every date & state.
- A is max contraction of Z s.t there is a point on the Pareto frontier that makes everyone indifferent to their allocation in initial equilibrium.

Exact Solution

- Let's construct the allocation that solves for A.
- For every point on frontier, agents get fixed share ω_h^* of total contracted output $Y_t(s)/A$.
- To make household h indifferent to the incomplete-markets allocation, ω_h^* must satisfy

$$u(\omega_h^* \boldsymbol{Y}/A) = u(\boldsymbol{c}_h^0).$$

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$$\mathrm{CE}(\omega_h^* \boldsymbol{Y}/A) = \mathrm{CE}(\boldsymbol{c}_h^0),$$

  where $\mathrm{CE}(\boldsymbol{c}_h)$ is the certainty-equivalent of the consumption process $\boldsymbol{c}_h$.
- Using homogeneity of degree 1 of CE and imposing that the shares add up to 1 yields

$$\frac{\omega_h^*}{A}\mathrm{CE}(\boldsymbol{Y}) = \mathrm{CE}(\boldsymbol{c}_h^0) \quad \Rightarrow \quad A = \frac{\mathrm{CE}\left(\sum_h \boldsymbol{c}_h^0\right)}{\sum_h \mathrm{CE}(\boldsymbol{c}_h^0)}.$$

- Formula similar to Benabou (2002), but as a result rather than a definition. Adding capital accumulation, leisure, and different preferences changes A relative to Benabou's definition.

Approximate Characterization

- Use 2nd-order approx. to build sufficient statistics that can be taken to the data more easily.
- Replicate incomplete market equilibrium using Arrow-Debreu with consumption taxes $\mu_{ht}(s)$.
- Let $\omega_{ht}(s)$ be h's share of consumption in date t, state s. Taxes that replicate equilibrium are

$$\log \mu_{ht}(s) = -\frac{1}{\eta}\left[\log \omega_{ht}(s) - \log \omega_{h0}\right].$$

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- A obeys deadweight-loss triangles formula to second order (Baqaee-Burstein 2025a):

$$\Delta \log A = -\sum_{t,h,s} \frac{r}{(1+r)^{t+1}} \pi(s) \underbrace{\omega_h}_{h\text{'s average consumption share}} \times \underbrace{\left(\frac{1}{2} \log \mu_{ht}(s) \Delta \log c_{ht}(s)\right)}_{\text{area deadweight loss triangle}} + O(\log \mu^3),$$

$\log \mu_{ht}(s)$ is the tax wedge and $\Delta \log c_{ht}(s)$ is distortion in quantity caused by wedges.

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$$\log \mu_{ht}(s) = -\frac{1}{\eta}\left[\log \omega_{ht}(s) - \log \omega_{h0}\right].$$

- Substituting wedges & changes in consumption, deadweight-loss triangles formula becomes:

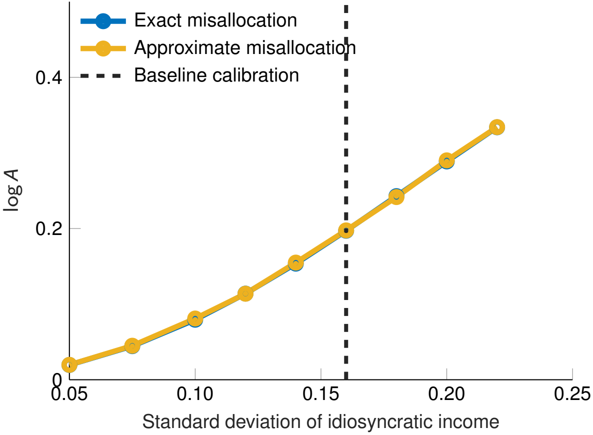
$$\Delta \log A \approx \frac{1}{2}\frac{1}{\eta}\sum_h \omega_{h0} \operatorname{Var}_{r,\pi}[\log \omega_{ht}(s) \mid h],$$

  where $\operatorname{Var}_{r,\pi}[\log \omega_{ht}(s) \mid h]$ is total lifetime variance of log consumption shares for h.

  Requires only moments of expenditures, no model of portfolio choice & income process.

Example: Off-the-Shelf Calibration of Bewley Model

- Baseline: roughly 20% of output left after everyone is kept indifferent.



- Approximation formula works extremely well, even when wedges are not small.

