Productivity and Misallocation in General Equilibrium

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Aggregation Theorems for Efficient Economies

- For efficient economy, Solow (1957):

$$\mathrm{d}\log Y = \mathrm{d}\log TFP + \Lambda_L \,\mathrm{d}\log L + \Lambda_K \,\mathrm{d}\log K.$$

- For efficient economy, Hulten (1978):

$$\mathrm{d}\log TFP = \sum \lambda_k \,\mathrm{d}\log A_k, \quad \text{where} \quad \lambda_k = \frac{sales_k}{GDP}.$$

- Ex-ante (structural counterfactuals) *and* ex-post (growth accounting) content.

What We Do

- Extend these results to inefficient economies and other shocks.
- General reduced-form, non-parametric formula.
- Mapping from micro to macro using a *general* structural model.
  - micro wedges.
  - structural micro elasticites of substitution.
  - returns to scale.
  - factor market reallocation.
  - network linkages.
- Wide range of applications in different contexts: sources of TFP growth, impact of misallocation, macro impact of micro shocks, effects of monetary policy with nominal rigidities, etc.
- Some selected numbers:
  - 50% of TFP growth 1997-2014 from improved allocative efficiency.
  - 20% rise in TFP from eliminating markups.

Related Literature

- Efficient Network Production Economies:
  Long and Plosser (1983), Gabaix (2011), Acemoglu et al. (2012), Foerster et al. (2011), Acemoglu et al. (2016), Baqaee and Farhi (2017).

- Inefficient Network Production Economies:
  Basu and Fernald (2001), Fernald and Neiman (2011), Jones (2011), Jones (2013), Bigio and La'O (2016), Baqaee (2016), Altinoglu (2016), Grassi (2017), Liu (2017), Caliendo et al. (2017), Bartelme and Gorodnichenko (2015).

- Misallocation
  Restuccia and Rogerson (2008), Hsieh and Klenow (2009), Hopenhayn and Rogerson (1993), Giné and Townsend (2004), Banerjee and Duflo (2005), Chari et al. (2007), Jeong and Townsend (2007), Guner et al. (2008), Townsend (2010), Buera et al. (2011), Epifani and Gancia (2011), Fernald and Neiman (2011), Buera and Moll (2012), D'Erasmo and Moscoso Boedo (2012), Bartelsman et al. (2013), Caselli and Gennaioli (2013), Oberfield (2013), Peters (2013), Reis (2013), Caballero et al. (2013), Asker et al. (2014), Hopenhayn (2014), Moll (2014), Midrigan and Xu (2014), Sandleris and Wright (2014), Edmond et al. (2015), David et al. (2017), David and Venkateswaran (2017), and Gopinath et al. (2017).

Related Literature

- Falling Labor Share, Increasing Markups, Productivity Slowdown:
  Davis et al. (2007), Gordon (2012), Neiman and Karabarbounis (2014), Elsby et al. (2013), Piketty and Zucman (2014), Baqaee (2015), Barkai (2016), Rognlie (2016), Koh et al. (2016), Gutiérrez and Philippon (2016), De Loecker and Eeckhout (2017), Autor et al. (2017), Kehrig and Vincent (2017), Hsieh and Klenow (2017), Gutierrez (2017), Decker et al. (2018).

- Nominal Rigidity with intermediate inputs:
  Basu (1995), Nakamura and Steinsson (2010), Bouakez et al. (2009), Pasten et al. (2016), Pasten et al. (2017).

Agenda

General Non-parametric Result

General Parametric Result

Applications
- Growth Accounting
- Quantitative Model

Extensions (see paper)

Conclusion

Agenda

General Framework

- Final demand as maximizer of homothetic aggregator:

$$Y = \mathscr{D}(c_1, \ldots, c_N),$$

with c_k final consumption of good k.

- Budget constraint:

$$\sum_k (1 + \tau_k^c) p_k c_k = \sum_f w_f F_f + \sum_k \pi_k + \tau,$$

with p_k prices, π_k profits, τ_k^c consumption wedges, w_f wages, F_f factors, τ lump-sum rebate.

General Framework

- Good k produced with constant-returns cost function:

  $$\frac{y_k}{A_k}\mathbf{C}_k\left((1+\tau_{k1})p_1,\ldots,(1+\tau_{kN})p_N,(1+\tau^f_{k1})w_1,\ldots,(1+\tau^f_{kF})w_F\right),$$

  with y_k total output, A_k Hicks-neutral productivity shock, τ_{kl} input-specific wedge, τ^f_{ki} factor-specific wedge.

