AI, Tech & the Future of Productivity

Laura Veldkamp
Columbia University

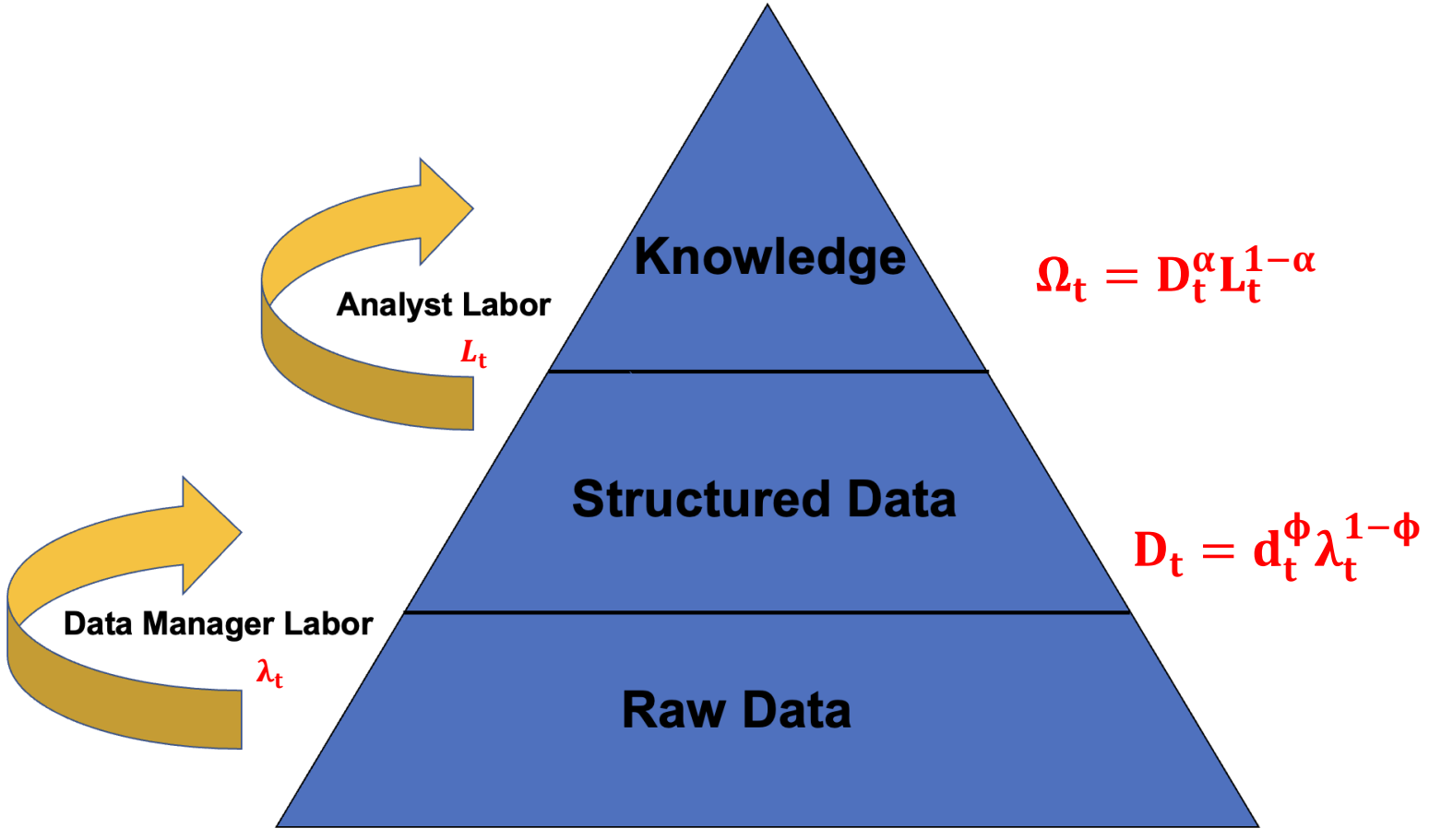
NY Fed Symposium on Productivity Growth

AI IS THE INDUSTRIALIZATION OF KNOWLEDGE PRODUCTION

- Key feature of industrialization:
  It changed the relative intensity of labor and capital (data).
  - Is AI doing the same?
  - How much is AI changing the labor intensity of knowledge production?
  - This matters for employment / labor income share / firm size and competition...
- Challenge:
  We are in the early stages of adoption.
- Abis-Veldkamp (2023) quantify the impact of AI on an early adopting industry, investment management.
- The downside: AI and market power.

