"Micro Data and Macro Technology" by Ezra Oberfield and Devesh Raval

Loukas Karabarbounis

University of Chicago Booth & NBER

Discussion NBER SI, Economic Growth Meeting

Summary of Paper

1. Estimates the elasticity of substitution between capital and labor σ at the plant level using variation in MSA-level wages.

2. Shows how to aggregate across plants to derive the aggregate elasticity σ^{agg} for manufacturing, allowing for reallocation of inputs across plants.

3. Given estimated elasticities below one, it argues against a role of factor prices in explaining the decline in the labor share.

4. The residual (factor-augmenting technical change) accounts for the decline in the labor share by definition.

Summary of Comments

1. I exclusively focus on the estimation of σ and the main take-away that factor prices do not explain the decline of the labor share.

2. Paper is very thorough on other dimensions.
    - Neat mapping of micro-elasticities and heterogeneity into aggregates.
    - Careful treatment of data.
    - Additional countries.
    - Very well written.
    - Lots of extensions and robustness.

Importance of σ

$$Y = \left(\alpha_k \left(A_K K \right)^{\frac{\sigma-1}{\sigma}} + (1-\alpha_k) \left(A_N N \right)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

The elasticity of substitution σ important for:

- evolution of factor shares
- responsiveness of factor demands to policies
- transitional dynamics
- incentives to innovate
- estimates of technology

Estimating Equations (s_L is labor share)

Using the labor first-order condition ($\tilde{W}$ is nominal wage):

$$\log\left(\frac{1}{s_L}\right) = -\sigma\log(1-\alpha_k) + (\sigma-1)\log\left(\frac{\tilde{W}}{P}\right) + (1-\sigma)\log(A_N)$$

Using the capital first-order condition ($\tilde{R}$ is nominal rental rate):

$$\log\left(\frac{1}{1-s_L}\right) = -\sigma\log(\alpha_k) + (\sigma-1)\log\left(\frac{\tilde{R}}{P}\right) + (1-\sigma)\log(A_K)$$

Combining both first-order conditions (W and R are real):

$$\log\left(\frac{1-s_L}{s_L}\right) = -\sigma\log\left(\frac{1-\alpha_k}{\alpha_k}\right) + (\sigma-1)\log\left(\frac{W}{R}\right) + (1-\sigma)\log\left(\frac{A_N}{A_K}\right)$$

Which Should We Use?

- Using both FOCs has the advantage that estimates are robust to common distortions (e.g. markups). However, data requirements are higher as we need quality data on both W and R.
- Whenever we use wages (labor FOC or both FOC), we have to worry about the covariation of W with A_N or A_N/A_K.
- Whenever we use rental rates (capital FOC or both FOC), we have to worry about the covariation of R with A_K or A_K/A_N.
- Impossibility theorem says we can't estimate simultaneously σ and A_N or A_K unless we make assumptions. Theory can help make progress.
- Paper uses both FOCs, but omits R into the constant. So, we have to worry about covariance of W both with A_N/A_K and with R.
- Bartik (1991) instrument for MSA W is not convincing because initial industrial composition may be endogenous e.g. to persistent A_N.

Sources of Variation

1. Variation over aggregate time series (estimation in levels/differences):
   - Antras (2004)
2. Variation across plants/firms at a point of time (estimation in levels):
   - Oberfield and Raval (2014)
3. Variation across countries/industries in trends (need to Δ the equations):
   - Karabarbounis and Neiman (2014)

Which Should We Use?

- Generally, time series methods have been the most popular because of data availability on labor shares and capital/labor.

- A problem with time series methods is that short-run fluctuations in the user costs of labor and capital may be difficult to properly measure.

- Cross sectional (i.e. more long-run) estimates are less likely to suffer from this problem. For example, using long-term trends has the advantage that estimates are robust to short-run frictions embedded in R (adjustment costs, credit premia).

- Estimates in levels may suffer from an omitted variable bias as the adoption of different technologies (α_k) may be correlated with wages and rental rates.

- Using differences over time controls for such fixed effects.