- Markup μ_k over marginal cost.

- Equilibrium: all markets clear.

Generality

- Captures factor augmenting productivity shocks with relabeling.
- Captures demand shocks as mix of productivity shocks.
- Captures decreasing returns with fixed quasi-factors.
- Can capture “technical” adjustment costs and capacity utilization.
- See later for increasing returns.
- Can be applied to final demand within period, or intertemporally.

Notation and Accounting Convention

- Represent all wedges as markups with relabeling.
- Assume that in *data*, expenditures by i on j and revenues of i recorded *gross* of wedges and markups.
- If not, for ex. with implicit wedges (e.g. credit constraints), re-write expenditures gross of these wedges.

Revenue-Based vs. Cost-Based

Definition

Ω and $\tilde{\Omega}$ are $N \times N$ input-output matrices with ijth element:

$$\Omega_{ij} = \frac{p_j x_{ij}}{p_i y_i}, \quad \tilde{\Omega}_{ij} = \frac{p_j x_{ij}}{\sum_k p_k x_{ik} + \sum_f w_f F_{if}}.$$

Ψ and $\tilde{\Psi}$ are $N \times N$ Leontief inverse matrices:

$$\Psi = (I - \Omega)^{-1}, \quad \tilde{\Psi} = (I - \tilde{\Omega})^{-1}.$$

b is $N \times 1$ consumption-shares vector with ith element:

$$b_i = \frac{p_i c_i}{\sum_j p_j c_j}.$$

λ and $\tilde{\lambda}$ are $N \times 1$ Domar weights:

$$\lambda = b' \Psi, \quad \tilde{\lambda} = b' \tilde{\Psi}.$$

Revenue-Based vs. Cost-Based

Cost-based definitions capture correct notion of exposure:

- $\tilde{\Omega}_{ij}$ is direct exposure of i to j.
- $\tilde{\Psi}_{ij}$ is direct and indirect exposure of i to j.
- $\tilde{\lambda}_k$ is direct and indirect exposure of household to k.

Macro Impact of Micro Shocks

- $\mathscr{Y}(A, \mathrm{X})$: output Y given productivities A and shares $\mathrm{X}_{ij} = x_{ij}/y_j$.
- Change in equilibrium in response to shocks:

$$\mathrm{d}\log Y = \underbrace{\frac{\partial \log \mathscr{Y}}{\partial \log A} \mathrm{d}\log A}_{\Delta \text{Technology}} + \underbrace{\frac{\partial \log \mathscr{Y}}{\partial \mathrm{X}} \mathrm{d}\mathrm{X}}_{\Delta \text{Allocative Efficiency}} .$$

- For efficient economies, macro-envelope implies Hulten:

$$\mathrm{d}\log Y = \underbrace{\lambda' \mathrm{d}\log A}_{\Delta \text{Technology}} + \underbrace{0}_{\Delta \text{Allocative Efficiency}} .$$

- Inefficient economies: no macro-envelope, only micro-envelope.

Macro Impact of Micro Productivity Shocks

Theorem

$$\frac{\mathrm{d}\log Y}{\mathrm{d}\log A_k} = \underbrace{\tilde{\lambda}_k}_{\Delta Technology} \underbrace{-\sum_f \tilde{\Lambda}_f \frac{\mathrm{d}\log \Lambda_f}{\mathrm{d}\log A_k}}_{\Delta Allocative\ Efficiency}.$$

- Yields Hulten's theorem for efficient economies:

$$\tilde{\lambda}_k = \lambda_k \qquad \text{and} \qquad -\sum_f \tilde{\Lambda}_f \frac{\mathrm{d}\log \Lambda_f}{\mathrm{d}\log A_k} = 0.$$

- See later for structural formula for $-\sum_f \tilde{\Lambda}_f \,\mathrm{d}\log \Lambda_f / \mathrm{d}\log A_k$.

Macro Impact of Micro Markup Shocks

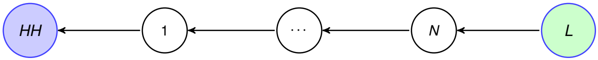
Theorem

$$\frac{d\log Y}{d\log \mu_k} = \underbrace{-\tilde{\lambda}_k - \sum_f \tilde{\Lambda}_f \frac{d\log \Lambda_f}{d\log \mu_k}}_{\Delta \text{Allocative Efficiency}}.$$

- Also applies to shocks to other wedges.
- Can be applied to endogenous wedges via chain rule.
- See later for structural formula for $-\sum_f \tilde{\Lambda}_f \, d\log \Lambda_f / d\log \mu_k$.

