Valuing Data as a New Asset Type

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Big Data is Raising Big Questions

The most valuable firms in the world today are valued largely for their data.

Raises a whole agenda of questions, theoretical and empirical, that touch on many aspects of economics:

- Data is a new asset class. How do we price it? (finance)
- How do we measure monopoly power? What are reasonable harms to assess from data malfeasance? (law, IO)
- Is GDP measuring the value of an economy correctly? (macro)
- Does the value of data vary? Is it interest-rate sensitive? (monetary)

Our industrial-era economic tools need updating for the modern data economy.

Outline

This talk: How do we start on this agenda?
It begins with measuring the amount and value of firms' data.

- What do we mean by data?
- Data economy mechanics
  - A by-product of transactions
  - Buying and selling data
  - Depreciating data
- Measuring and valuing data: 6 approaches
- Conclude: Where next?

What do we mean by data?

- Data is digitized information
- Data of interest is big data:
  Often generated by economic activity: search history, traffic patterns, purchases...
- AI / ML are prediction technologies. Data used for prediction.
- Data is distinct from tech, patents, learning-by-doing and algorithms.
  - Ideas/ technologies: procedures or concepts. Data may be an input.
  - Learning by doing: Human capital, owned by workers. Not tradeable.
  - Data is the fuel for algorithms / AI

How data is generated and accumulated?

"It's free, but they sell your information."

Data price is zero. Data value is positive.

