How Has Recent Technology Changed the Labor Market? A Quantitative Macroeconomic Perspective

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November 30, 2018
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  - Highlight findings using neoclassical theory for polarization and labor share
  - Discuss recent and ongoing work to further address channels through which technology impacts polarization and the labor share
Machines are Getting Cheaper

Benchmark way to think of technological change is that innovation makes machines cheaper and cheaper over time.

Figure VII
Declining Global Price of Investment Goods

Source: Karabarbounis and Neiman (2013)

Reduction in price of machines impacts labor demand – firms to substitute from certain workers to machines, reducing labor income and changing job composition.
Neoclassical Production Framework

Aggregate production function (in spirit of Autor and Dorn (2013)):

\[ Y = K^{1-\alpha} \left[ \left( \mu_{nr} \frac{L_{nr}^{\gamma_{nr}-1}}{\gamma_{nr}} + (1-\mu_{nr}) \left\{ \mu_{r} \frac{L_{r}^{\gamma_{r}-1}}{\gamma_{r}} + (1-\mu_{r}) M^{\gamma_{r}-1} \frac{1}{\gamma_{r}} \right\} \right)^{\gamma_{nr}-1} \gamma_{nr} \right]^{(1-\alpha) \frac{\gamma_{nr}}{\gamma_{nr}-1}} \]

- \( L_{nr} \): Non-routine workers
- \( L_{r} \): Routine workers
- \( M \): Machines
- \( K \): Other capital

Key parameters: elasticities of substitution (\( \gamma_{nr}, \gamma_{r} \)), production weights (\( \mu_{nr}, \mu_{r} \))
Implications for Polarization and Labor Share

How will declining price of machines ($P_M$) impact share of employment in routine jobs ($s_r$) and labor share of income ($Lsh$)?

Assuming profit maximization and competitive markets, comparative statics imply:

\[
\frac{\partial s_r}{\partial P_M} = s_r \xi_M (1 - s_r) (\gamma_r - \gamma_{nr})
\]

\[
\frac{\partial Lsh}{\partial P_M} = Lsh (1 - Lsh) \left[ (1 - \xi_M s_{nr}^{inc}) \gamma_r + \xi_M s_{nr}^{inc} \gamma_{nr} - 1 \right]
\]

Three critical quantitative objects:

- $\gamma_r, \gamma_{nr}$: elasticities of substitution
- $\xi_M = \frac{P_M M}{P_M M + w_r L_r}$: share of income machines receive relative to routine workers (function of prices and parameters)
- $\frac{\partial P_m}{P_m}$: amount of change in price of machines
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Findings: Eden and Gaggl (2018b, RED)

- Eden and Gaggl (2018) – use version of this framework to show technological change can account for 50% of labor share decline

- Caveat: requires a re-nesting of routine and non-routine labor – capital-skill complementarity (Krusell et al. (2000)); model can’t fit the data with Autor and Dorn (2013) nesting.
Findings: Cortes, Jaimovich and Siu (2017, JME)

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- Contrast: use movements in quantities of machines ($\frac{\Delta M}{M}$) instead of prices ($\frac{\Delta P_M}{P_M}$)
- Quantitative exercises: estimate $\Delta M \approx 1$ and $\gamma r = 1 \Rightarrow$ account for roughly 10% of observed changes in employment between routine and non-routine jobs.
- To exactly match observed polarization, need $\Delta M > 20,000\%$ of observed change.
- Results may be sensitive to using prices vs. quantities and capital aggregation (see Eden and Gaggl (2018a, WP))
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Findings: vom Lehn (2018a, WP)

vom Lehn (2018a) extends production to treat high-skill (abstract) and low-skill (manual) non-routine occupations separately:

\[
Y = \left[ \mu_m L_m \frac{\gamma_m - 1}{\gamma_m} + (1 - \mu_m) \left( \mu_a L_a \frac{\gamma_a - 1}{\gamma_a} + (1 - \mu_a) \left( (1 - \mu_r) M_t \frac{\gamma_r - 1}{\gamma_r} + \mu_r L_r \frac{\gamma_r - 1}{\gamma_r} \right) \right) \right] \frac{\gamma_m}{\gamma_m - 1}
\]

Measure $\xi_M$ using all equipment capital instead of just ICT; use investment price data to generate price of machines.

To maximize fit of technology hypothesis, calibrate model to match polarization over subsample of the data (1980s).

General Equilibrium – consider both representative household and heterogeneous workers.
Findings: vom Lehn (2018a, WP)

- Even with favorable calibration, can’t match observed polarization and labor share behavior post-2000

- Robust to labor supply, endogenous occupational and educational choices, calibration window, nesting structures, ICT instead of all equipment

- Can fit data if fall in price of machines counterfactually actually ends in 2000

- Key point: single set of elasticities of substitution can’t reconcile changing dynamics of polarization over time
Possible Resolutions

▶ Other shocks (e.g. trade)

▶ Changing relationship between technology and high-skill labor
  ▶ due to role of skills in technology production/adoption
  ▶ due to evolution of technological capabilities

Hypothesize: Slowing investment post-2000 (due to slowing fall in price of machines) means fewer high skill workers are needed to produce/install/adopt new technology.
Extending neoclassical framework to have high skill workers produce investment improves fit of technology hypothesis

Caveat: strong assumption about all investment produced by high skill workers
vom Lehn (2018b) studies cross-industry relationship between worker tasks and labor share declines.

Construct measure of high-skill occupations most susceptible to automation – “abstract replaceable”

OLS and IV evidence finds that industries with large fraction of abstract replaceable jobs in 2004 saw accelerated labor share declines post-2004.

Suggestive evidence that technology may be evolving to replace some high-skill occupations.
Conclusion

- Both anecdotal and empirical evidence suggest that technology has substantially impacted labor markets.
- Understanding quantitative mechanisms for how technology impacts labor markets still a work in progress.
- Key aspect of future research is understanding the exact interaction of technology with higher skilled workers.
References


