Did R&D Misallocation Contribute to Slower Growth?

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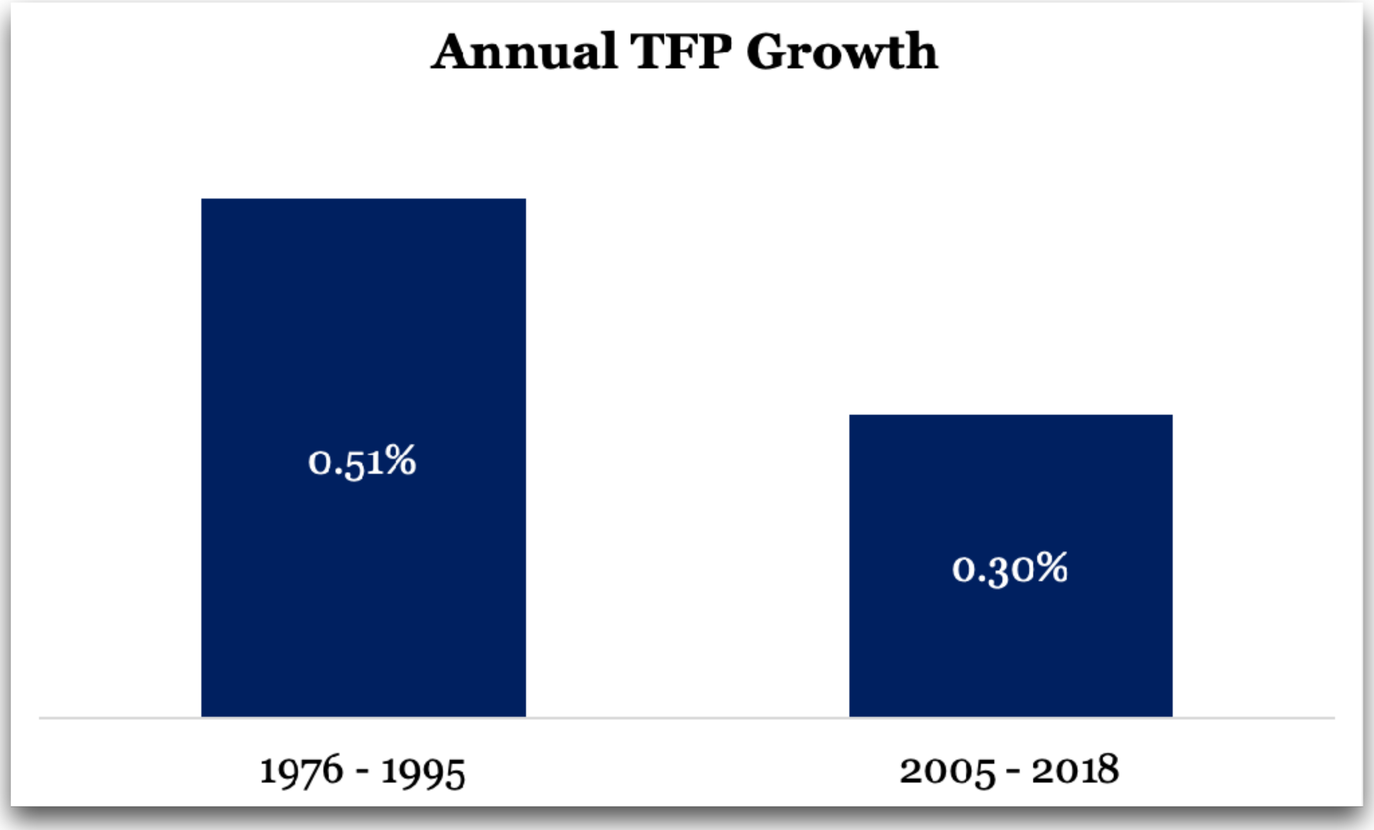
Nils H. Lehr, IMF