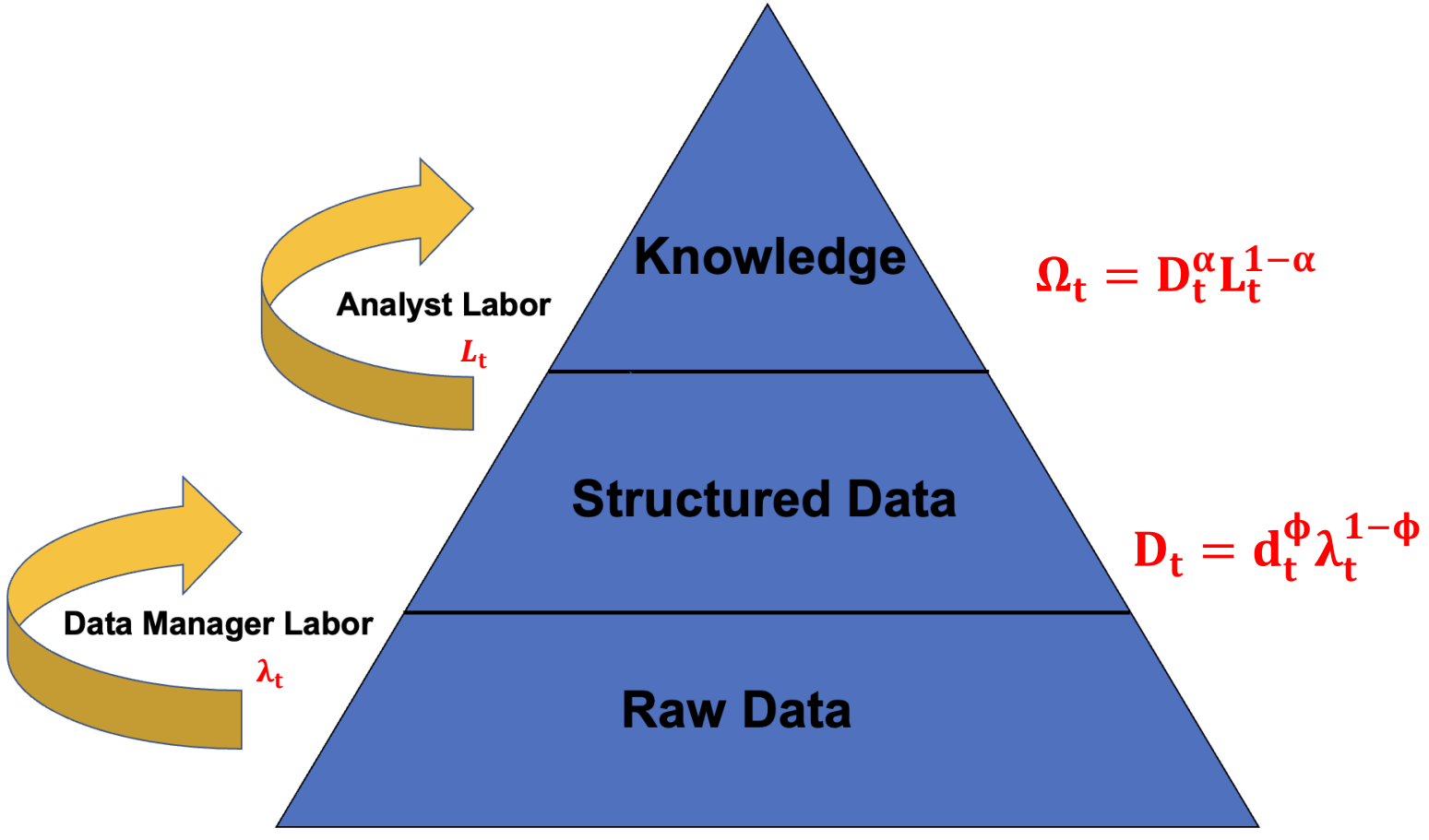
A Data Feedback Loop

What is Higher Quality?
How Does Data Create Value for Firms?

- Raises current profits: Choose better products, inventory, transportation, advertise to better customers. (Tucker '22)
- Creates market power
  - Firms with more data can grow bigger, exert monopoly power.
- Reduces risk
  - Data is information. Information resolves uncertainty (risk).
  - Finance tools here are crucial.
  - This could be big: Risk compensation is 2x expected return.

Accumulating Data: Raw Data, Structured Data and Knowledge

Maybe labor is an input into useable data?



Accumulating Data: Buying/Selling It

- Data is non-rival: You can sell it and keep it.
- Data leaks: through prices, through neighbors' transactions (Acemoglu et al '22)
- Data known by others loses value (strategic substitutability).
- Firms selling data face a commitment problem: (Liu, Ma, Veldkamp '23)
  To extract monopoly rents, sell data to few clients.
  But tomorrow, data seller can sell more copies at a lower price and dilute the value of data.

How does data depreciate?

- A key question for valuation.
- Ex: Data to predict an moving target: $\theta_{t+1} = \rho\theta_t + \epsilon_{t+1}$
- Data about today's state θ_t is less valuable tomorrow because the state θ_{t+1} has changed.
- Similar to capital depreciation: $k_{t+1} = (1-\delta)k_t + i_t$, where $\delta = 1 - (\rho^2 + \sigma_\epsilon^2 \Omega_t)^{-1}$.
- Data depreciates faster when it's abundant Ω_t and the environment has volatile innovations σ_ϵ^2.

Measuring and Valuing Data

Six Approaches to Measuring Data

1. Complementary inputs
2. Value functions
3. Revenue
4. Choice covariance
5. Market prices
6. Cost accounting

Measurement Approach 1: Complementary Inputs

- Knowledge is produced using structured data and "analyst" labor:

$$K_{it} = {D_{it}}^{\alpha} {L_{it}}^{1-\alpha}, \tag{1}$$

- New structured data is added to the existing stock of structured data with "data management" labor. Depreciates at rate δ:

$$D_{i,t+1} = (1-\delta) D_{it} + \lambda_{it}^{1-\phi} \tag{2}$$

- Estimate data stock from hiring and wages of each.
  What amount of data would make employing L_{it}, λ_{it} workers at wages w_{Lt}, $w_{\lambda t}$ optimal? (Abis-Veldkamp '23)

- Another observable complementary input: IT capital
  (Bresnahan, Brynjolfsson '02)

Measurement Approach 2: Value Function Approach

- The same tools macro uses to value capital work for data, with an adjusted law of accumulation.

$$V(\text{data}_t) = max_{K,L} A(\text{data}_t) K_t^{\alpha} L_t^{1-\alpha} - wL_t - rK_t + \beta V(\text{data}_{t+1})$$

- The state law of motion is the depreciation equation:

$$data_{t+1} = \underbrace{(\rho^2 data_t^{-1} + \sigma_\epsilon^2)^{-1}}_{depreciated\ \ data} + \underbrace{n_s \sigma_s^{-2}}_{new\ \ data\ \ inflows}$$

- Pair with theories of data inflows:
  - By-product of transactions
  - Data purchases / sales
  - Using labor to process raw data