Accumulating Data: Raw Data, Structured Data and Knowledge

Maybe labor is an input into useable data?



A Model for Measurement

- Knowledge is produced using either the old technology or big data tech (AI). Same data can be used for both. Technologies have different rates of diminishing returns and use differently-skilled labor:

$$K_{it}^{AI} = A_t^{AI} a_i^{AI} D_{it}^{\alpha} (L_{it}^{AI})^{1-\alpha}, \tag{1}$$

$$K_{it}^{OT} = A_t^{OT} a_i^{OT} D_{it}^{\gamma} (L_{it}^{OT})^{1-\gamma}. \tag{2}$$

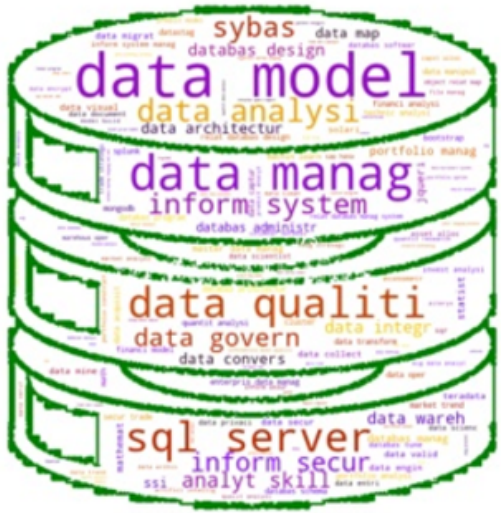
  A large $(\alpha - \gamma)$ = big revolution

- Data inputs are not raw data. They need to be structured, cleaned and machine-readable. This requires labor (L^{DM}) with diminishing marginal returns.
- New structured data is added to the existing stock of structured data. But data also depreciates at rate δ:

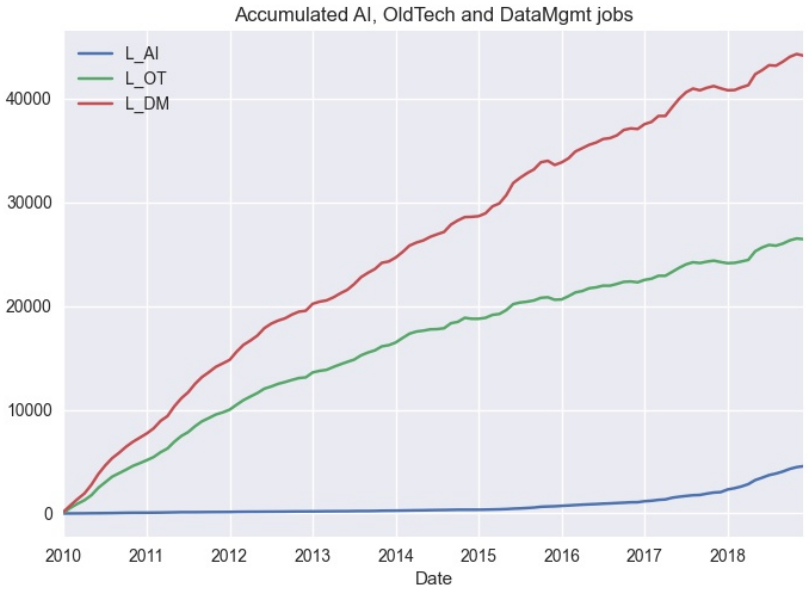
$$D_{i(t+1)} = (1-\delta) D_{it} + (L_{it}^{DM})^{1-\phi} \tag{3}$$