US Economic Growth Has Slowed Down

Despite Continued Investment in R&D



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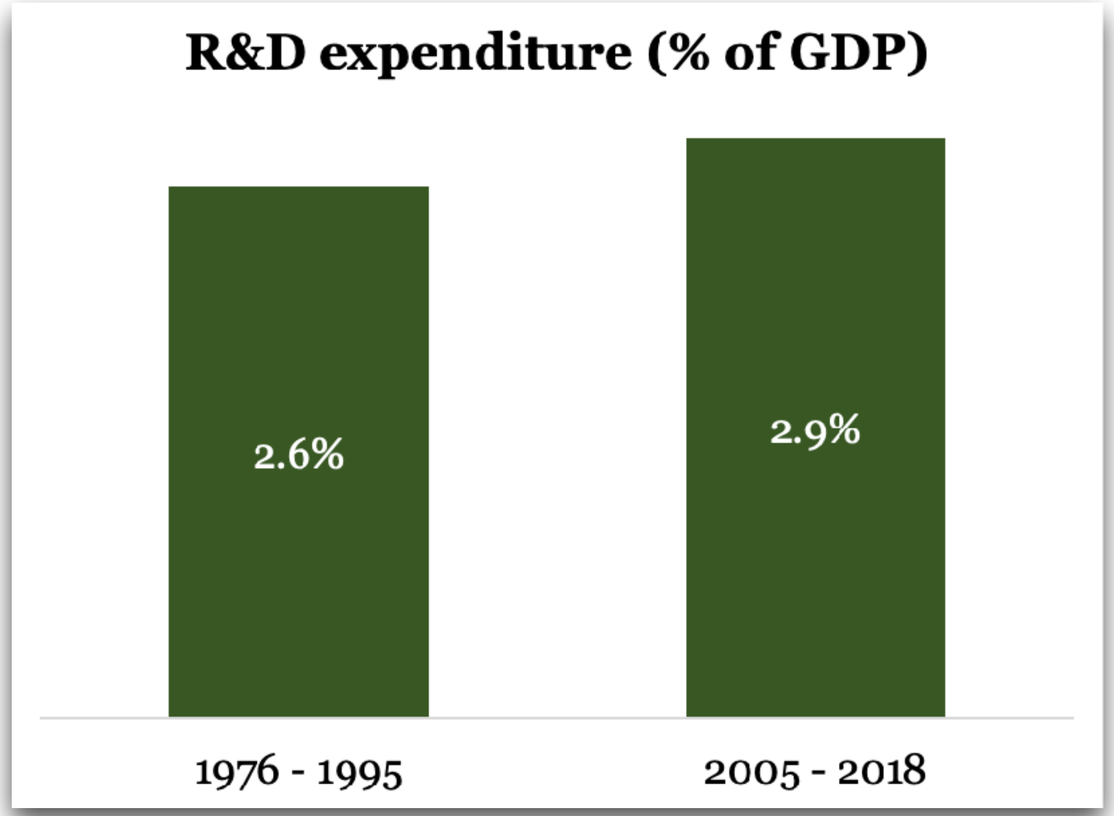
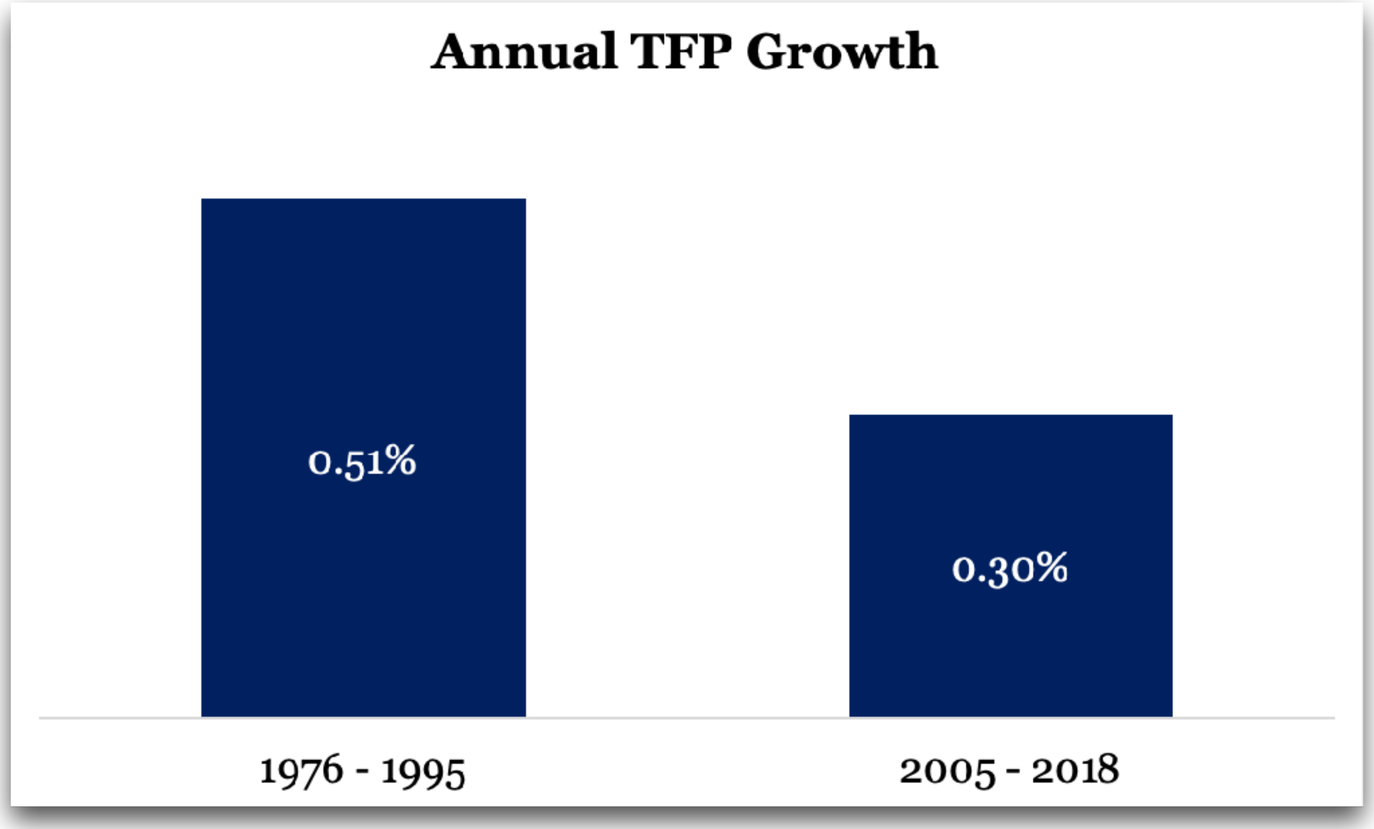