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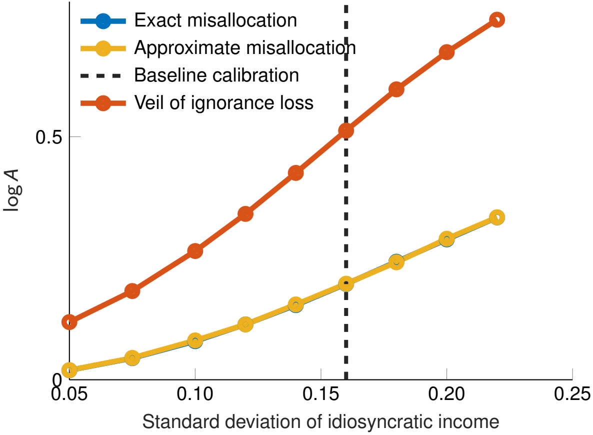

- Approximation formula works extremely well, even when wedges are not small.
- Veil-of-ignorance SWF treats inequality and risk symmetrically.

Extensions

- In the paper we show that the measure can be easily extended to allow for:
  1. labor-leisure choice,
  2. endogenous capital accumulation.
- Quantitative results are very similar.

Extension with Labor-Leisure Choice

- Household preferences: $u(\boldsymbol{c}_h, \boldsymbol{l}_h) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t v(c_{ht}(s), l_{ht}(s))$.
- Resource constraint: $\sum_h c_{ht}(s) = \sum_h z_{ht}(s)\,(1 - l_{ht}(s))$.
- A measures how much time is wasted due to incomplete markets.

Extension with Labor-Leisure Choice

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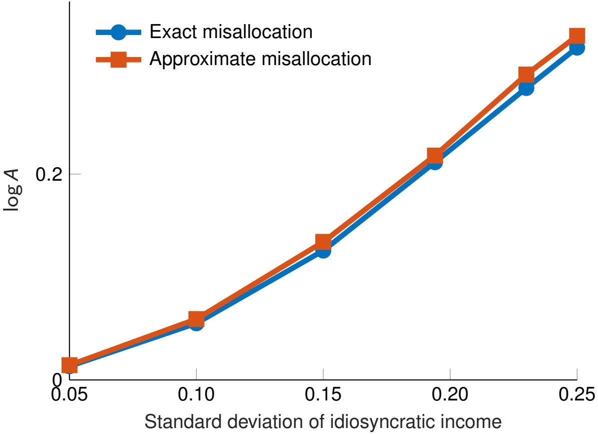
- Resource constraint: $\sum_h c_{ht}(s) = \sum_h z_{ht}(s)(1 - l_{ht}(s))$.
- A measures how much time is wasted due to incomplete markets.
- Benabou (2002) ranks allocations by the sum of certainty-equivalents, $\sum_h CE(\boldsymbol{c}_h, \boldsymbol{l}_h)$, for a fixed leisure level $\bar{l}$.
- Benabou's measure assigns different values to different points on the Pareto frontier.
- In contrast, if initial allocation is on Pareto frontier, then $A = 1$ always.

Example: Bewley with Labor-Leisure Choice

- Frisch $= 0.5$, calibrate shocks to target baseline cross-sectional variance of consumption.



- Misallocation very similar to the baseline model.
- Approximation formula works well – leisure margin doesn't matter much quantitatively.

Extension with Capital Accumulation

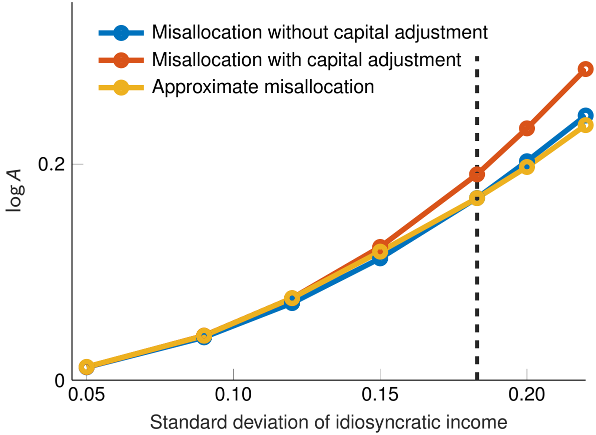
- Introduce physical capital accumulation.
- Can show that A satisfies:

$$A = \frac{\mathrm{CE}(\{c_t^*(s)\}_{t,s})}{\sum_h \mathrm{CE}(\boldsymbol{c}_h^0)},$$

  where $c_t^*(s)$ is agg. consumption in a neoclassical growth model with initial capital stock k_0.
- That is, $c_t^*(s)$ satisfies Euler equation & resource constraints (with usual transversality).
- Precautionary motive distorts aggregate capital stock.