VALUE FUNCTION ESTIMATION RESULTS ABIS, VELDKAMP '22

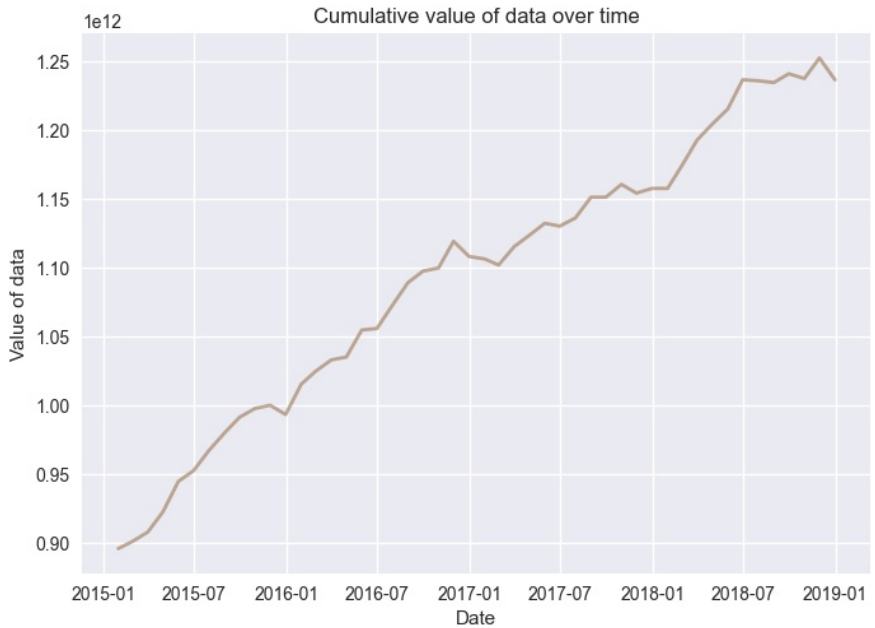


FIGURE: Estimated Value of the Aggregate Stock of Data, used for financial analysis, in hundreds of billions of current U.S. dollars, 2015-2018.

Data value is growing for 3 reasons:

1. Firms manage more data.
2. More analysis workers make each data point more valuable.
3. Firms are becoming more productive at using AI.

Measurement Approach 3: Revenue Approach

- The value of data is the pdv of the revenue it generates
- How to isolate data revenue from other revenue?
- This is doable. But you need a clear idea of how data generates revenue. A model is essential to compute counter-factuals with more/less data.
  (Manela, Kadan '21; Davila, Parlatore '21; Cong, Xie, Zhang '21)
- Problem: Data has different values to different agents (a private value asset)

Next: an example of valuing data as a private value asset, using a revenue approach.

Revenue Valution and Data's Private Value

- Suppose data is used to purchase a portfolio of risky assets.
- Value of data in $\mathcal{I}_{it}$ from an equilibrium with heterogeneous investors, correlated information and learning from noisy prices depends on 3 sufficient statistics:
  Expected return, variance of return and the variance of return, conditional on data.
- One can estimate these moments from return forecasting regressions.
- Finding: The same data is worth $\$10 - \$1.2m$, depending on the investor's wealth, investment style, price impact or trading frequency.
  (Farboodi, Singal, Veldkamp, Venkateswaran, 2022)

Measurement Approach 4: Choice Covariance

- Data allows agents to make better choices or matches.
- Better choices means actions q_t that covary with payoffs r_t.

$$E[q_t r_t] = E[q_t]E[r_t] + cov(q_t, r_t)$$

- Agents cannot achieve high covariance without information.
  They could have good data and no skill at analyzing it. This is a lower bound on data.
- Measure the covariance.
  Ex: Portfolio alpha or a customer click-conversion rate.
  Covariances may show up as aggregation effects: In Eeckhout-Veldkamp ('23): (firm markup - product markup) measures data

Measurement Approach 5: Market Prices

- Market prices for data
  - Data marketplaces: Snowflake, Datarade, etc.
  - This is the intersection of supply and demand.
    Lower bound on buyer firm's private value.
  - The value to a buyer often depends on who else knows the data.
- Market prices for firms
  - Market-to-book values can measure intangibles
    Crouzet-Eberly '20, Peters-Taylor '17
  - Already used for: Branding, patents, organizational capital, ...
    e.g., Belo, Gala, Salomao, Vittorino '21, Eisfeldt-Papanikolaou '13, '14
  - How to tease apart the value of data?
- Presumes that market participants know how to value data.

Measurement Approach 6: Cost Accounting

- A book value approach to valuing assets is to cumulate the sum of costly investments.
  Why not add up data costs?

- Most data is a by-product of some other economic transaction.
  - There was no explicit cost for it.
  - GAAP accounting rules only count data if it was purchased.