Resource Allocation Matters in R&D

- Core equation in endogenous growth:

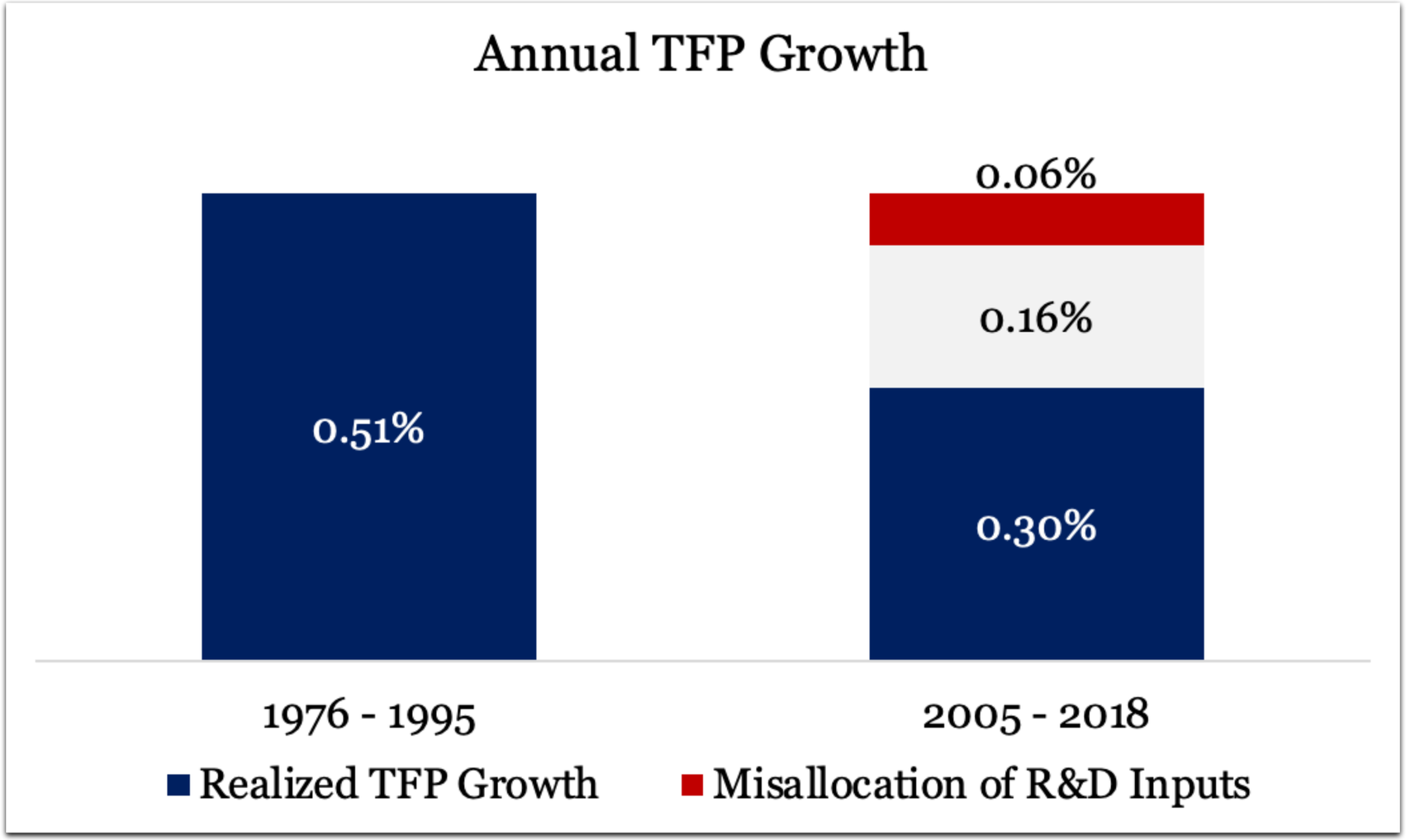
$$\textbf{Economic Growth} = \textbf{Agg. R\&D Investment} \times \textbf{Agg. R\&D Productivity}$$

- R&D investment has remained steady $\Rightarrow$ Declining R&D Productivity

$$\textbf{Agg. R\&D Productivity} \approx \textbf{Avg. R\&D Productivity} \times \textbf{R\&D Allocation}$$

