Misallocation

EC502 Macroeconomics
Topic 4

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2024 Spring

Why Are Some Countries Richer than Others?

- Development accounting suggests differences in A are important

- Romer model endogenizes A as a process of knowledge (idea) accumulation

- So, is China poorer than the US because China has fewer ideas?

- But ideas are non-rival — they should be usable by everyone in the world

- Shouldn't China have access to the same knowledge as the US?

- Of course, there are various frictions in idea flows in reality
  … but hard to imagine they account for 5-50 times differences in income per capita

Misallocation Hypothesis

■ Perhaps China and the US have access to the same technology

■ But resources are more misallocated in China than US
… due to regulations, corruption, financial frictions, etc

■ Firms with low productivity produce more, high productivity produce less

■ Misallocation manifests as a lower TFP, A

  • Lower output even with the same L and K

Simple Model of Misallocation – Hsieh and Klenow (2009)

Environment and Market Equilibrium

- We now move away from one production function

- Suppose there are N firms in a country, $i = 1, \ldots, N$

- Each firm i has access to the following technology

$$y_i = \underbrace{\tilde{A}_i k_i^\alpha}_{\equiv A_i} l_i^{1-\alpha}$$

- For simplicity, we assume k_i is fixed

- Each firm takes wage w as given, decide l_i, and sells the goods at price of 1

- The labor markets clear (labor demand = labor supply):
$$\sum_{i=1}^{N} l_i = L$$

Equilibrium without Misallocation

- Let us start with the case there is no misallocation

- All firms solve

$$\max_{l_i} A_i l_i^{1-\alpha} - w l_i$$

- The first-order condition is

$$\underbrace{(1-\alpha)A_i l_i^{-\alpha}}_{\text{Marginal product of labor}} = w$$

- This implies that the marginal product of labor is equalized across all firms

$$(1-\alpha)A_1 l_1^{-\alpha} = (1-\alpha)A_2 l_2^{-\alpha} = \cdots = (1-\alpha)A_N l_N^{-\alpha}$$

Why is there no misallocation?

■ Suppose a government (planner) forces firm 1 to hire more and firm 2 to hire less

■ Can we increase total output?

■ Firm 1's output increases by

$$\frac{dy_1}{dl_1} = (1 - \alpha)A_1 l_1^{-\alpha}$$

■ Firm 2's output decreases by

$$\frac{dy_2}{dl_2} = (1 - \alpha)A_2 l_2^{-\alpha}$$

■ Changes in total output:

$$\frac{dy_1}{dl_1} - \frac{dy_2}{dl_2} = (1 - \alpha)A_1 l_1^{-\alpha} - (1 - \alpha)A_2 l_2^{-\alpha} = 0$$

Efficient Allocation

- More generally, the efficient allocation of the economy is

$$\max_{l_1,\ldots,l_N} \sum_{i=1}^{N} A_i l_i^{1-\alpha}$$

$$\text{s.t.} \quad \sum_{i=1}^{N} l_i = L$$

- Lagrangian is

$$\mathcal{L} = \sum_{i=1}^{N} A_i l_i^{1-\alpha} + \lambda \left[L - \sum_{i=1}^{N} l_i \right]$$

- Taking the first-order condition,

$$(1-\alpha)A_1 l_1^{-\alpha} = (1-\alpha)A_2 l_2^{-\alpha} = \cdots = (1-\alpha)A_N l_N^{-\alpha} = \lambda$$

$\Rightarrow$ the marginal product of labor is equalized across all firms!

Firm's Hiring Decisions

■ Now suppose that firms get different taxes for hiring labor, $(1 + \tau_i)$

■ All firms now solve

$$\max_{l_i} A_i l_i^{1-\alpha} - (1 + \tau_i) w l_i$$

■ First-order condition

$$\underbrace{(1 - \alpha) A_i l_i^{-\alpha}}_{\text{Marginal product of labor}} = w(1 + \tau_i)$$

Why is there "misallocation"?

