# Research Presentation

## Using Beamer

Alejandro Gonzalez and Shoaib Laghari

University of Washington and Washington University

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# Agenda

1. Learning by doing
   - Previous literature
   - Limitations
2. Issues to consider
   - Organizational forgetting
   - Learning spillovers
3. Extending FFV CJE

# Learning by doing: Overview

Task: find estimates of $\eta$ in Alejandro's simplified model

$$Y_t = A_t(1 - u_t) \tag{1}$$

$$A_t = exp(\phi)A_{t-1}(1 - u_{t-1})^{\eta} \tag{2}$$

$\eta$: measure of the impact that previous GDP/employment (in time t-1) has on current technology (time t)

# Learning by doing: Previous literature

- Journals
  - Econometrica
  - American Economic Review
  - Journal of Political Economy
  - Journal of Monetary Economics
- Timeline of LDB Literature
  - 30s-40s: Wright and Middleton, aircraft industry; Searle, shipbuilding
  - 50s: Development of Wright's model
  - 60s-80s: Empirical Studies of LBD in various industries
  - 90s: Spillover effects
  - 2000s-2010s: Organizational forgetting

# Learning by doing: Previous literature

- Where's the data being collected?
  - Shipyards
  - Assembly plants (automobiles, semic-conductors)
  - Aircraft production facilities
  - Energy technology
- Sample Specifications
  - Production functions and progress ratios

T.P. Wright (JAS, 1936)

$$Y = aX^b \qquad (3)$$

$$p = 1 - 2^{-\beta} \qquad (4)$$

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Rapping (AER, 1965)

$$lnX_{it} = lnA + \lambda t_1 lne + \beta_1 lnM_{it}(5) + \beta_2 lnK_{it} + \beta_3 \sum_{t=0}^{T-1} X_t + lnV_{it} \qquad (5)$$

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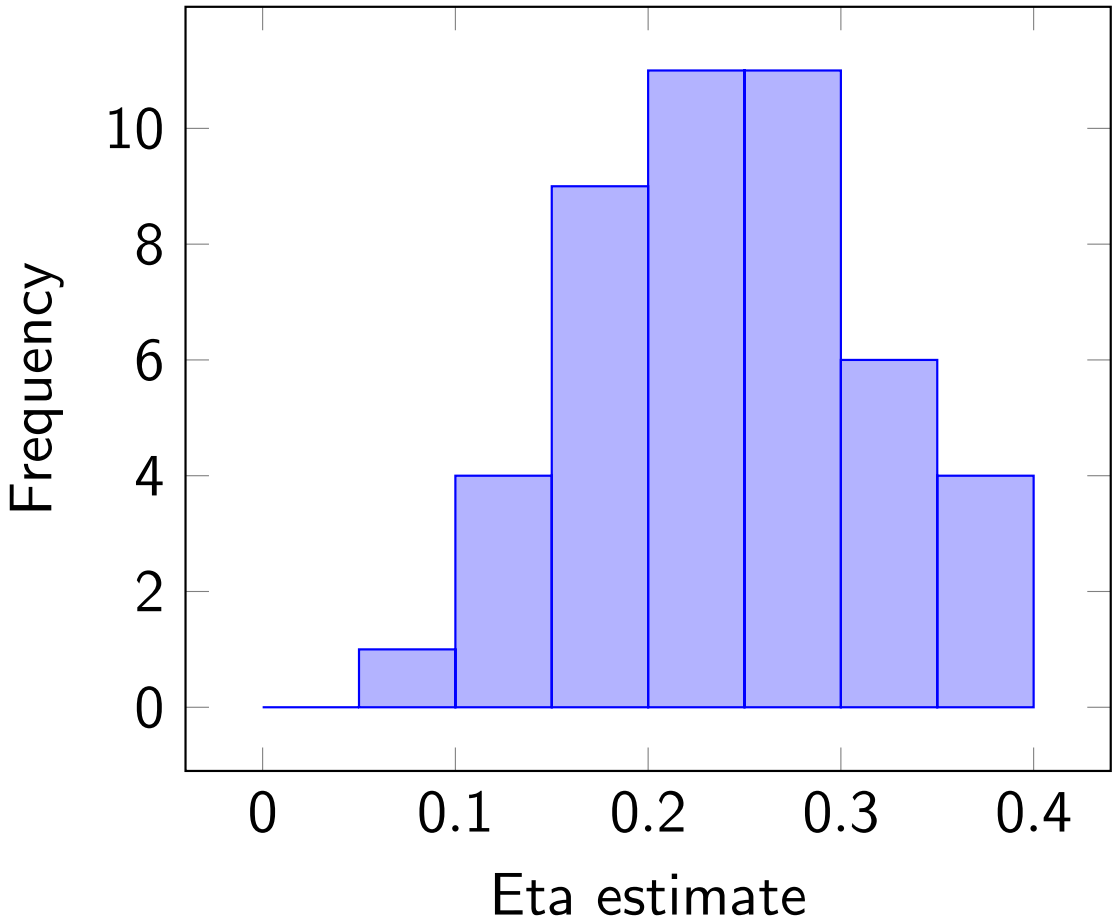
Cooper and Johri (JME, 2002)

$$\Delta TFP_{it} = \gamma \Delta TFP_{it-1} + \varepsilon\eta \Delta y_{it-1} + \Delta a_{it} \qquad (6)$$

# Learning by doing: Estimates




- Mean: .235
- Median: .233
- Older data

# Learning by doing: Limitations

A limitation of the estimates collected is that they rely on manufacturing data, which is only 1/3 of US production.

Could be okay, though, because Kaldor (1978) also relies on manufacturing sector to explain productivity growth.

Is translating estimates from previous literature into the aggregate economy reasonable?

# Issues to consider: Forgetting and Spillovers

C.L. Benkard (AER, 2000) - Learning and Forgetting: The Dynamics of Aircraft Production

$$lnL_i = lnA(\overline{K}) + \theta lnE_i + \gamma_0 lnS_i + \varepsilon_i \qquad (7)$$

, and

$$E_i = \left\{ \begin{array}{r} E_{1,t} : \text{if i is type } -1, -100, -200 \\ E_{500,t} : \text{if i is type } -500 \end{array} \right\}$$

, where

$$E_{1,t} = \delta E_{1,t-1} + q_{1,t-1} + \lambda q_{500,t-1} \qquad (8)$$

$$E_{500,t} = \delta E_{500,t-1} + q_{500,t-1} + \lambda q_{1,t-1} \qquad (9)$$

$\delta = 1.0$ and $\lambda = 1.0$ correspond to no organizational forgetting and complete spillovers, respectively.

# Issues to consider: Organizational Forgetting

Eta here is a combination of multiple coefficients (their learning, forgetting, AND spillovers).

Estimated learning coefficient (0.36) is misleading because our definition assumes no forgetting/spillovers.

Other specifications: Cooper and Johri (2002), Levitt (2013), Irwin and Klenow (1994), Thornton and Thompson (2001)

# Issues to consider: Coefficient Estimates

| **Author (year)** | **Forgetting** | **Spillovers** |
|---|---|---|
| Cooper (2002) | 0.985 | 0.562 |
| Levitt (2013) | 0.965 | 0.41 |
| Irwin (1994) | 0.98 | 0.29 |
| Benkard (1994) | 0.92 | 0.32 |

Table: Estimates of forgetting and spillovers

# Extending FFV CJE

Key items:

How to extend Steve's model to account for spillovers and forgetting

Adjusting our learning estimate (.25) to account for forgetting