- Growing literature on declining R&D productivity (Bloom et al. 2020; DeRidder 2023; Aghion et al. 2023; Olmsted-Rumsey 2023; Akcigit and Ates 2021, …)
- **This paper**: Investigate the role of R&D (mis)allocation due to frictions (DeRidder, 2023; Manera, 2022; Aghion et al., 2023)

25% of the Slowdown in US Economic Growth Can Be Explained by Rising R&D Misallocation



Literature

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  - Ideas create profits for firms
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- **Result:** Economic growth rate decreasing in dispersion in R&D wedges
  - *Intuition*: Differences in marginal R&D returns imply "gains from trade"
- Derive ***summary statistic*** for the effect of private frictions on growth
  - ***R&D allocative efficiency*** $\in [0,1]$

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Innovative firms $i \in [0,1]$ hire inventors ℓ_{it} at wage W_t

Produce inventions $z_{it} = \varphi_{it} \cdot \ell_{it}^{\gamma}$ and value them at V_{it}

Input choice is subject to wedge Δ_{it} s.t. $\dfrac{\partial z_{it}}{\partial \ell_{it}} \cdot V_{it} = (1 + \Delta_{it}) \cdot W_t$

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Private value of innovation

Impact-Value Factor

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Fishing-out effect

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The Impact of Frictions on Growth

Proposition 1. The *equilibrium* economic growth rate can be expressed as the products of two terms:

$$g_t = g_t^* \times \frac{\int_0^1 \omega_{it} \cdot \tilde{\zeta}_{it} \cdot (1+\Delta_{it})^{-\frac{\gamma}{1-\gamma}}}{\left(\int_0^1 \omega_{it} \cdot (1+\Delta_{it})^{-\frac{1}{1-\gamma}} \cdot di \right)^{\gamma}}$$

where ω_{it} is a weight depending on *private* R&D productivity.

R&D Mis. Alloc. Proposition 1

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Depends on R&D productivity, state of technology, etc.

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Corollary. R&D efficiency declines in R&D wedge dispersion as long as it is not too negatively correlated with $\tilde{\xi}_{it}$. (Hsieh & Klenow, 2009; Akcigit, Hanley, Stantcheva, 2018; König, Storesletten, Song, Zilibotti, 2022)

R&D Mis. Alloc. | Proposition 1

Data

Financial statements and patent information

- Data on U.S. listed firms for 1975—2014
- Information from financial statements (Compustat)
  - R&D expenditure, revenue, capital stock, etc.
- Patent information from Kogan et al (2017) and USPTO Patentsview
  - Patent valuations estimated in event study design
  - Forward citations, application year, inventors, etc.
- Restrict sample ex-ante to firms with significant patent and R&D activity
  - >80% of R&D expenditure and patents for U.S. listed firms
  - >40% of R&D expenditure in BEA

Measurement of R&D Wedges

- R&D wedges can be measured from average R&D products/ R&D returns

$$\text{R\&D Wedge} = \text{Scale Factor} \cdot \frac{\text{Expected Value Created}}{\text{R\&D Expenditure}}$$