Ex. Simple Vertical Economy

- Example of multiple marginalization taken from Baqaee (2016):



- $\tilde{\lambda}_k = 1 \neq \lambda_k = \prod_{i=1}^{k-1} \mu_i^{-1}$ and $\Lambda_L = \prod_{i=1}^{N} \mu_i^{-1} \neq 1$.

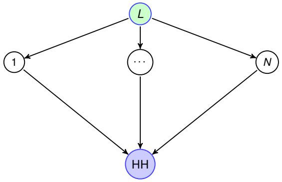
- Productivity shocks:

$$\frac{\mathrm{d}\log Y}{\mathrm{d}\log A_k} = \tilde{\lambda}_k - \frac{\mathrm{d}\log \Lambda_L}{\mathrm{d}\log A_k} = 1$$

- Markups/wedges shocks:

$$\frac{\mathrm{d}\log Y}{\mathrm{d}\log \mu_k} = -\tilde{\lambda}_k - \frac{\mathrm{d}\log \Lambda_L}{\mathrm{d}\log A_k} = 0$$

Ex. Simple Horizontal Economy



- $\tilde{\lambda}_k = \lambda_k$ and $\Lambda_L = \sum_j \lambda_j \mu_j^{-1} \neq 1$.
- Productivity shocks:

$$\frac{\mathrm{d}\log Y}{\mathrm{d}\log A_k} = \tilde{\lambda}_k - \frac{\mathrm{d}\log \Lambda_L}{\mathrm{d}\log A_k} = \lambda_k - (\theta_0 - 1)\left(\frac{\mu_k^{-1}}{\sum_j \lambda_j \mu_j^{-1}} - 1\right)\lambda_k.$$

- Markup/wedge shocks:

$$\frac{\mathrm{d}\log Y}{\mathrm{d}\log \mu_k} = -\tilde{\lambda}_k - \frac{\mathrm{d}\log \Lambda_L}{\mathrm{d}\log A_k} = \theta_0 \left(\frac{\mu_k^{-1}}{\sum_j \lambda_j \mu_j^{-1}} - 1\right)\lambda_k.$$

Ex. Cobb-Douglas Economies

- Productivity shocks:

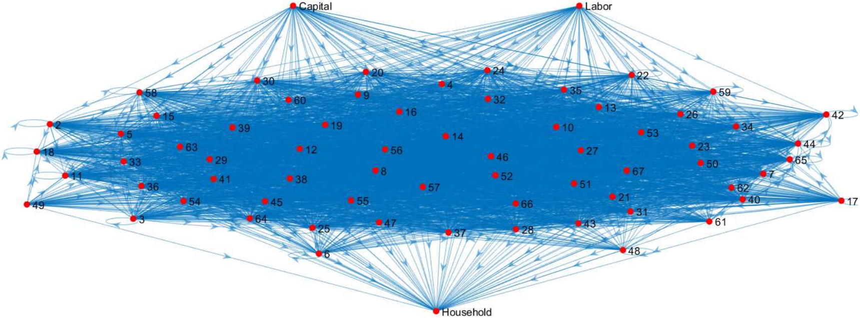
$$\frac{d\log Y}{d\log A_k} = \tilde{\lambda}_k - \sum_f \tilde{\Lambda}_f \frac{d\log \Lambda_f}{d\log A_k} = \tilde{\lambda}_k.$$

- Markup/wedge shocks:

$$\frac{d\log Y}{d\log \mu_k} = -\tilde{\lambda}_k - \sum_f \tilde{\Lambda}_f \frac{d\log \Lambda_f}{d\log A_k} = -\tilde{\lambda}_k + \lambda_k \sum_f \tilde{\Lambda}_f \Psi_{kf}/\Lambda_f.$$

- Cobb-Douglas functional forms very popular in literature.
- For an efficient economy, first-order approximation equivalent to Cobb-Douglas (not true at higher order).
- For inefficient economies, first-order approximation not equivalent to Cobb-Douglas, and so assumption even more problematic!