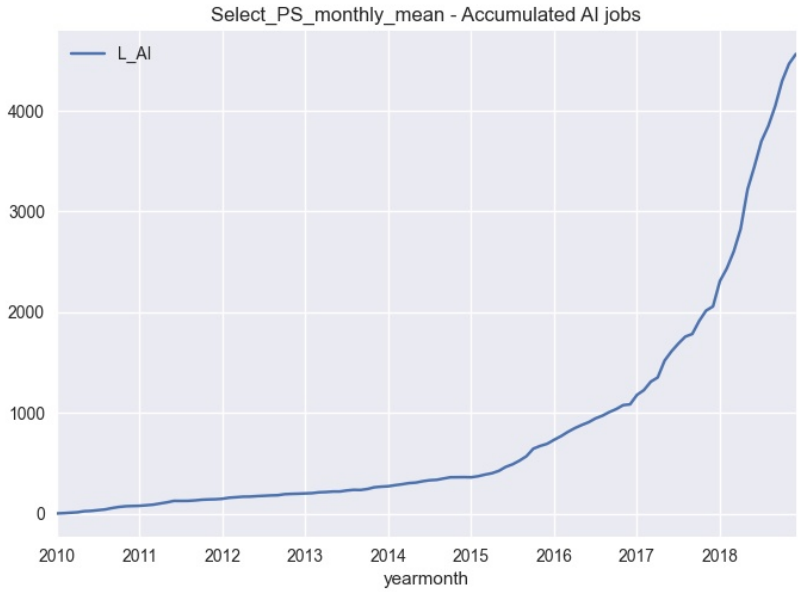
Labor Demand: Job Postings Categorization

- Job postings sample:
  - Burning Glass Technologies (BGT), 2010 – 2018.
  - Filtered to jobs of predominantly investment management firms.
- Identify Data Management, AI or OldTech jobs:
  - Develop dictionaries of words and short phrases indicating data management or analysis (AI or OldTech) skills.
  - Identify jobs beloging to the three categories based on the relative frequency of skills in the full job text.



Labor Stocks: Growth in AI employment





- AI employment has been growing at a faster rate since 2015. We use 2015-2018 as our estimation period.
- Between 2015 and 2018 AI employment rose 13 times (from 350 to 4,537 jobs).

Wages: PayScale

- Crowd-sourced salary data from PayScale salary surveys.
  - Detailed salary information at the industry, job title and skills-mix level.
  - 925,480 survey responses in the industries of interest.
  - Subset to match O*NET, job titles and employers in job postings.
  - Final sample: 11,041 surveys categorized as AI (2,585), OldTech (2,817) and DataMgmt (5,639), in 2015-2018.