- Measure R&D wedges from 5-year R&D returns

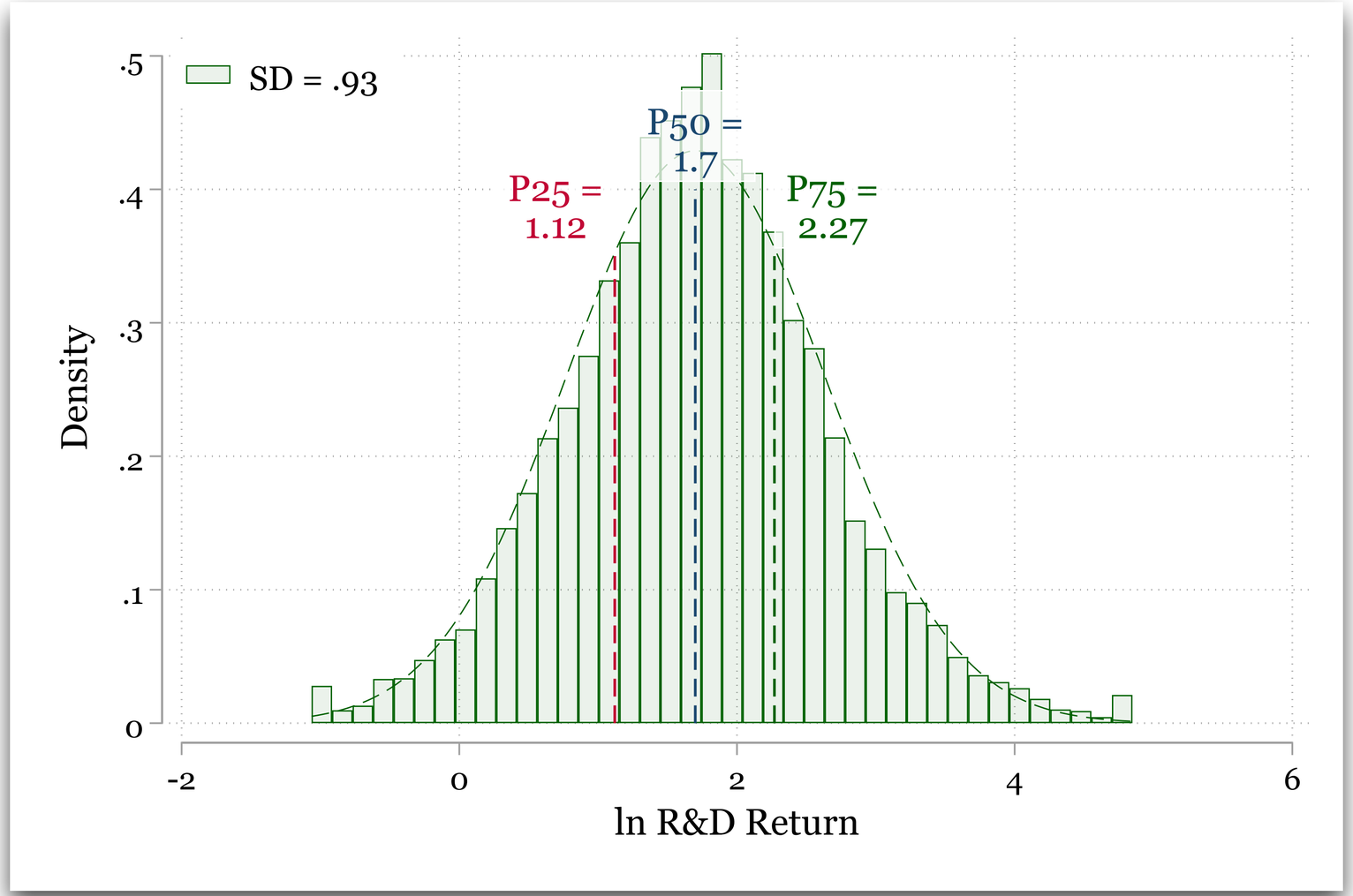
$$\widehat{\text{R\&D Wedge}}_{it} = \text{Scale Factor}_{j(i)t} \cdot \frac{\sum_{s=0}^{4} \text{Patent Valuations}_{it+s}}{\sum_{s=-1}^{3} \text{R\&D Expenditure}_{it+s}}$$

  - **Key idea**: Measure value creation from patent valuations (Pakes, 1985; Griliches, 1990; Cohen et al., 2000; Hall, Jaffe, Trajtenberg, 2005; KPSS, 2017)
  - Restrict sample to returns with at least 50 patents
  - Residualize w.r.t. industry × year fixed effects