■ Suppose a government (planner) forces firm 1 to hire more and firm 2 to hire less

■ Can we increase total output?

■ Changes in total output:

$$\frac{dy_1}{dl_1} - \frac{dy_2}{dl_2} = \underbrace{(1-\alpha)A_1 l_1^{-\alpha}}_{w(1+\tau_1)} - \underbrace{(1-\alpha)A_2 l_2^{-\alpha}}_{w(1+\tau_2)}$$

$$= w(\tau_1 - \tau_2)$$

■ The total output increases if firm 1 pays higher taxes than firm 2

■ Firm 1 was hiring too little, while firm 2 was hiring too much
  ● Reallocating labor from firm 2 to 1 improves allocative efficiency

Dispersion in MPL ⇒ TFP Loss

- We can show that, to a second-order approximation around the efficient allocation,

$$Y \approx \bar{A}ML^{1-\alpha}$$

where

$$\bar{A} = \left(\sum_{i=1}^{N} A_i^{1/\alpha} \right)^{\alpha}$$

$$M = \exp\left[-\frac{1-\alpha}{\alpha}\text{Var}(\log MPL_i) \right] \leq 1$$

- **Dispersion** in the marginal product of labor, MPL_i, lowers aggregate productivity

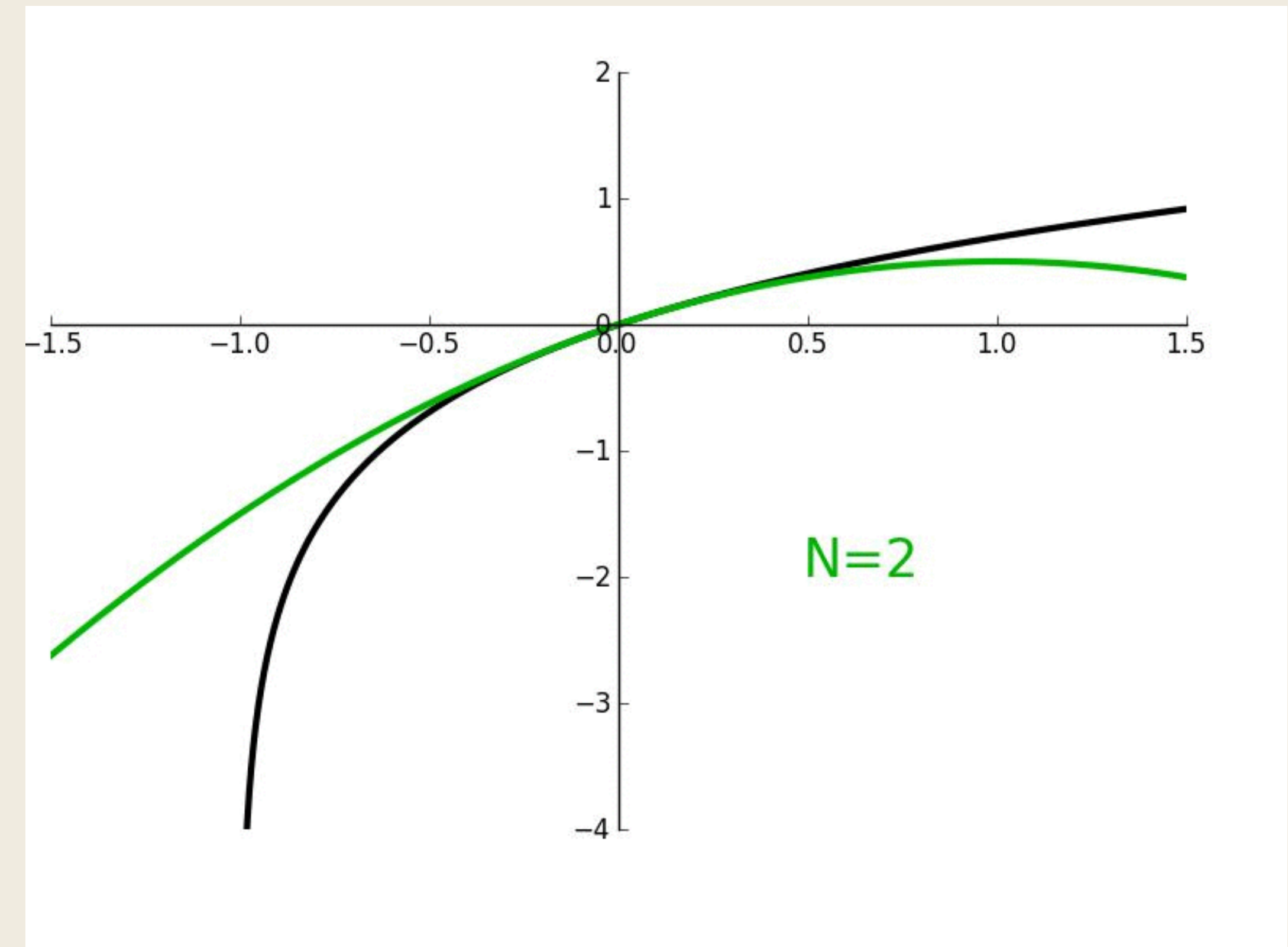# Second-Order Approximation

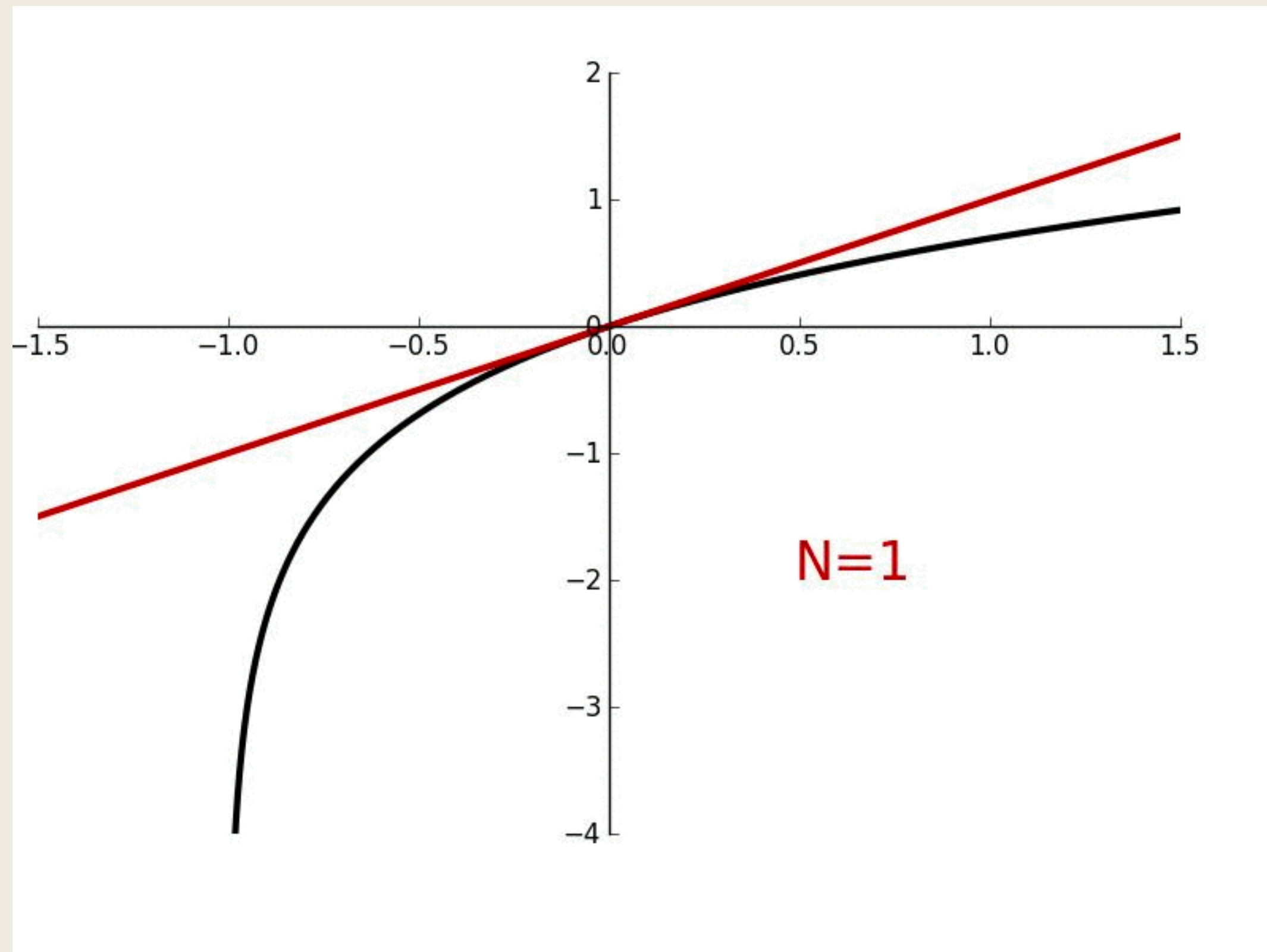- Consider a function

$$f(x_1, \ldots, x_N)$$

- The first-order approximation around $(\bar{x}_1, \bar{x}_2, \ldots, \bar{x}_N)$ is

$$f(x_1, \ldots, x_N) \approx f(\bar{x}_1, \ldots, \bar{x}_N) + \sum_{i=1}^{N} \frac{\partial f(\bar{x}_1, \ldots, \bar{x}_N)}{\partial x_i}(x_i - \bar{x}_i)$$

- The second-order approximation is

$$f(x_1, \ldots, x_N) \approx f(\bar{x}_1, \ldots, \bar{x}_N) + \sum_{i=1}^{N} \frac{\partial f(\bar{x}_1, \ldots, \bar{x}_N)}{\partial x_i}(x_i - \bar{x}_i)$$

$$+ \frac{1}{2} \sum_{i=1}^{N} \sum_{j=1}^{N} \frac{\partial^2 f(\bar{x}_1, \ldots, \bar{x}_N)}{\partial x_i \partial x_j}(x_i - \bar{x}_i)(x_j - \bar{x}_j)$$

