# Challenges in the Digital Age:

## *Puzzles from the digital economy*

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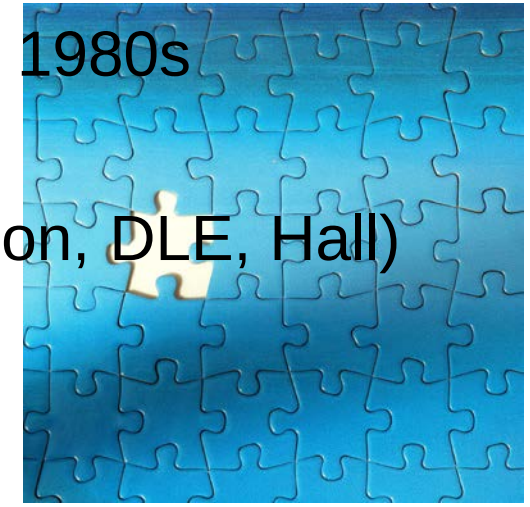
# Change is everywhere, for everyone

- Pessimism: Gordon (2018) – we shouldn't have expected growth
- Optimism: It's there, but we are not measuring it.
    - Research suggests "no" (Byrne, Fernald, Reinsdorf 2016, Syverson 2017), or at least not enough
- Guarded optimism: it's there, but …
  - Not yet: diffusion is still in progress
    - Replay of personal computing in the 1980s
  - Rents have been created, captured
    - Market power (Gutierrez and Philippon, DLE, Hall)
    - Super stars (Autor et al 2017)



# Macro trends => clues?

- Rising concentration (US especially)
- Weak investment in physical capital (widespread), especially in growing industries.
- Rising intangible capital (widespread, especially in health, high tech)
- Falling labor share – what rises depends on how you treat capital compensation.
  - Risk free cost of capital is low, profits are high
  - Additional compensation to capital could be
    - Risk, rents, unmeasured K (intangibles)
- Farhi and Gourio (2018) include all three, and need all three
  - Higher risk premium allows low rf and higher MPK, but crushes asset prices and investment
  - Need rents and/or intangibles to recover measured asset prices and investment