Derivation Valuations

Large & Persistent Differences in R&D Returns

Simple Model Interprets These as Frictions



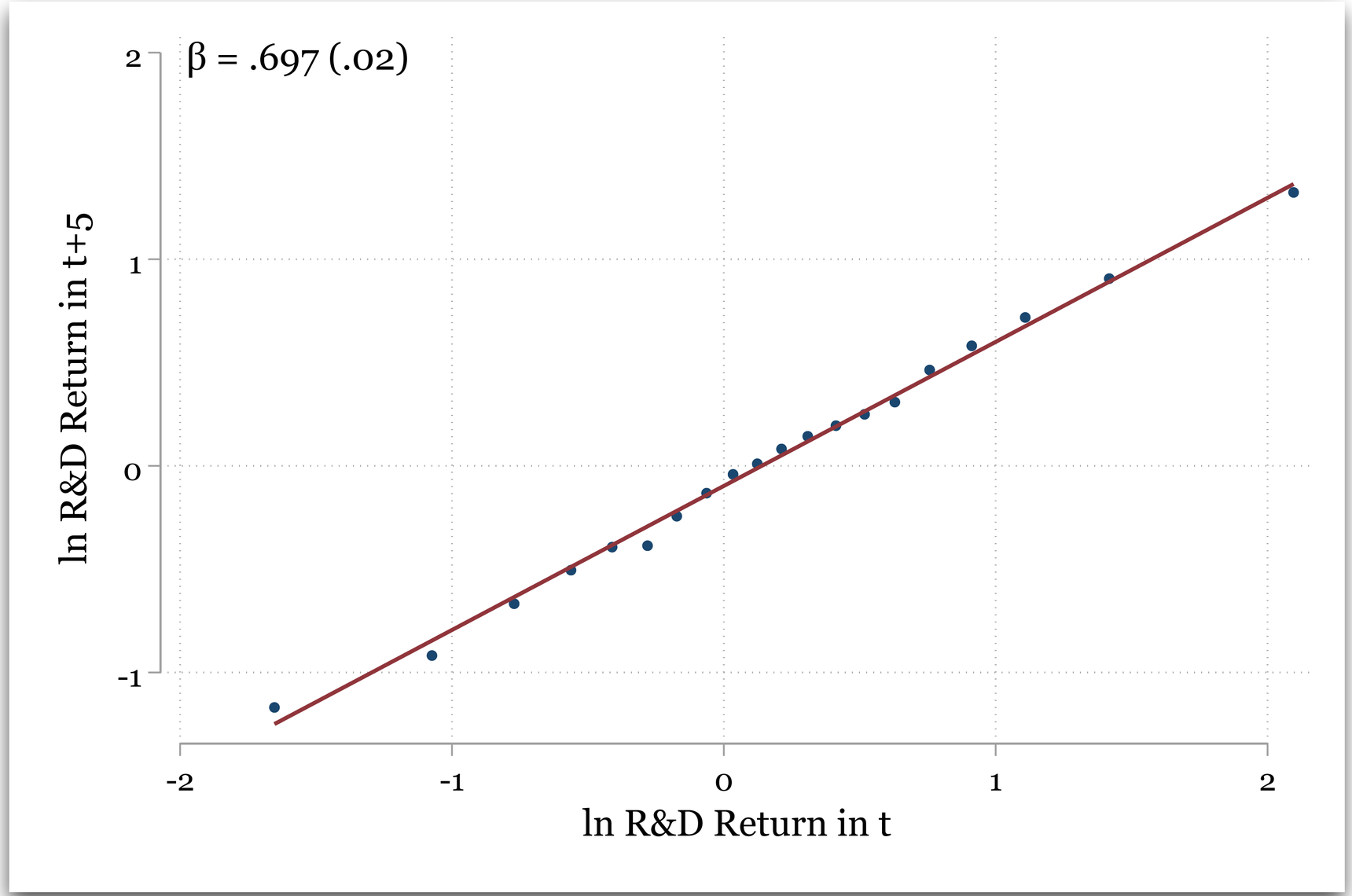
Horizon

Gap

Patents

Industry

Large & Persistent Differences in R&D Returns

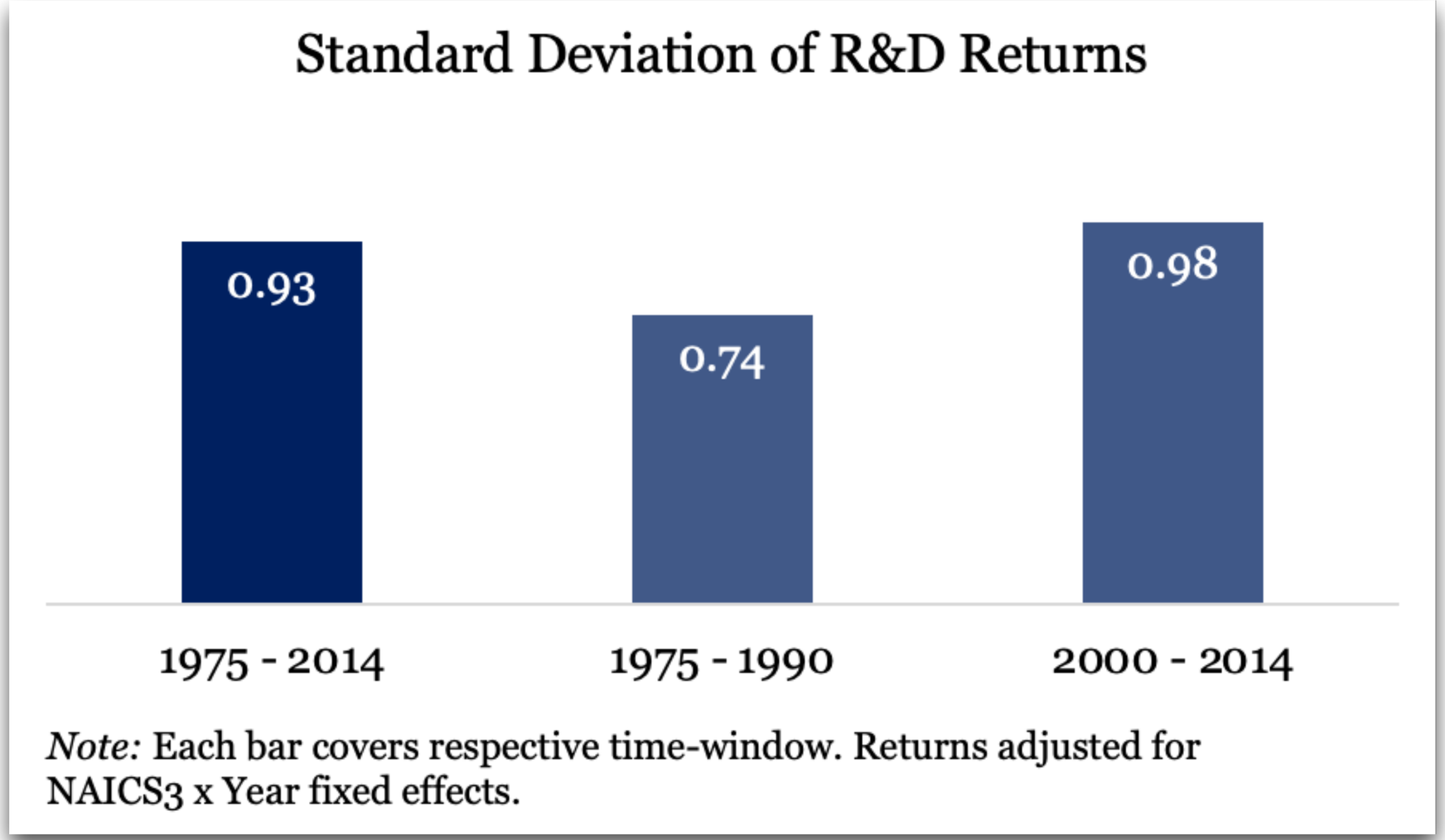


Decomp.