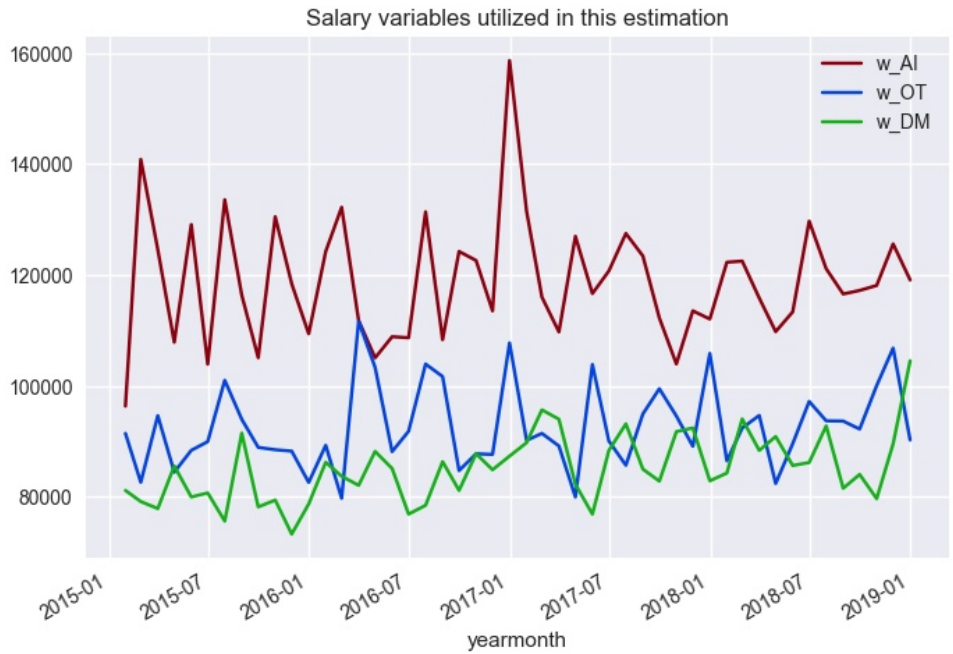


Figure: Average total compensation (salary + bonus + profit share) for AI, OldTech and DataMgmt workers. PayScale, 2015-2018.

Main Results: Greater Productivity of Data

		$\delta = 1\%$	$\delta = 3\%$	$\delta = 10\%$
AI Analysis	α	0.924	0.868	0.694
		(0.0010)	(0.0015)	(0.0018)
Old Technology Analysis	γ	0.751	0.821	0.647
		(0.0029)	(0.0020)	(0.0018)
Data Management	ϕ	0.337	0.443	0.010
		(0.0061)	(0.0058)	(0.0074)
Change in Labor Share	$\gamma - \alpha$	-17.3%	-4.7%	-4.7%

Table: α and γ are the diminishing returns to data in the new and old technologies.

- $\alpha > \gamma$
  - AI has significantly raised the productivity of analyzing larger data sets.
  - Labor share fell from 18% to 13% (for $\delta = 3\%$).
    Same size change for $\delta = 10\%$.
- Technological change is substantial.
  - Industrial revolution: capital exponent estimated to have risen of $0.05 - 0.20$. We estimate an increase of 0.05 in the data exponent.

Results: Not a Labor Replacing Technology

A fall in the labor share could mean fewer workers, or could mean more data. Which was it?