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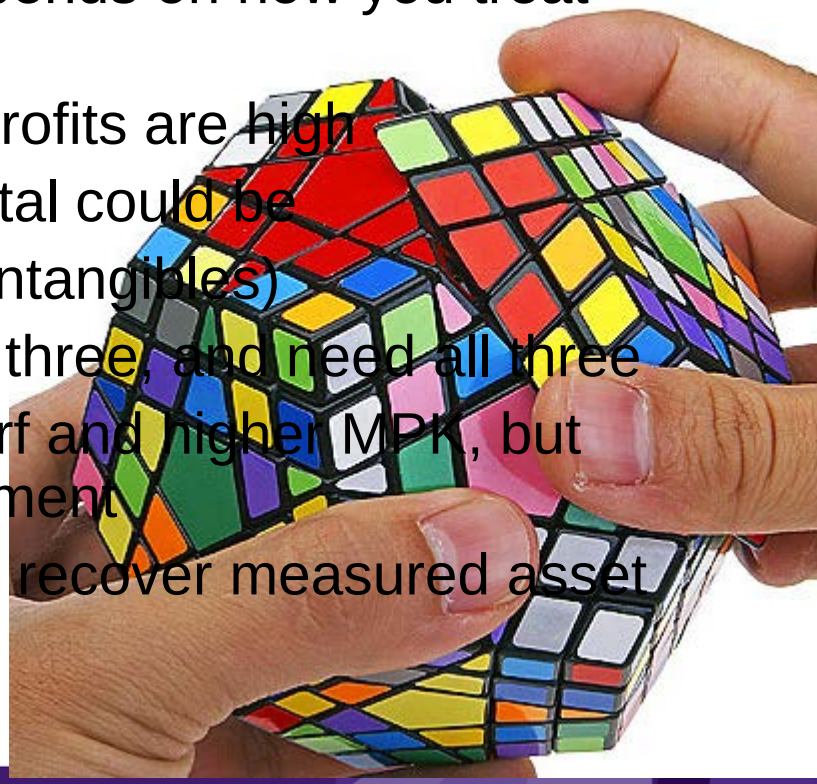
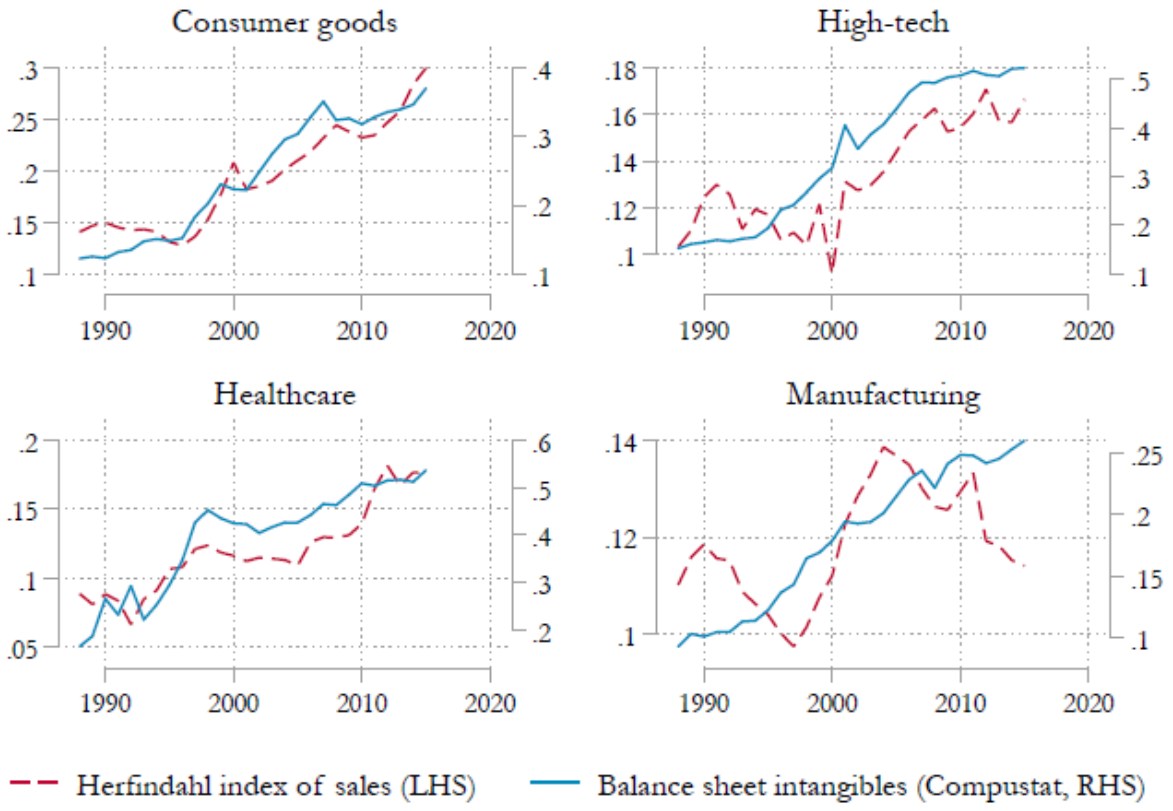