Table

Dispersion is Larger in Recent Years

Suggesting rising frictions



Estimating R&D Efficiency

… with the sample analog

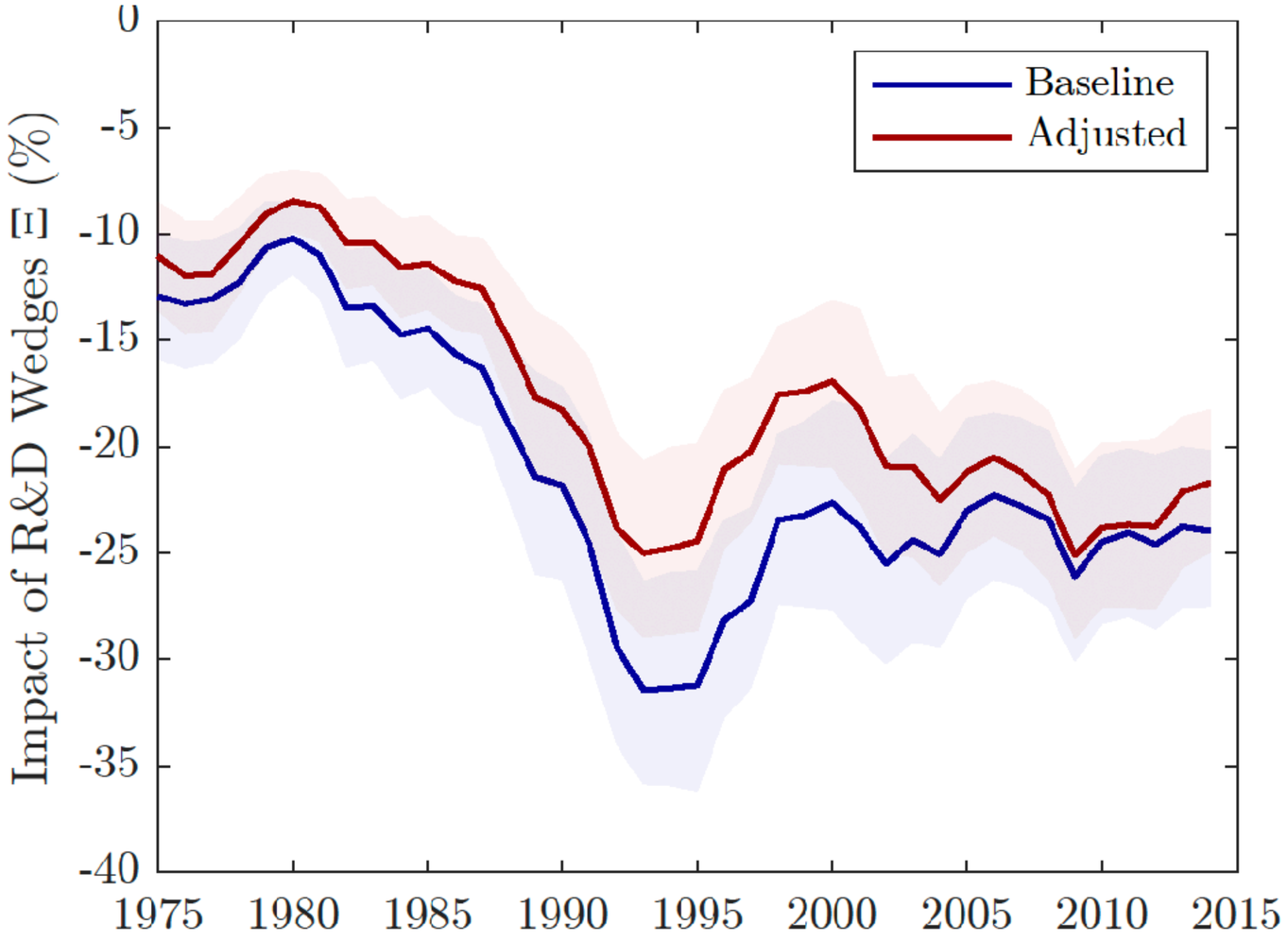
- I estimate R&D efficiency in the data using the sample analog:

$$\hat{\Xi}_t = \frac{\sum_{i=1}^{N_t} \hat{\omega}_{it} \cdot \left(\widehat{(1+\Delta_{it})^{\hat{\kappa}_t}} \right)^{-\frac{\gamma}{1-\gamma}}}{\left(\sum_{i=1}^{N_t} \hat{\omega}_{it} \cdot \left(\widehat{(1+\Delta_{it})^{\hat{\kappa}_t}} \right)^{-\frac{1}{1-\gamma}} \right)^{\gamma}} \quad \text{with} \quad \hat{\omega}_{it} = \frac{\hat{\theta}_{it}^{\frac{1}{1-\gamma}}}{\sum_{i=1}^{N_t} \hat{\theta}_{it}^{\frac{1}{1-\gamma}}}$$