Ex. US Economy



- Productivity shocks:

$$\frac{d\log Y}{d\log A_k} = \tilde{\lambda}_k - \tilde{\Lambda}_L \frac{d\log \Lambda_L}{d\log A_k} - \tilde{\Lambda}_K \frac{d\log \Lambda_K}{d\log A_k}.$$

- Markup/wedge shocks:

$$\frac{d\log Y}{d\log \mu_k} = -\tilde{\lambda}_k - \tilde{\Lambda}_L \frac{d\log \Lambda_L}{d\log \mu_k} - \tilde{\Lambda}_K \frac{d\log \Lambda_K}{d\log \mu_k}.$$

Sources of Growth and Solow Residual

- Easy extension to changing factor supplies:

$$d\log Y - \tilde{\Lambda}' d\log L = \underbrace{\tilde{\lambda}' d\log A}_{\Delta\text{Technology}} \underbrace{-\tilde{\lambda}' d\log \mu + \tilde{\Lambda}' d\log \Lambda}_{\Delta\text{Allocative Efficiency}}.$$

- Solow residual:

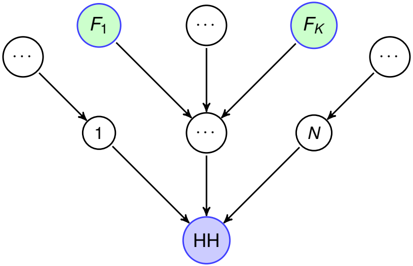
$$d\log Y - \hat{\Lambda}' d\log L = \underbrace{\tilde{\lambda}' d\log A}_{\Delta\text{Technology}} \underbrace{-\tilde{\lambda}' d\log \mu + \tilde{\Lambda}' d\log \Lambda}_{\Delta\text{Allocative Efficiency}} + \underbrace{(\tilde{\Lambda} - \hat{\Lambda})' d\log L}_{\text{Miscounting Factor Growth}},$$

where $\hat{\Lambda}$ adjusts Λ to count profit share in capital share.

- Can perform decomposition without imposing *any* parametric assumptions on production functions. Example: handles factor augmenting productivity and demand shocks with no modification.

Alternative Decompositions

- Alternative decompositions of Basu-Fernald (2002) and Petrin-Levinsohn (2012).
- Do not use input-output information.
- Revealing example of acyclic economies:



- These decompositions detect changes in allocative efficiency, even though allocation is efficient. Ours does not.

Measuring Allocative Efficiency

- Measure of change in allocative efficiency along equilibrium path.
- Different from change of distance to frontier a la Restuccia and Rogerson (2008) or Hsieh and Klenow (2009).
- Relation between the two concepts:

$$\log\left(\frac{Y(A,1)}{Y(A,\mu)}\right) = -\int_0^1 \frac{\mathrm{d}\log Y(A,\hat{\mu}(t))}{\mathrm{d}\log\mu}\frac{\mathrm{d}\log\hat{\mu}(t)}{\mathrm{d}t}\,\mathrm{d}t$$
$$= \frac{1}{2}\sum_i \frac{\mathrm{d}\log Y(A,\mu)}{\mathrm{d}\log\mu_i}\left(\frac{1-\mu_i}{\mu_i}\right) + O(\|\mu-1\|^3),$$

  where $\hat{\mu}_k = \tau\mu_k + (1-\tau)$.

- Ex. for a horizontal economy:

$$\log\left(\frac{Y(A,1)}{Y(A,\mu)}\right) = \frac{1}{2}\theta_0\frac{Var_\lambda(\mu^{-1})}{E_\lambda(\mu^{-1})}.$$

Parametric Model

- Final demand:

$$\frac{Y}{\overline{Y}} = \left(\sum_k b_k \left(\frac{c_k}{\overline{c}_k} \right)^{\frac{\theta_0 - 1}{\theta_0}} \right)^{\frac{\theta_0}{\theta_0 - 1}} .$$

- Production of good k:

$$\frac{y_k}{\overline{y}_k} = A_k \left(a_k \left(\frac{l_k}{\overline{l}_k} \right)^{\frac{\theta_k - 1}{\theta_k}} + (1 - a_k) \left(\frac{X_k}{\overline{X}_k} \right)^{\frac{\theta_k - 1}{\theta_k}} \right)^{\frac{\theta_k - 1}{\theta_k}} .$$

- X_k composite intermediate input given by

$$\frac{X_k}{\overline{X}_k} = \left(\sum_l \omega_{kl} x_{lk}^{\frac{\varepsilon_k - 1}{\varepsilon_k}} \right)^{\frac{\varepsilon_k - 1}{\varepsilon_k}} ,$$

where x_{kl} intermediate inputs from industry l used by industry k.