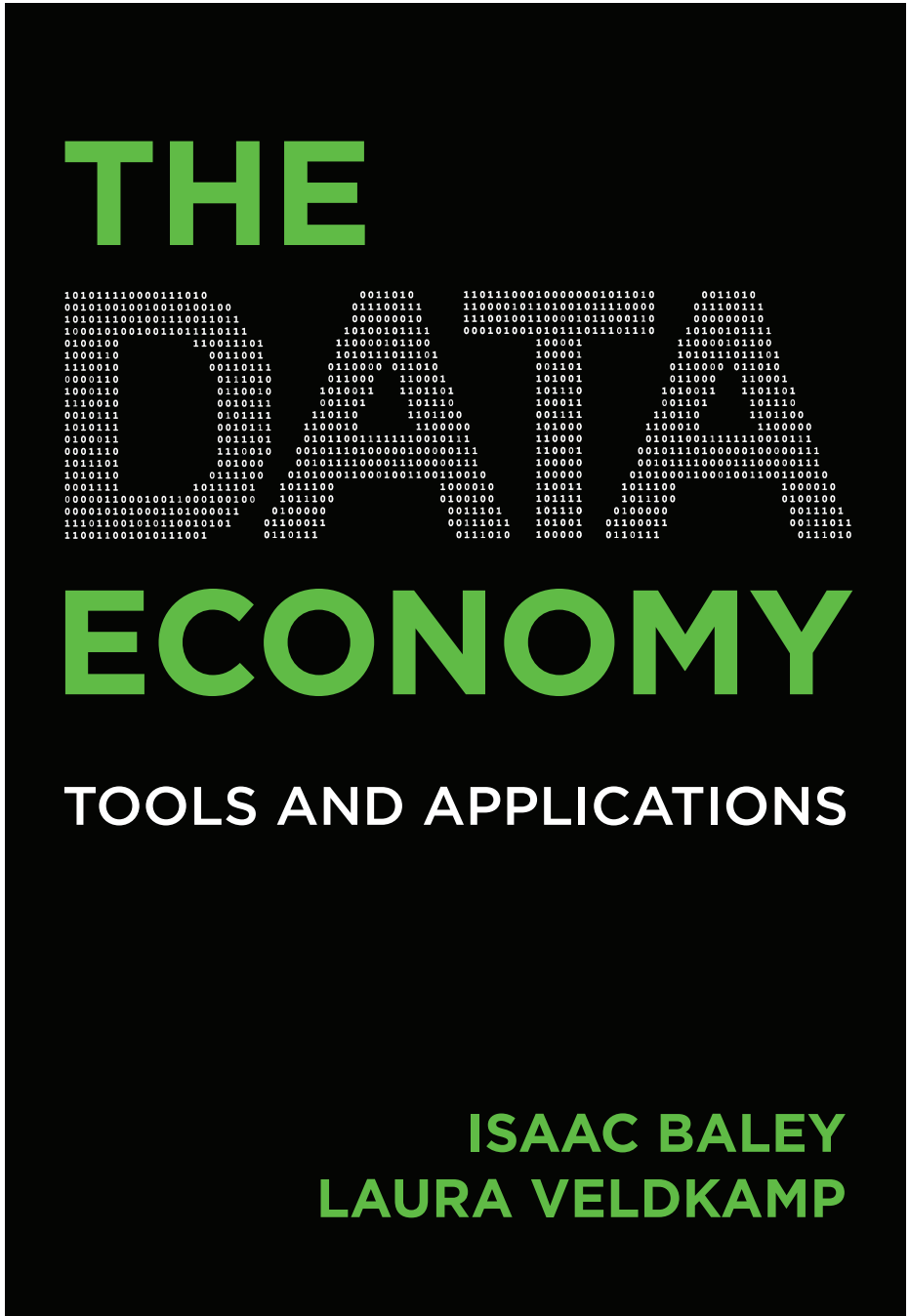
- An implicit cost: Data is bartered.
  - That shows up as a discount in the price of the good.

- This could work, if we can impute the data barter discount.

Conclusions

- Data is one of the most important and highly-valued assets in the modern economy.
  Also one of the hardest to observe, measure and put a price on.
- Different approaches needed for different situations.
- Theory and measurement need to work together here.
- Next steps:
  - Quantify the data barter value.
  - Private vs. social value: Do privacy laws prevent or worsen price discrimination, by undermining competition?
  - Data accumulation and firm life-cycles. Size, scope and competition.
- Textbook coming Soon

Coming Soon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