Example: Aiyagari with Capital Accumulation

- Precautionary motive distorts aggregate capital stock.



- Misallocation slightly larger allowing the capital stock to adjust.
- Original approximation formula works well holding capital stock fixed.

Sufficient Statistics Applied to PSID, 1999-2020

- Apply triangles formula directly to consumption panel data in the US from PSID.

$$\Delta \log A \approx \frac{1}{2}\frac{1}{\eta}\sum_h \omega_{h0} \operatorname{Var}_{r,\pi}[\log \omega_{ht}(s) \mid h].$$

- Estimate expectations by regressing on initial household characteristics:

$$\mathbb{E}[\log \omega_{ht}|h] \approx \gamma_{1t}\log(\omega_{h0}) + \psi_{1t}\boldsymbol{X}_{h0} + \varepsilon_{ht}, \quad \mathbb{E}[\log \omega_{ht}^2|h] \approx \gamma_{2t}\log(\omega_{h0}) + \psi_{2t}\boldsymbol{X}_{h0} + \varepsilon_{ht}.$$

  Form life-time variance by discounting back to present.

- Remaining parameters are EIS, $\eta = 0.5$, & riskfree rate, $r = 0.05$. (as in Bewley calib.).

- Find gains of eliminating idiosyncratic volatility: $\approx$ **20**% of output in every period and state.

- Contrast with gains from eliminating *aggregate* volatility (Lucas, 1987): 0.05%.

Sufficient Statistics Applied to PSID, 1999-2020, Sensitivity

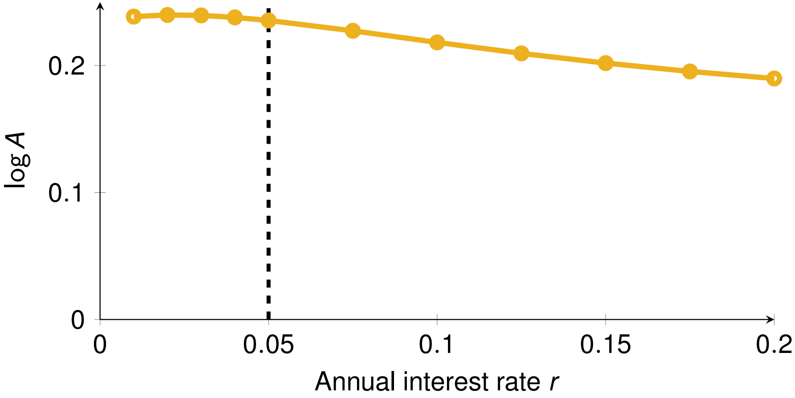


Figure: Estimated misallocation in PSID. Dashed line is the benchmark.

- Results are insensitive to value of risk-free rate.

Agenda

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Gains from Completing International Financial Markets

- Similar question can be asked in open economy.
- Main complication: different countries consume different goods.
- Two challenges:
  1. Quantifying "how much are we losing?" when different agents value different things.
     We use the same measure as before.
  2. Separating efficient volatility due to productivity shocks,from inefficient volatility due to frictions.
     We use sufficient statistic deadweight-loss triangles formula.

Gains from Completing International Financial Markets

- CRRA preferences that can differ across h due to e.g. non-tradeables.
- Goods produced from intermediates and factors:

$$y_{it}(s) = z_{it}(s)\left(\sum_{j\in N}\alpha_{ij}\left(y_{ijt}(s)\right)^{\frac{\theta_i-1}{\theta_i}} + \sum_{f\in F}\alpha_{if}\left(Zl_{ift}(s)\right)^{\frac{\theta_i-1}{\theta_i}}\right)^{\frac{\theta_i}{\theta_i-1}}.$$

  International input-output linkages with arbitrary iceberg trade costs.
- Resource constraints for final goods, intermediates, and factor endowments:

$$c_{ht}(s) = y_{ht}(s), \quad \sum_{j\in N} y_{jit}(s) = y_{it}(s), \quad \sum_{j\in N} l_{jft}(s) = z_{ft}(s).$$

- Define misallocation by:

  Max. contraction of Z under complete markets s.t. possible to keep everyone indifferent.