Parametric Model

- Relabel network so that each node corresponds to one CES nest.
- Structure can actually represent ***any*** nested CES economy with arbitrary pattern of nests and wedges.

Definition

$$Cov_{\tilde{\Omega}^{(j)}}\left(\tilde{\Psi}_{(k)}, \Psi_{(L)}\right) = \sum_i \tilde{\Omega}_{ji} \tilde{\Psi}_{ik} \Psi_{iL} - \left(\sum_i \tilde{\Omega}_{ji} \tilde{\Psi}_{ik}\right) \left(\sum_i \tilde{\Omega}_{ji} \Psi_{iL}\right).$$

Macro Impact of Micro Productivity Shocks: One Factor

Proposition

Suppose there is only one factor (with index L). Then

$$\frac{d\log Y}{d\log A_k} = \underbrace{\tilde{\lambda}_k}_{\Delta Technology} \quad \underbrace{-\frac{d\log \Lambda_L}{d\log A_k}}_{\Delta Allocative\ Efficiency},$$

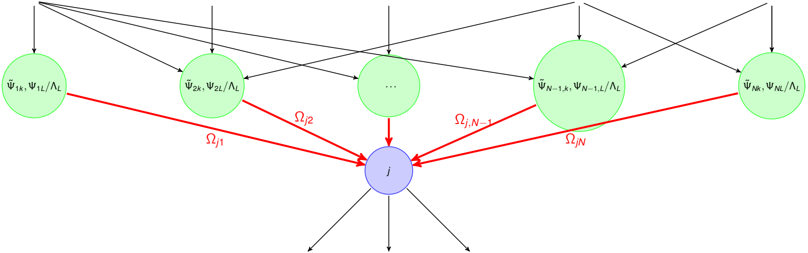
where

$$\frac{d\log \Lambda_L}{d\log A_k} = \sum_j (\theta_j - 1)\mu_j^{-1}\lambda_j Cov_{\tilde{\Omega}(j)}\left(\tilde{\Psi}_{(k)}, \frac{\Psi_{(L)}}{\Lambda_L}\right).$$

- Centrality measure mixing network and elasticities.
- Upstream and downstream distortions matter.

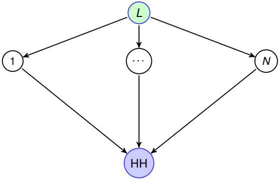
Explaining Covariance Operator

$$\frac{\mathrm{d}\log Y}{\mathrm{d}\log A_k} = \tilde{\lambda}_k - \sum_j \underbrace{(\theta_j - 1)\mu_j^{-1}\lambda_j Cov_{\tilde{\Omega}^{(j)}}\left(\tilde{\Psi}_{(k)}, \frac{\Psi_{(L)}}{\Lambda_L}\right)}.$$



- High $\tilde{\Psi}_{ik}$: i's highly exposed to k.
- High Ψ_{iL}/Λ_L: most of i's revenues are ultimately paid to workers.

Ex. Back to Simple Horizontal Economy



- Change in technology and change in allocative efficiency:

$$\frac{\mathrm{d}\log Y}{\mathrm{d}\log A_k} = \lambda_k - (\theta_0 - 1)\left(\frac{\mu_k^{-1}}{\sum_j \lambda_j \mu_j^{-1}} - 1\right)\lambda_k.$$

- Key: markup vs. average and elasticity minus one.

Macro Impact of Micro Markup Shocks: One Factor

Proposition

Suppose there is only one factor indexed by L. Then

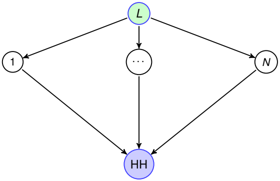
$$\frac{d\log Y}{d\log \mu_k} = \underbrace{-\tilde{\lambda}_k - \frac{d\log \Lambda_L}{d\log A_k}}_{\Delta Allocative\ Efficiency},$$

where

$$\frac{d\log \Lambda_L}{d\log \mu_k} = \sum_j (1-\theta_j)\mu_j^{-1}\lambda_j Cov_{\tilde{\Omega}_j}\left(\tilde{\Psi}_{(k)}, \frac{\Psi_{(L)}}{\Lambda_L}\right) - \lambda_k \frac{\Psi_{kL}}{\Lambda_L}.$$

- Positive markup shock like negative productivity shock...
- ...but also releases labor.