Evidence from KLEMS

- EU KLEMS 2008 and 2009 releases, covering $t = 1970, ..., 2007$.
- $i = 1, ..., I$ countries and $j = 1, ..., J$ industries. Require at least 15 years of data.
- Two measures of labor share: unadjusted (U) and adjusted for proprietor's income and taxes on production (A).
- Two measures of nominal wages $\tilde{W}_{ijt}$: compensation per hour (H) and compensation per employee (E).
- Approximate nominal rental rate by $\tilde{R}_{ijt} = \Xi_{ijt}\left(1/\beta - 1 + \delta_{ijt}\right)$, where Ξ_{ijt} is the nominal price of investment and δ_{ijt} is the depreciation rate (calculated from the capital input accounts).
- Deflate wages and rental rates by price of output P_{ijt} at the industry-country level.

Estimates of σ from KLEMS: Levels (i, j, and t FE)

Samples			N FOC		K FOC		Both, omit R		Both, omit W	
s_L	W	J	$\hat{\sigma}$	SE	$\hat{\sigma}$	SE	$\hat{\sigma}$	SE	$\hat{\sigma}$	SE
U	H	10	0.77	0.02	1.19	0.02	0.56	0.04	1.50	0.05
A	H	10	0.82	0.03	1.25	0.04	0.41	0.05	1.45	0.06
U	E	10	0.83	0.02	1.19	0.02	0.68	0.03	1.50	0.05
A	E	10	0.86	0.02	1.25	0.04	0.44	0.05	1.45	0.06
U	H	23	0.87	0.01	1.11	0.02	0.69	0.02	1.27	0.03
A	H	23	0.89	0.01	1.12	0.02	0.60	0.03	1.22	0.04
U	E	23	0.89	0.01	1.11	0.02	0.74	0.02	1.27	0.03
A	E	23	0.90	0.01	1.12	0.02	0.60	0.03	1.22	0.04

Estimates of σ from KLEMS: Trends (i and j FE)

Samples			N FOC		K FOC		Both, omit R		Both, omit W	
s_L	W	J	$\hat{\sigma}$	SE	$\hat{\sigma}$	SE	$\hat{\sigma}$	SE	$\hat{\sigma}$	SE
U	H	10	0.74	0.10	1.30	0.07	0.47	0.14	1.62	0.16
A	H	10	0.74	0.10	1.36	0.16	0.29	0.18	1.64	0.22
U	E	10	0.74	0.10	1.30	0.07	0.48	0.14	1.62	0.16
A	E	10	0.74	0.10	1.36	0.16	0.33	0.18	1.64	0.22
U	H	23	0.86	0.05	1.21	0.06	0.61	0.09	1.39	0.11
A	H	23	0.84	0.06	1.30	0.11	0.48	0.12	1.45	0.14
U	E	23	0.87	0.05	1.21	0.06	0.63	0.09	1.39	0.11
A	E	23	0.85	0.05	1.30	0.11	0.51	0.13	1.45	0.14

Using Wages: Bias from A_N/A_K and R

True model:

$$\log\left(\frac{1-s_L}{s_L}\right) = \kappa + (\sigma - 1)\log W + (1-\sigma)\log(A_N/A_K) + (1-\sigma)\log R + u$$

Estimating equation:

$$\log\left(\frac{1-s_L}{s_L}\right) = \kappa + (\sigma - 1)\log W + \nu \Longrightarrow \hat{\sigma}$$

Estimated coefficient:

$$\hat{\sigma} = \sigma + (1-\sigma)\left(\underbrace{\frac{\text{Cov}(\log(A_N/A_K), \log W)}{\text{Var}(\log W)}}_{\epsilon(A_N/A_K, W)} + \underbrace{\frac{\text{Cov}(\log R, \log W)}{\text{Var}(\log W)}}_{\epsilon(R, W)}\right)$$

Using Rental Rates: Bias from A_K/A_N and W

True model:

$$\log\left(\frac{1-s_L}{s_L}\right) = \kappa + (1-\sigma)\log R + (\sigma-1)\log(A_K/A_N) + (\sigma-1)\log W + u$$

Estimating equation:

$$\log\left(\frac{1-s_L}{s_L}\right) = \kappa + (1-\sigma)\log R + \nu \implies \hat{\sigma}$$