- As a baseline I set $\kappa_t = 1$
  - I present robustness checks estimating κ_t using the citations to sales growth measure over a rolling window
- Counterfactuals for endogenous and semi-endogenous growth model

Counter Welfare

R&D Efficiency has Declined Consistently



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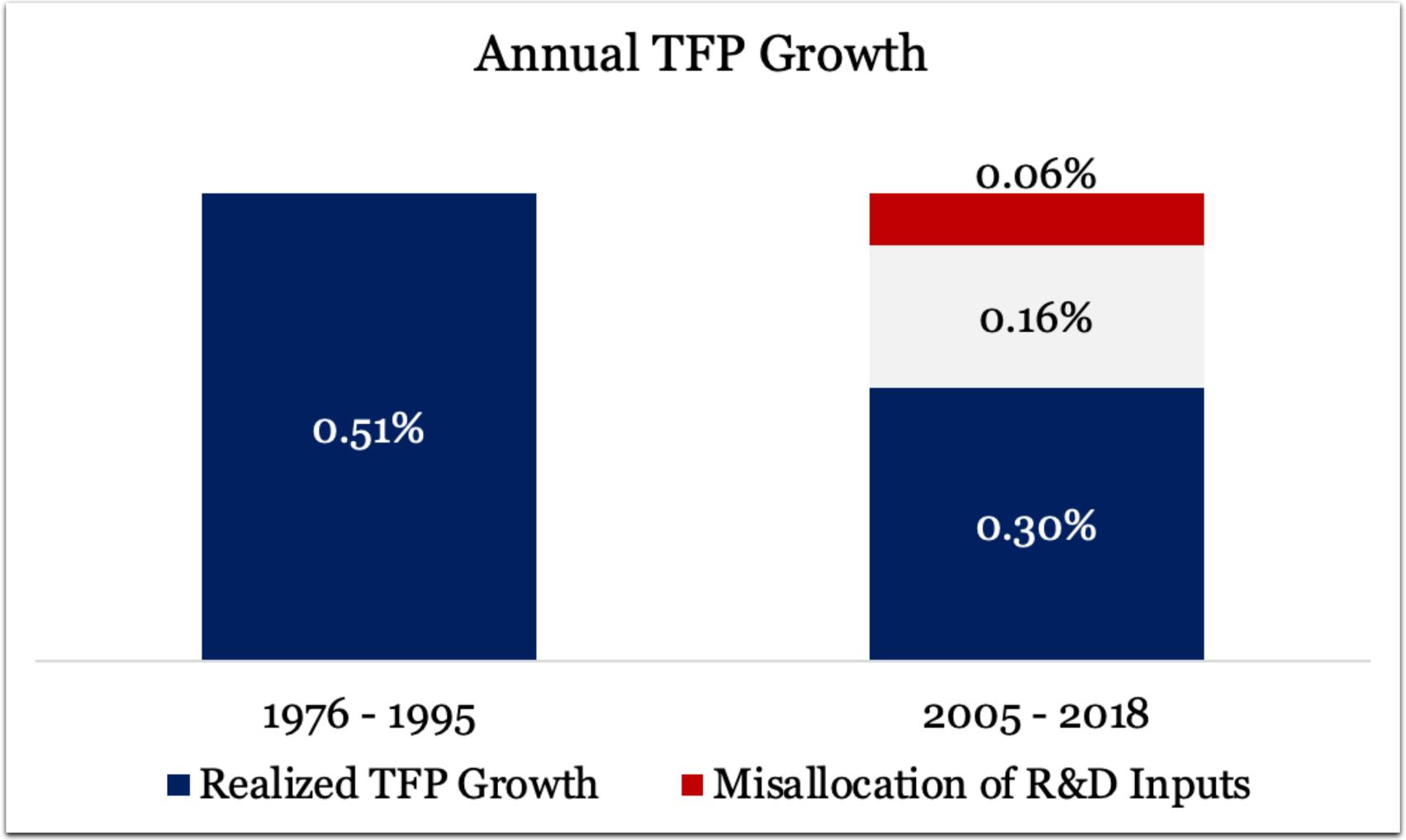

Declining Economic Growth Can be Partly Explained by Declining R&D Efficiency

- *Novel* growth accounting framework suggests a summary statistic for the impact of frictions: R&D allocative efficiency.
  - R&D allocative efficiency is maximized when (adjusted) R&D wedges (marginal returns on R&D investment) are *equalized across firms*.
- Measure R&D wedges from the average R&D return per dollar
  - Large and persistent differences in R&D returns
  - R&D return dispersion increasing over time
- Model and data combined suggest declining R&D allocative efficiency
  - R&D allocative *in*efficiency reduces economic growth by 18% on average
  - Declining R&D allocative efficiency can explain 25% of growth slowdown

Thank you!

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