Ex. Simple Horizontal Economy



- Change in allocative efficiency:

$$\frac{\mathrm{d}\log Y}{\mathrm{d}\log \mu_k} = -\tilde{\lambda}_k - (1-\theta_0)\lambda_k\left(\frac{\mu_k^{-1}}{\Lambda_L} - 1\right) + \frac{\lambda_k \mu_k^{-1}}{\Lambda_L},$$

$$= \theta_0\left(\frac{\mu_k^{-1}}{\sum_j \lambda_j \mu_j^{-1}} - 1\right)\lambda_k.$$

- Key: markup vs. average and elasticity.

Macro Impact of Micro Productivity Shocks: Multiple Factors

Proposition

The following linear system describes the elasticities of factor shares:

$$\frac{d\log\Lambda}{d\log A_k} = \Gamma\frac{d\log\Lambda}{d\log A_k} + \delta_{(k)},$$

with

$$\Gamma_{f,g} = -\sum_j(\theta_j - 1)\lambda_j\mu_j^{-1}Cov_{\tilde{\Omega}^{(j)}}\left(\tilde{\Psi}_{(f)}, \frac{\Psi_{(g)}}{\Lambda_g}\right),$$

and

$$\delta_{fk} = \sum_j(\theta_j - 1)\lambda_j\mu_j^{-1}Cov_{\tilde{\Omega}^{(j)}}\left(\tilde{\Psi}_{(k)}, \frac{\Psi_{(f)}}{\Lambda_f}\right).$$

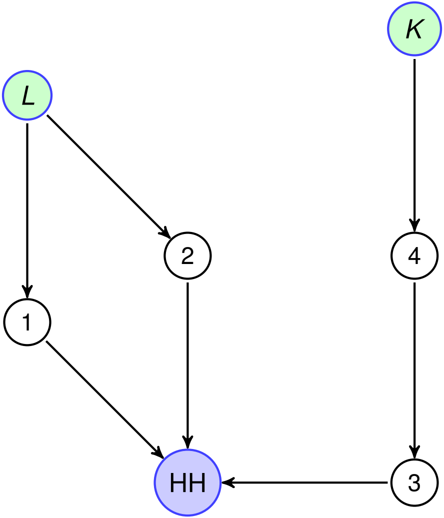
Given the elasticities of factor shares, we have

$$\frac{d\log Y}{d\log A_k} = \underbrace{\tilde{\lambda}_k}_{\Delta Technology} \underbrace{-\sum_f\tilde{\Lambda}_f\frac{d\log\Lambda_f}{d\log A_k}}_{\Delta Allocative\ Efficiency}.$$

Multiple Factors

- Extends Hulten (1978), Jones (2011), Oberfield and Raval (2014), Caliendo et al. (2017), , and Baqaee and Farhi (2017) in one place.
- Can derive similar formula for markups/wedge shocks.

Ex. Multiple Factors



Ex. Multiple Factors

- Change in technology and change in allocative efficiency:

$$\frac{\mathrm{d}\log Y}{\mathrm{d}\log A_k} = \lambda_k + \lambda_k(\theta_0 - 1)\left(1 - \frac{\mu_k^{-1}}{\frac{\lambda_1}{\lambda_1+\lambda_2}\mu_1^{-1} + \frac{\lambda_2}{\lambda_1+\lambda_2}\mu_2^{-1}}\right) \quad (k = 1, 2),$$

$$\frac{\mathrm{d}\log Y}{\mathrm{d}\log A_3} = \lambda_3,$$

$$\frac{\mathrm{d}\log Y}{\mathrm{d}\log A_4} = \tilde{\lambda}_4 = \mu_3\lambda_4.$$

- No change in allocative efficiency between (1+2) and (3+4).

Agenda

General Non-parametric Result

General Parametric Result

Applications

- Growth Accounting
- Quantitative Model

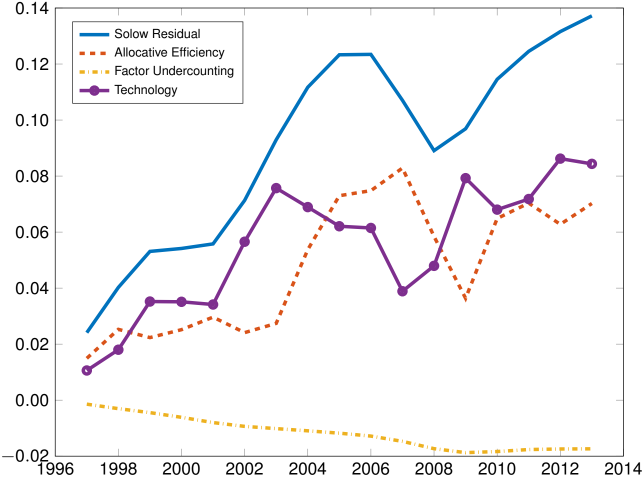
Extensions (see paper)