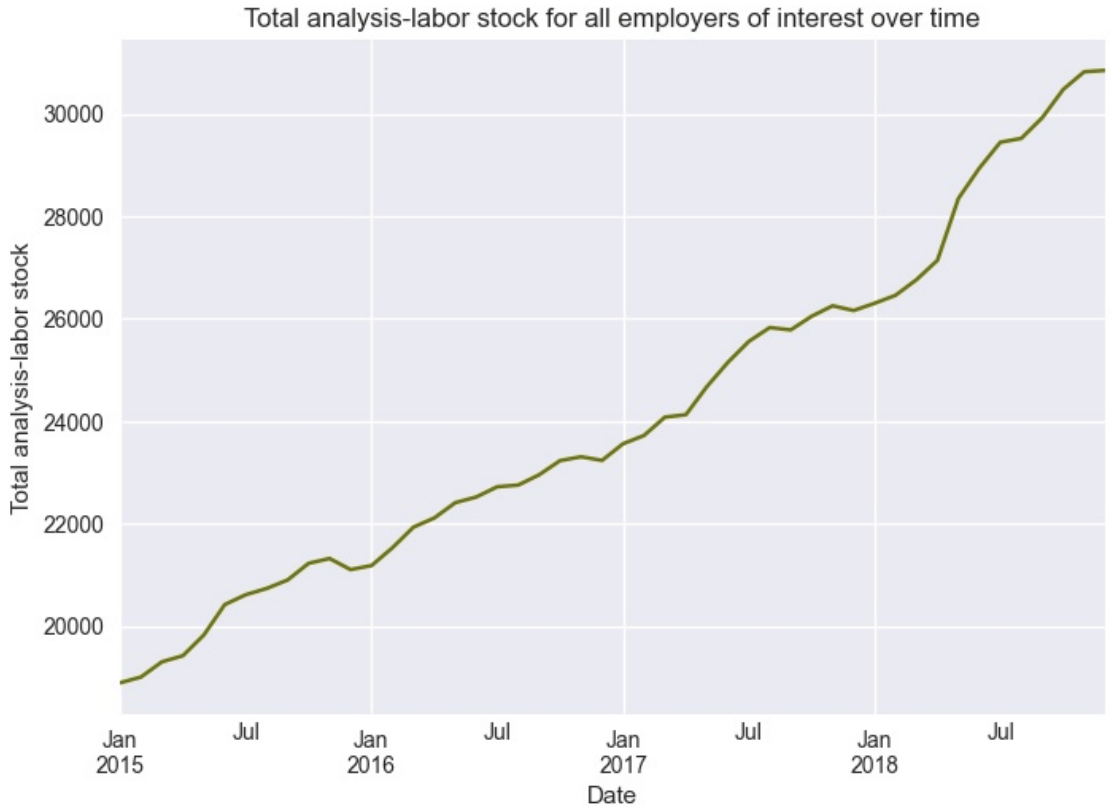


Figure: The aggregate stock of analysis labor (AI and OldTech).

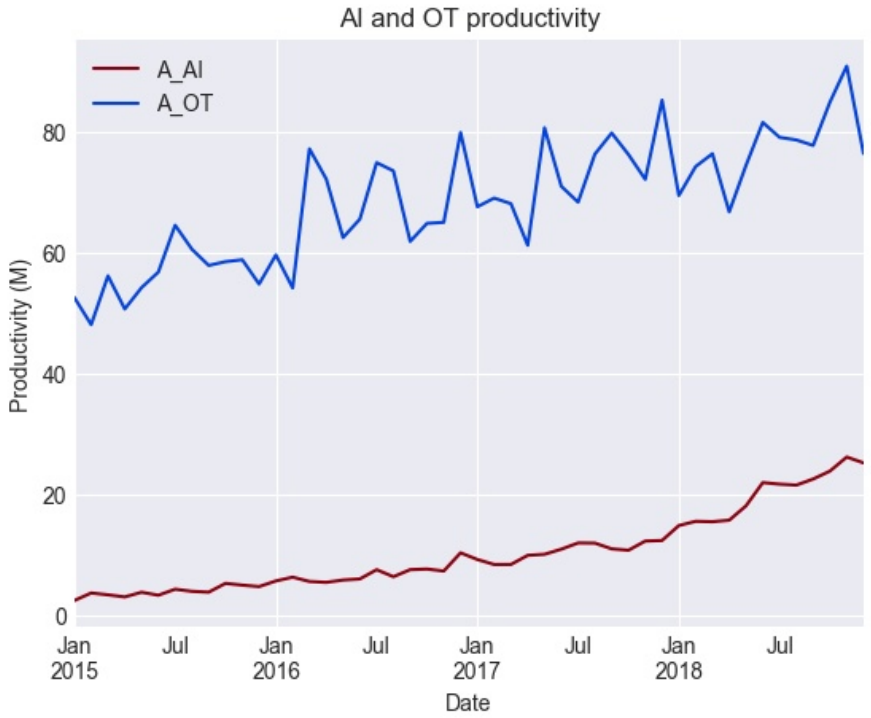
- Labor stock has been increasing steadily, split about evenly between AI and OldTech analysts

AI is Raising the Value of Data: 3 Reasons

1. A larger data stock determines a higher cumulative value of data

2. More analysis workers make each data point more valuable

3. Firms are becoming more productive at using data:



Market Power

1. Less diminishing returns to data means optimal size of a firm's data set is larger.

2. Firms acquire some data by doing transactions. More data from bigger firms.

3. Big firms with great data operate efficiently.
   But market power typically reduces firms' efficiency.

4. Regulation or competition could help. Both are hindered when we can't see the price of data.

Conclusions

- For financial services firms that adopted AI:
  - Labor share fell 5%, but labor & total compensation rose.
  - About $\frac{1}{2}$ magnitude of industrial revolution.
  - Productivity $>$ quadrupled in AI-adopting firms, over 4 years.
    Lots more scope for AI-driven growth.
- Is financial services representative of services? Of the economy as a whole?
- Will market power offset the productivity gains?