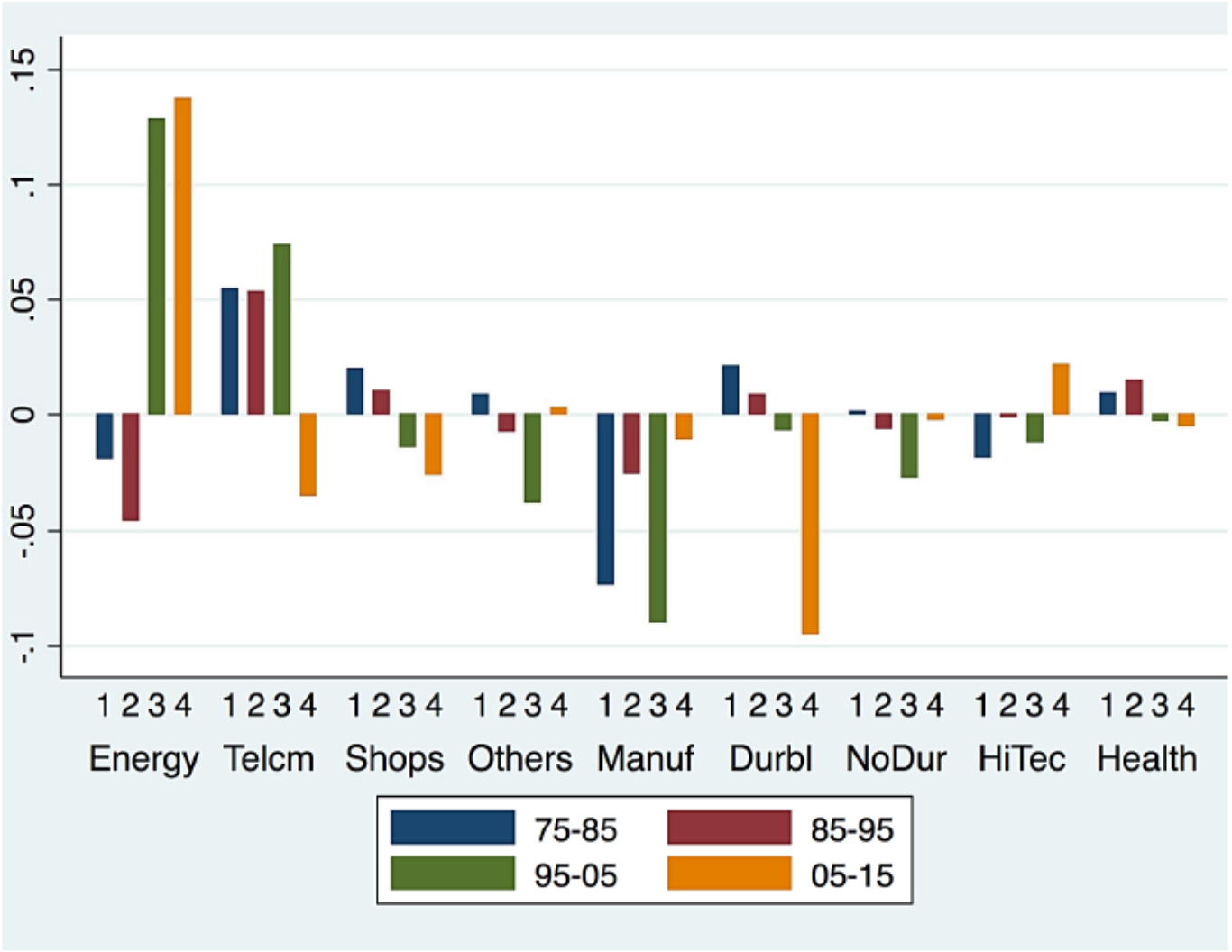
# Explaining the Rising Concentration of US Industries

- Evidence that US industries have become more concentrated
  - Sales Herfindahl increased by at least 50% in 75% of US industries since mid-1990's
  - Grullon, Larkin, Michaely (2017), Autor, Dorn, Katz, Patterson, Van Reenen (2018)
  - Crouzet and Eberly (2018) below, averaging across industries




Intangibles have risen most in high-tech and health, followed by consumer.

# The distribution of investment across industries, over time




Physical investment is increasingly allocated toward "fixed" industries, like energy and telecomm. High growth industires, like Tech and Health, show little growth in physical capital.

# The $Q$ model with two types of capital and market power

Q plus model (Crouzet and Eberly, 2019): Market pwr & Tech change

- Modify the revenue function of firm $j$ to allow market power and two types of capital:

$$\Pi_{j,t} = \mu D_t^{\frac{\mu-1}{\mu}} \left(Z_{j,t}\right)^{\mu} \left((1-\eta)K_{1,j,t}^{\rho} + \eta K_{2,j,t}^{\rho}\right)^{\frac{\mu}{\rho}}.$$

  - $Z_{j,t}$: firm-level productivity.
  - $D_t$: industry-wide demand shifter.
  - $\epsilon \geq 1$: demand elasticity; $\mu = \dfrac{\epsilon}{\epsilon - 1} \geq 1$: markup.