Conclusion

Sources of Growth and Solow Residual

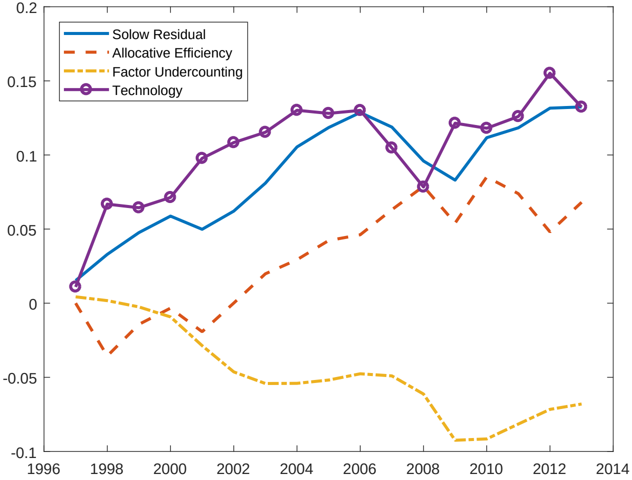
- Suppose markups are only distortions.
- Use annual IO tables from BEA from 1997-2015.
- Use markups from Gutiérrez and Philippon (2016), De Loecker and Eeckhout (2017), and Lerner Indices for firms in Compustat.
- All measures show large increases in markups, from composition effects across firms, not from effects within firms: high markup firms getting bigger, not large firms getting higher markups. Also consistent with Autor et al. (2017).
- Perform decomposition.

Sources of Growth and Solow Residual



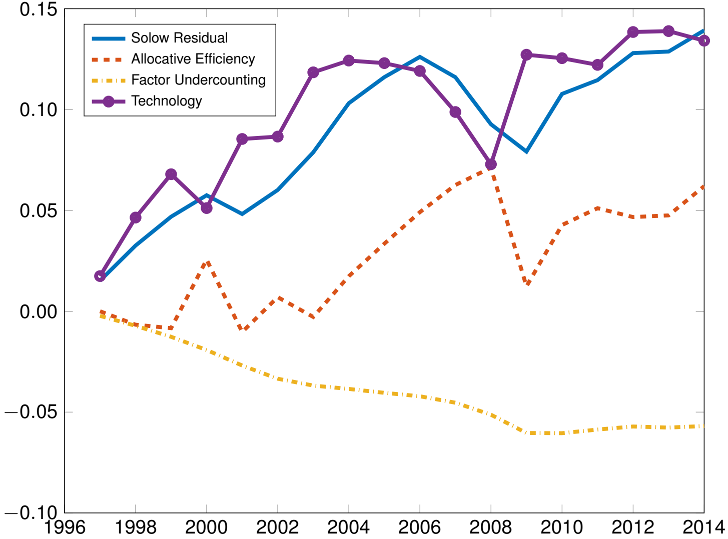
- Using the Gutiérrez and Philippon (2016) markup data.
- Similar with De Loecker and Eeckhout (2017) and Lerner Indices.

Sources of Growth and Solow Residual



- Using the De Loecker and Eeckhout (2017) markup data.

Sources of Growth and Solow Residual



- Using Lerner indices.

Quantitative Results

Calibrate parametric model.

- Benchmark elasticities of substitution:
  - consumption 0.4;
  - value and intermediates 0.3;
  - across intermediates be 0.01;
  - between labor and capital 1;
  - within industries 8.
- Use IO table from BEA from 2015.
- Robustness checks: role of elasticities and input-output structure.

Gains from Eliminating Markups

	Gutierrez-Philippon	Lerner Index	De Loecker-Eeckhout
2014	20%	17%	35%
1997	3%	5%	21%

- Measures show big increase between 1997 and 2014.
- Contrast with 0.1% estimate of Harberger (1954) triangles!

"It takes a heap of Harberger triangles to fill an Okun gap."
— Tobin

Gains from Shrinking Markups: Robustness

	Benchmark	CD+CES	CD+CD	VA Benchmark	VA CD + CES	VA CD + CD
GP	20%	21%	4%	8%	8%	1%
LI	17%	18 %	4 %	7%	7%	1%
DE	35%	38%	7%	18 %	18%	3%

- Elasticities matter.
- Input-output structure matters.
- Value-added production functions misleading!