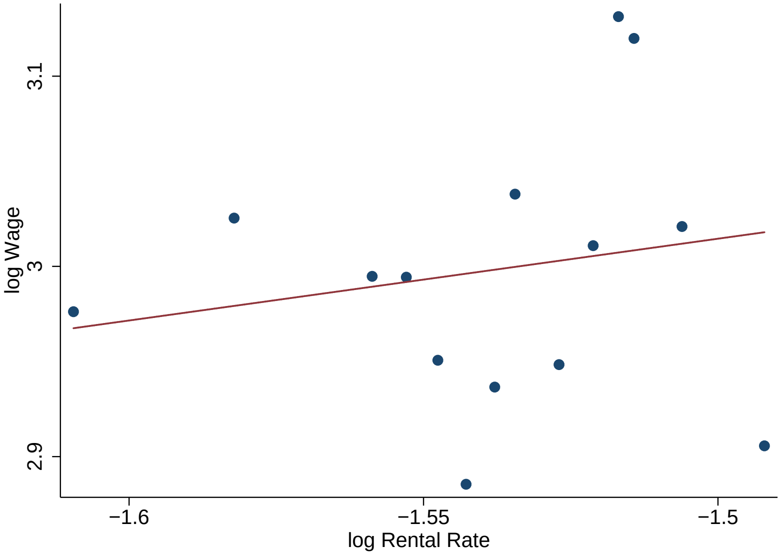
Estimated coefficient:

$$\hat{\sigma} = \sigma + (1-\sigma)\left(\underbrace{\frac{\text{Cov}(\log(A_K/A_N), \log R)}{\text{Var}(\log R)}}_{\epsilon(A_K/A_N, R)} + \underbrace{\frac{\text{Cov}(\log W, \log R)}{\text{Var}(\log R)}}_{\epsilon(W, R)}\right)$$

Covariance of Rental Rates with Wages from KLEMS

Samples			**Levels** (i, j, and t FE)				**Trends** (i and j FE)			
s_L	W	J	$\epsilon(R,W)$	SE	$\epsilon(W,R)$	SE	$\epsilon(R,W)$	SE	$\epsilon(W,R)$	SE
U	H	10	0.52	0.01	0.77	0.02	0.62	0.09	0.76	0.11
A	H	10	0.54	0.02	0.74	0.02	0.63	0.08	0.83	0.11
U	E	10	0.45	0.01	0.76	0.02	0.62	0.08	0.77	0.12
A	E	10	0.48	0.02	0.71	0.02	0.62	0.07	0.83	0.12
U	H	23	0.48	0.01	0.77	0.01	0.63	0.05	0.84	0.06
A	H	23	0.50	0.01	0.75	0.01	0.63	0.05	0.88	0.06
U	E	23	0.46	0.01	0.77	0.01	0.65	0.05	0.85	0.07
A	E	23	0.48	0.01	0.74	0.01	0.65	0.05	0.88	0.06

MSA/State Level ($R = 0.2/(1-\tau^c)$, τ^c from Owen Zidar)



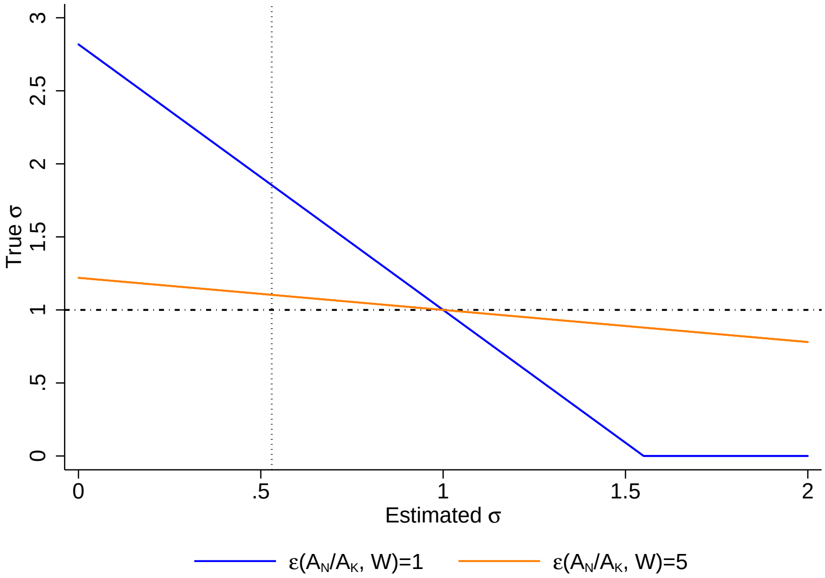
Variation Across BGPs: $\epsilon\,(A_N/A_K, W)$ and $\epsilon\,(A_K/A_N, R)$