Approximate Characterization

- Replicate equilibrium allocation in Arrow-Debreu using consumption-taxes:

$$\log \mu_{ht}(s) - \log \mu_{\bar{h}t}(s) = -\frac{1}{\eta}\left[\log \frac{\omega_{ht}(s)/\omega_{h0}}{\omega_{\bar{h}t}(s)/\omega_{\bar{h}0}}\right] + \frac{1-\eta}{\eta}\left[\log \frac{p_{ht}(s)/p_{h0}}{p_{\bar{h}t}(s)/p_{\bar{h}0}}\right]$$

- If everyone consumes the same good, then second term is zero.
- If wedges $\log \mu_{ht} = 0$, then consumption growth perfectly negatively correlated with real exchange rate (Backus-Smith, 1993).

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- If everyone consumes the same good, then second term is zero.
- If wedges $\log \mu_{ht} = 0$, then consumption growth perfectly negatively correlated with real exchange rate (Backus-Smith, 1993).
- The triangles formula is still valid:

$$\Delta \log A \approx -\sum_{t,h,s} \frac{r}{(1+r)^{t+1}} \pi(s) \underbrace{\omega_h}_{h\text{'s average consumption share}} \times \underbrace{\left(\frac{1}{2} \log \mu_{ht}(s) \Delta \log c_{ht}(s)\right)}_{\text{area of deadweight-loss triangle}}$$

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- If everyone consumes the same good, then second term is zero.
- If wedges $\log \mu_{ht} = 0$, then consumption growth perfectly negatively correlated with real exchange rate (Backus-Smith, 1993).
- Can re-write this as:

$$\log A \approx \frac{1}{2} \sum_{h \in H} \omega_h \sum_{h' \in H} \mathcal{M}_{hh'} \operatorname{Cov}_{r,\pi}\left[\log \mu_{ht}(s), \log \mu_{h't}(s) \middle| h, h' \right],$$

where $\mathcal{M}_{hh'}$ depends **only** on **static input-output** matrix and **elasticities of substitution**.

In closed economy, $\mathcal{M}$ is $(-\eta \times$ identity matrix$)$.

Approximate Characterization: Simple Example

- Symmetric two countries, each country produces one good using labor.
- Misallocation is approximately:

$$A \approx \frac{1}{2}\left[\frac{\alpha(1-\alpha)}{4\alpha(1-\alpha)\left(\frac{1}{\eta}-\frac{1}{\theta}\right)+\frac{1}{\theta}}\right]\mathrm{Var}_{r,\pi}[\log \mu_{1t}(s)]\,,$$

  where α is import share, η is the EIS, and θ is Armington trade elasticity.

- Misalloc. high if $\alpha \approx 0.5$ or θ high — more missed opportunities to share risk.
- Misalloc. high if EIS η is low — consumption fluctuations more costly.
- $\mathcal{M}$ in previous slide generalizes this example.

Applying Sufficient Statistics in Open Economy Application

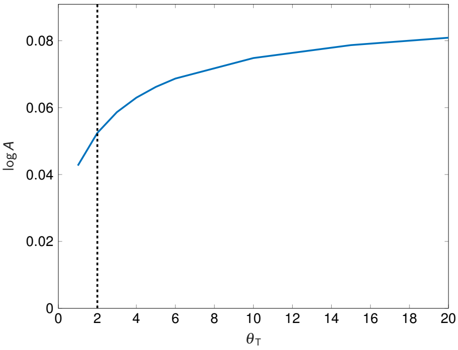
- To apply triangle formula, abstract from within-country heterogeneity.
- Use world input-output database with 32 countries & 54 industries, Armington elast. = 3.
- Use Global Macro Database (Muller et al) for Backus-Smith wedges from $1970 - 2019$.
- No info needed on portfolio problems or ownership of assets.
- No info needed on country-sector-level productivity and trade cost processes.