Example with One-Dimensional Function

Measuring MPL
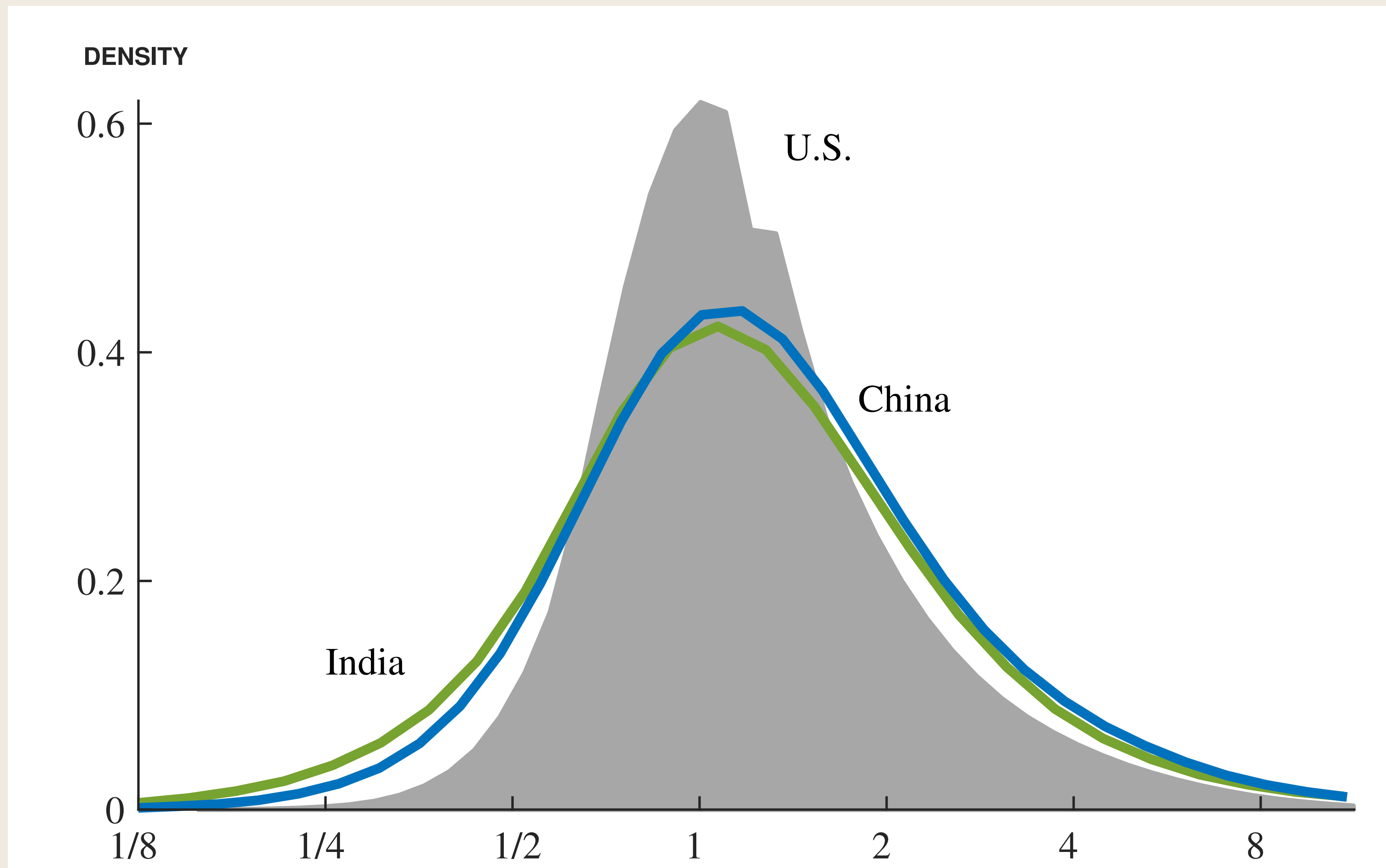
■ How do we measure marginal product of labor?

■ With our functional form assumption, this is easy:

$$MPL_i = (1 - \alpha)\frac{y_i}{l_i}$$

■ Hsieh and Klenow (2009):

  • Use manufacturing plant-level data from the US, India, and China
  • They measure dispersions in MPL_i at the plant-level using $MPL_i = (1 - \alpha)y_i/l_i$
  • Quantify the TFP losses from misallocation

Dispersions in MPL

Huge Misallocation, More So in China & India

- More dispersions in MPL, and thereby misallocation, in China and India than the US

- Removing misallocation increases total output by

  - $\approx$ 100% in China

  - $\approx$ 120% in India

  - $\approx$ 40% in the US

- If China and India had the same level of misallocation as the US,

  - Manufacturing TFP goes up by $\approx$ 40% in China and by $\approx$ 50% in India
  - Close the manuf. TFP gap to the US by 50% for China and for 35% for India

- Misallocation accounts for 30-50% of the difference in TFP

Is This the Number We Believe in?

– Carrillo, Donaldson, Pomeranz & Singhal (2023)

Do We Believe It?

- We relied on the following equation:

$$MPL_i = (1 - \alpha)\frac{y_i}{l_i}$$

- This relies on a very strong functional form assumption, $y_i = A_i l_i^{1-\alpha}$

- Simple functional form assumptions are useful to obtain insights
  … but not something we seriously believe in

- Is there any way to test misallocation without relying on strong assumptions?