$$W = (1-\alpha_k)A_N y^{\frac{1}{\sigma}} \qquad \text{and} \qquad R = \alpha_k A_K^{\frac{\sigma-1}{\sigma}} \left[\frac{y}{k}(k)\right]^{\frac{1}{\sigma}}$$

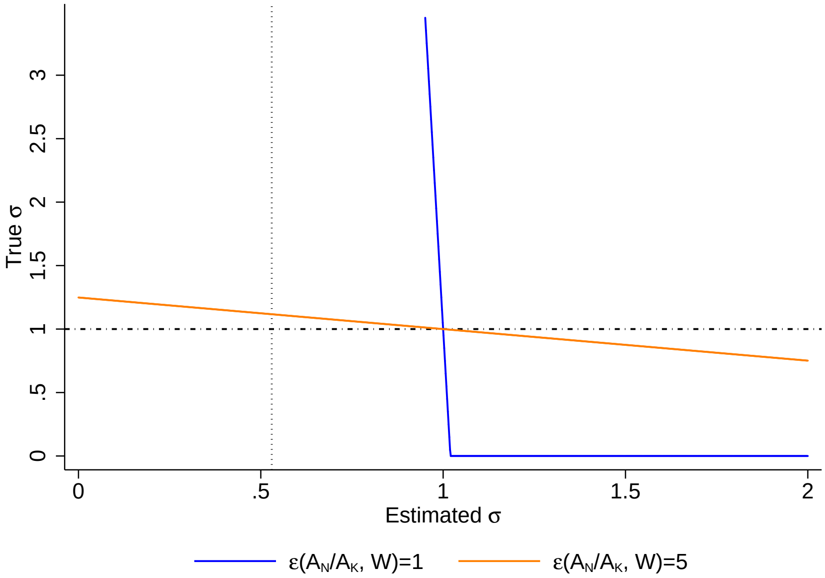
- Steady-State Growth Theorem imposes strong restrictions on these covariances ($A_K = 1$).
- Results partly depend whether supply of K is inelastic (e.g. Solow) or elastic (e.g. Ramsey model with R pinned down by supply).

Model	**Differences in** A_N	$\epsilon\,(A_N/A_K, W)$	$\epsilon\,(A_K/A_N, R)$
Solow	Levels	1	0
Ramsey	Levels	1	0
Solow	Growth	> 1	< 0
Ramsey	Growth	1	0

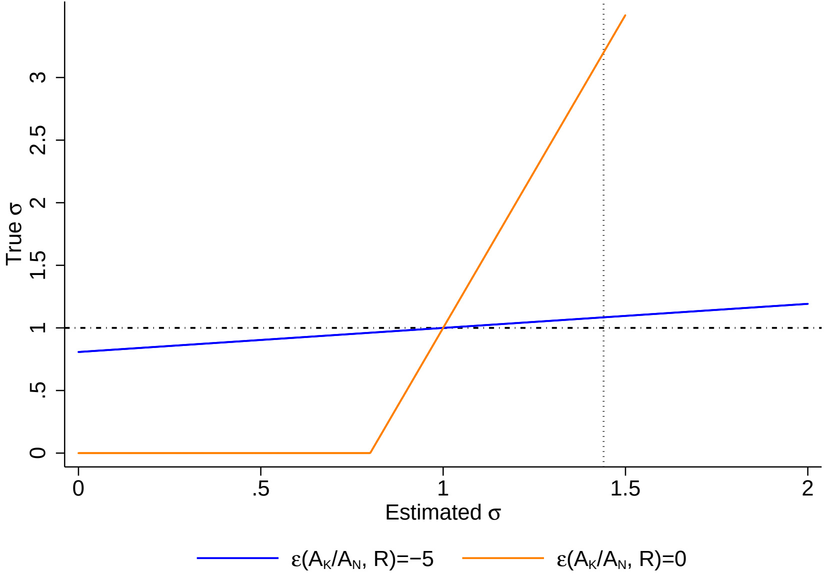
Using Wages (when $\epsilon(R, W) = 0.55$)