- This revenue function arises from optimal price-setting by a monopolistic producer:

$$\Pi_{j,t} = \max_{P_{j,t}} \; P_{j,t} \times P_{j,t}^{-\epsilon} D_t \quad \text{s.t.} \quad P_{j,t}^{-\epsilon} D_t \leq Z_{j,t} K_{j,t};$$

  it can be generalized to include variable inputs (labor), more goods. There is no intrinsic interaction between intangibles and market power.

## Allow for ***both*** market power and technological change.

In this setting, average $Q$ equals marginal $Q$ *plus* terms capturing intangible capital and market power.

$$Q_{1,j} = q_{1,j} + \underbrace{q_{2,j}\nu_j}_{\text{intangibles}} + \underbrace{\frac{1}{r-g_j}(\mu-1)R_{1,j}}_{\text{market power}} + \underbrace{\frac{1}{r-g_j}(\mu-1)\nu_j R_{2,j}}_{\text{intangibles} \times \text{market power}}$$

- The wedge between $Q_1$ and $q_1$ now reflects:
  - intangibles: shadow value $\times$ intangible share
  - market power: pv of rents;
  - *an interaction term*: pv of rents on intangibles.

- The empirically relevant case is $R_{1,j} < R_{2,j}$, because $\delta_1 < \delta_2$. So the interaction term will in general be larger than the market power term.

# Market power and technological change

- Market power generates rents
- Rents accrue to both measured and unmeasured capital
  - nb some unmeasured capital is held by labor
    - Allows for rising inequality in compensation
- Firm value and Q will overstate the return to individual fixed factors.
- Does intangible capital line up with rents?
  - Yes, by industry (earlier)
  - By investment?


Copyright or confidentiality statement.

# Patents, trademarks, and balance sheet measures of intangibles

| | $100 \times \frac{\texttt{SG\&A k}}{\texttt{R\&D k} + \texttt{SG\&A k} + \texttt{ppegt}}$ | $100 \times \frac{\texttt{R\&D k}}{\texttt{R\&D k} + \texttt{SG\&A k} + \texttt{ppegt}}$ |
|---|---|---|
| log (1 + # trademarks) | $0.662^{***}$ | 0.073 |
| | (4.06) | (0.59) |
| log (1 + # patents) | −0.012 | $0.361^{***}$ |
| | (−0.22) | (5.85) |
| Observations | 31,293 | 31,293 |
| Industry × year f.e. | Yes | Yes |
| Firm f.e. | Yes | Yes |
| Control for firm characteristics | Yes | Yes |
| Clustering of s.e. | Ind.-year and firm | Ind.-year and firm |

$p < 0.10$, ** : $p < 0.05$, *** : $p < 0.01$

- Patents are strongly correlated with R&D (Column 2).
- Trademarks are strongly correlated with SG&A (Column 1).
- Intangibles $\Longrightarrow$ *excludable* technologies/products/processes.

# Two measures of "excludable" intangibles: patents and trademarks

| | $100 \times \log$ (**markup**) | $100 \times \log$ (**Lerner index**) | $100 \times$ **Market share** |
|---|---|---|---|
| log (1 + # active trademarks) | $0.984^{***}$ | $0.536^{***}$ | $0.257^{***}$ |
| | (6.57) | (6.84) | (6.86) |
| log (1 + # active patents) | $2.085^{***}$ | $-0.090^{*}$ | $-0.226^{***}$ |
| | (21.04) | (−1.66) | (9.11) |
| Observations | 30,012 | 30,012 | 30,012 |
| Industry × year f.e. | Yes | Yes | Yes |
| Control for firm characteristics | Yes | Yes | Yes |
| Clustering of s.e. | Ind.-year | Ind.-year | Ind.-year |

$p < 0.10$, ** : $p < 0.05$, *** : $p < 0.01$

- Proxies for the stock of **excludable** technologies, business process, or products
- Trademarks more narrowly focus on products
- Trademarks have been relatively unstudied. (We retrieve them from USPTO files; merging is ongoing; results preliminary.)

# Connecting the puzzling dots

- Firms invest in excludable technologies
  - => patents and trademarks
  - => confer market power and/or efficiency gains
- Measured as intangible capital
- Rents accrue to both measured and unmeasured capital
  - Rising asset values (despite possible risk premium)
  - (Relatively) falling physical capital and rising intangible capital
- Broad trends likely to have multiple explanations
- May require interactions to understand the impact.