Misallocation from Incomplete International Financial Markets

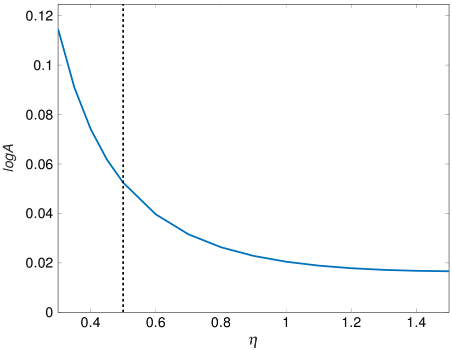
- Benchmark misallocation: roughly **5**%.
- Even though focus on financial frictions for consumers, accounting for IO linkages important.
- Abstracting from intermediate inputs (in production and trade), misallocation falls to **2.8**%
- Driven by differential growth rates between countries (e.g. China vs. Germany).
- Set wedges for China, India, Korea and Indonesia to zero, misallocation much smaller $\sim$ **1**%.
- Despite stark violations of risk-sharing, small gains from intern. business-cycle insurance.

Gains From Completing International Financial Markets

- Vary trade elasticity and EIS, holding data fixed.



(a) Armington elasticity



(b) EIS

- Estimated losses increasing in Armington elasticity: more missed opportunities.
- Estimated losses decreasing in EIS: fluctuations more costly.

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Conclusion and Ongoing Work

- Quantify misallocation due to inability to share resources across states and time.
- Can be extended to measuring misallocation relative to constrained-efficient frontier, accounting for other distortions and policy imperfections.
- Part of broader agenda studying this aggregate measure in different contexts:
  - *"Aggregate Productivity with Heterogeneous Agents"* (general framework, gains from trade)
  - *"Aggregate Welfare with Discrete Choice"* (spatial/occupational choice models)
  - *"An Approximate General Theory of Second Best"* (optimal policy)
  - *"Monetary Policy without Redistributive Concerns"* (in HANK type environments)

How to Solve for A

- Use results in Baqaee and Burstein (2025) to attack problem.
- Let $\tilde{u}_h(\mathbf{c}_h)$ be h's individual consumption equivalent:

$$u_h\left(\mathbf{c}_h/\tilde{u}_h\right) = u_h(\mathbf{c}_h^0).$$

Proposition

Misallocation can be written as

$$A = \max_{a,\boldsymbol{c}}\left\{a : \tilde{u}_h(\boldsymbol{c}_h) \geq a \text{ for every } h \text{ and } \boldsymbol{c} \in \mathcal{C}(1)\right\}.$$

Call maximizer of problem $\boldsymbol{c}^*$. Then, $\boldsymbol{c}^*/A$ is allocation that solves original problem.

Not interesting per se, useful device to calculate A.

Misallocation Measured via Sum of Compensating Variations

- Denote wealth needed to reach u_h under complete market prices $\boldsymbol{p}$ by $e_h(\boldsymbol{p}, u_h)$.

- Compensating variation from completing markets for agent h is

$$cv_h = e_h(\boldsymbol{p}, u_h^{\text{complete}}) - e_h(\boldsymbol{p}, u_h^0).$$

- Let A^{CV} denote ratio of aggregate wealth under complete markets relative to aggregate wealth needed to make households indifferent to the intial equilibrium:

$$A^{CV} = \frac{\sum_h e_h(\boldsymbol{p}, u_h^{\text{complete}})}{\sum_h e_h(\boldsymbol{p}, u_h^0)} = 1 + \frac{\sum_h cv_h}{\sum_h e_h(\boldsymbol{p}, u_h^0)}.$$

- If everyone's preferences are homothetic and identical, then $A^{CV} = A$.

- Coincidence breaks down if preferences vary across households, as in international model.

- We use A because A^{CV} is unreliable in GE when preferences vary across households.

Why Benabou Measure Varies on the Pareto Frontier

- Index any Pareto-efficient allocation by Pareto weights $\{\alpha_h\}$.
- Suppose $z_{ht} = 1$ and the intratemporal utility function is

$$v(c_h, l_h) = \frac{1}{1 - 1/\eta} \left[c_h^{\gamma} l_h^{1-\gamma} \right]^{1-1/\eta}.$$

- Along the Pareto frontier,

$$\sum_h CE(\boldsymbol{c}_h, \boldsymbol{l}_h) = \text{constant} \times \sum_h \alpha_h^{1/\gamma}.$$

- Since $\gamma \leq 1$, it weakly favors more unequal Pareto weights.
- So it is not neutral to pure redistribution, unlike our measure.

Approximate Characterization: Numerical Example

- Armington trade with 15 countries, rep agent within each country, $\theta = 3$, and $\eta = 0.5$.
- Randomize country sizes, I-O matrices, productivity shocks, and Backus-Smith wedges.