Using Wages (when $\epsilon(R, W) = 0.02$)



Using Rental Rates (when $\epsilon(W, R) = 0.80$)



Example: Solow Model with CES

$$A_{Kt} = 1, A_{Nt} = (1+g)A_{Nt-1}, K_{t+1} = (1-\delta)K_t + sY_t$$

Table: Estimates of Elasticity Across MSAs (Different BGPs)

	$(\Delta g = 0.2\%, \Delta s = 0.00)$		$(\Delta g = 0.2\%, \Delta s = -0.10)$	
True σ	0.50	1.50	0.50	1.50
N **FOC**	1.00	1.00	2.10	0.83
K **FOC**	0.50	1.50	0.50	1.50
Both, omit R	1.02	0.99	4.41	0.51
Both, omit W	0.36	1.81	0.26	1.76
Both	1.02	0.99	0.06	-0.38

Directed Technical Change (Acemoglu, 2002 and 2003)

- Steady states:

  1. When $\sigma < 1$, there exists BGP with constant $g_C = g_K$ in which all technology is A_N.
  2. When $\sigma > 1$, there exists equilibrium with constant $g_C > g_K$ in which technology can be A_K.

- What about off steady states? The following two equations always hold if both technologies are used:

$$\frac{A_K}{A_N} = \kappa \left(\frac{K}{N} \right)^{\sigma - 1}$$

$$\frac{R}{W} = \kappa \left(\frac{K}{N} \right)^{\sigma - 2}$$

Accounting for Endogenous Technical Change

- Models with either exogenous or endogenous technical change imply:

$$\frac{W/A_N}{R/A_K} \propto \left(\frac{A_N}{A_K}\right)^{-\frac{1}{\sigma}} \left(\frac{K}{N}\right)^{\frac{1}{\sigma}}$$

- Additionally, the model with endogenous technical change implies:

$$\frac{W/A_N}{R/A_K} = \frac{K}{N}$$

- Incorporate endogenous technical change into estimating equation:

$$\log\left(\frac{1-s_L}{s_L}\right) = \kappa + (\sigma - 1)\log\left(\frac{W}{R}\right) + (1-\sigma)\log\left(\frac{A_N}{A_K}\right) \Longrightarrow$$

$$\boxed{\log\left(\frac{1-s_L}{s_L}\right) = \kappa + (\sigma - 1)\log\left(\frac{K}{N}\right)}$$

Endogenous Technical Change: KLEMS

Samples			**Levels** (i, j, and t FE)		**Trends** (i and j FE)	
s_L	W	J	Estimated σ	SE	Estimated σ	SE
U	H	10	1.66	0.02	1.48	0.17
A	H	10	1.62	0.03	1.56	0.27
U	E	10	1.63	0.02	1.48	0.16
A	E	10	1.57	0.03	1.58	0.25
U	H	23	1.53	0.02	1.43	0.11
A	H	23	1.46	0.02	1.45	0.17
U	E	23	1.53	0.02	1.46	0.11
A	E	23	1.45	0.02	1.50	0.17

Conclusion

- Hugely important topic.
- Neat aggregation from micro-level estimates.
- Surprising small heterogeneity in capital shares within industries in US. Larger in developing economies.
- Given small heterogeneity in the US, the micro-level elasticity drives the claim that the decline of the labor share cannot be explained by the decline in the relative price of capital.
- Estimates of σ sensitive to first-order condition used, covariations of rental rates with wages, and labor-augmenting technological progress.