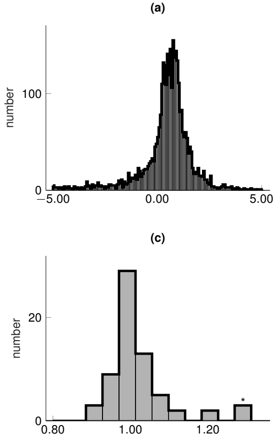
Macro-Volatility from Micro Shocks

$$Var(\log Y) \approx \|D_{\log A} \log Y\|^2 Var(\mathrm{d} \log A) + \|D_{\log \mu} \log Y\|^2 Var(\mathrm{d} \log \mu).$$

- Thought experiment: i.i.d. shocks to Compustat firms, not others.
- Tabluate diversification factors $std(\log Y)/std(\mathrm{d} \log A)$ and $std(\log Y)/std(\mathrm{d} \log \mu)$.

	Benchmark	Competitive	Cobb-Douglas	Passive
Firm Productivity Shocks (GP)	0.0491	0.0376	0.0396	0.0396
Firm Markup Shocks (GP)	0.0296	0.0000	0.0077	0.0000
Industry Productivity Shocks (GP)	0.3162	0.3118	0.3259	0.3259
Industry Markup Shocks (GP)	0.0084	0.0000	0.0391	0.0000

Macro Impact of Micro Shocks



- Output elasticity productivity and markup shocks relative to size.
- For firm shocks and for sectoral shocks.
- Distortions matter!

Extensions (see paper)

- Endogenous markups/wedges.
- Elastic Factors.
- Fixed costs and entry.
- Nonlinearities.

General Non-parametric Result

General Parametric Result

Applications

- Growth Accounting
- Quantitative Model

Extensions (see paper)

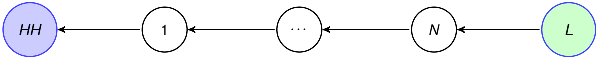
Conclusion

Conclusion

- Reduced-form aggregation theorem for economies with frictions.
- Structural aggregation theorems.
- Wide range of applications in different contexts.
- Work in progress: structural models of frictions (IO, financing constraints, search and matching, nominal rigidities, etc.), fixed costs, entry and exit, dynamics, non-homotheticities, endogenous innovation, other models of network formation, etc.
- Part of a broader research agenda.

Ex. Cost-Based vs. Revenue-Based Domar Weights

- Example of multiple marginalization taken from Baqaee (2016):

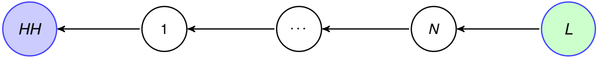


- Cost-based vs. revenue-based Domar weights:

$$b'\tilde{\Psi} = \tilde{\lambda}_k = 1 \quad \text{and} \quad b'\Psi = \lambda_k = \prod_{i=1}^{k-1} \mu_i^{-1} < 1.$$

Ex. Back to Simple Vertical Economy

- Example of multiple marginalization taken from Baqaee (2016):

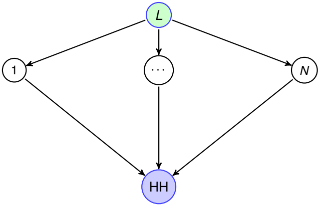


- Change in technology, no change in allocative efficiency:

$$\frac{\mathrm{d}\log Y}{\mathrm{d}\log A_k} = \tilde{\lambda}_k = 1 > \lambda_k = \prod_{i=1}^{k-1} \mu_i^{-1}.$$

- In accounting sense, Hulten's theorem fails.
- In economic sense, Hulten's theorem survives!

Ex. Back to Simple Horizontal Economy



- Shares and factor shares:

$$\tilde{\lambda}_k = \lambda_k, \quad \tilde{\Lambda}_L = 1 > \Lambda_L = \sum_j \lambda_j \mu_j^{-1}.$$

- Change in technology and change in allocative efficiency:

$$\frac{\mathrm{d}\log Y}{\mathrm{d}\log A_k} = \tilde{\lambda}_k + \frac{\mathrm{d}\, H(\tilde{\Lambda}, \Lambda)}{\mathrm{d}\log A_k} = \lambda_k - \frac{\mathrm{d}\log \Lambda_L}{\mathrm{d}\log A_k}.$$

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