Nonparametric Test of Misallocation

- Carrillo, Donaldson, Pomeranz & Singhal (2023) develop such an approach

- If there is an exogenous demand shock to firms, and suppose we observe

  - changes in output in response to the shock, dy_i
 - changes in input in response to the shock, dl_i

- Consequently, we observe

$$\frac{dy_i}{dl_i} = MPL_i$$

Construction Sector in Ecuador

- They implement this approach in the context of the construction sector in Ecuador

- Ecuador's public procurement system allocates construction contracts by lottery

- Projects below a certain value allocated through lotteries among qualified suppliers

- This generates random demand shocks at the firm level (exactly what we want)
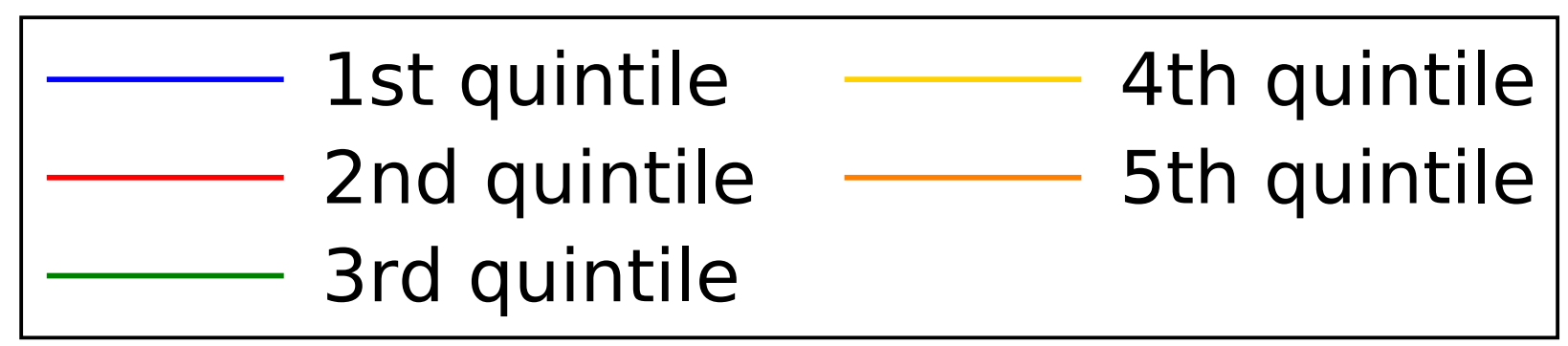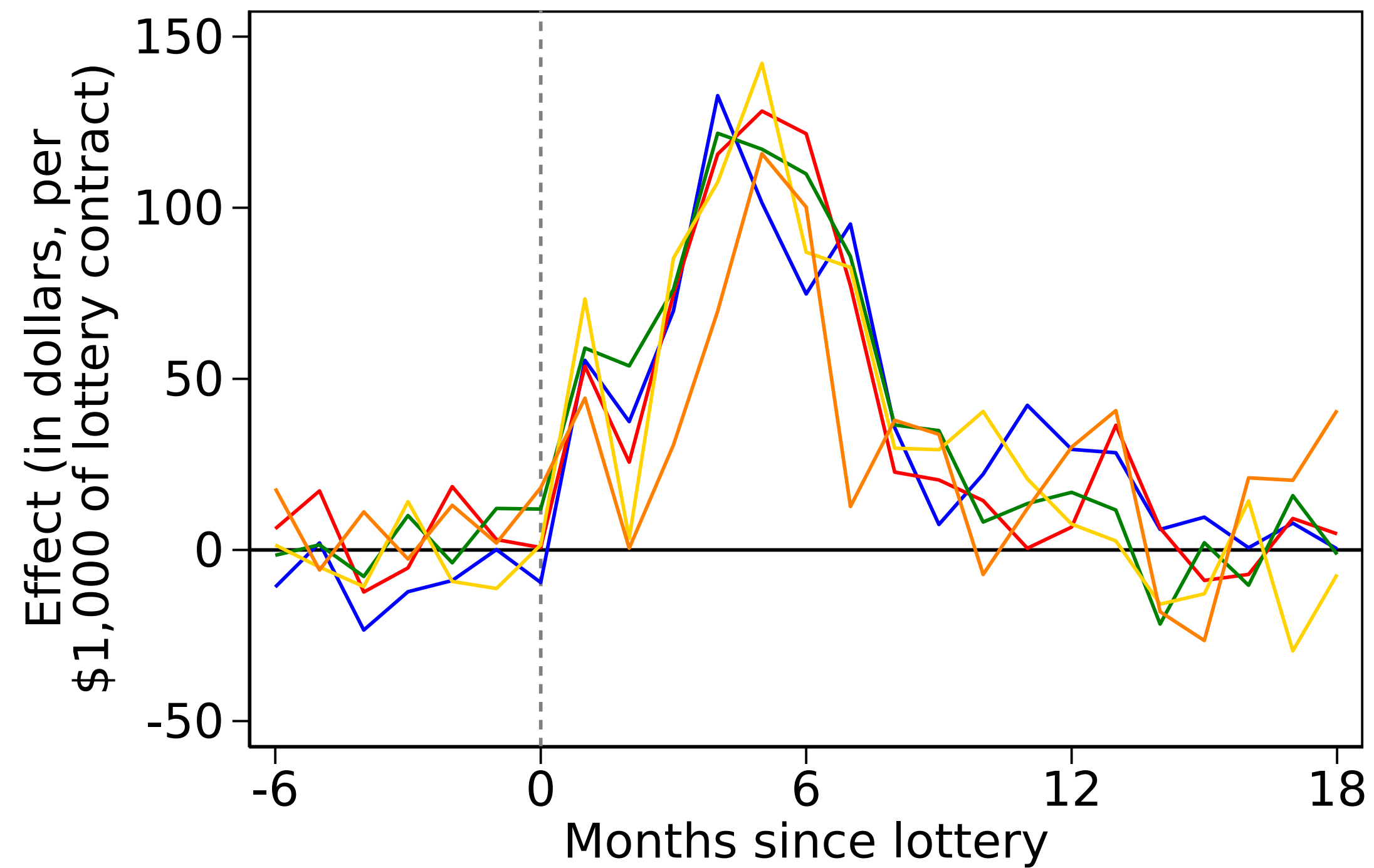
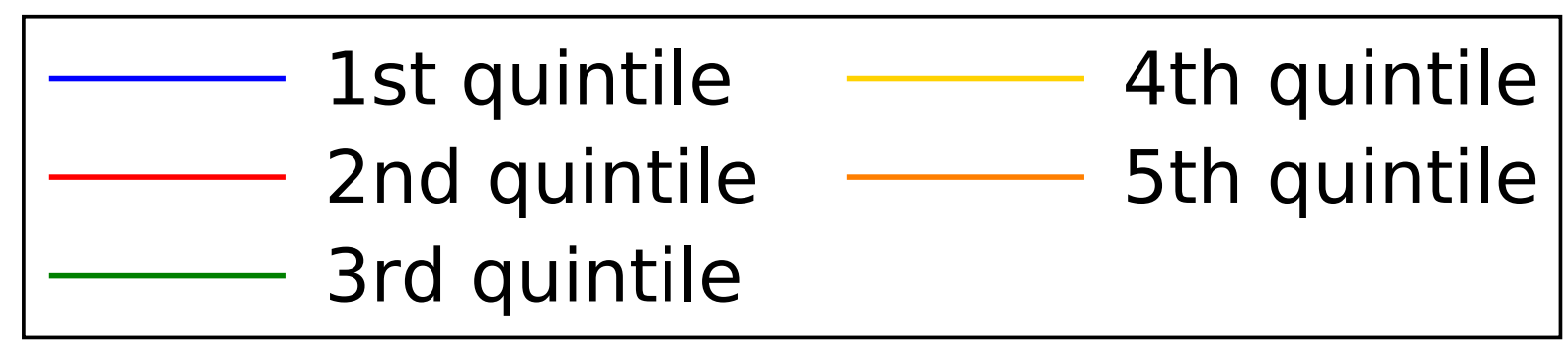# Impact of Winning Lottery
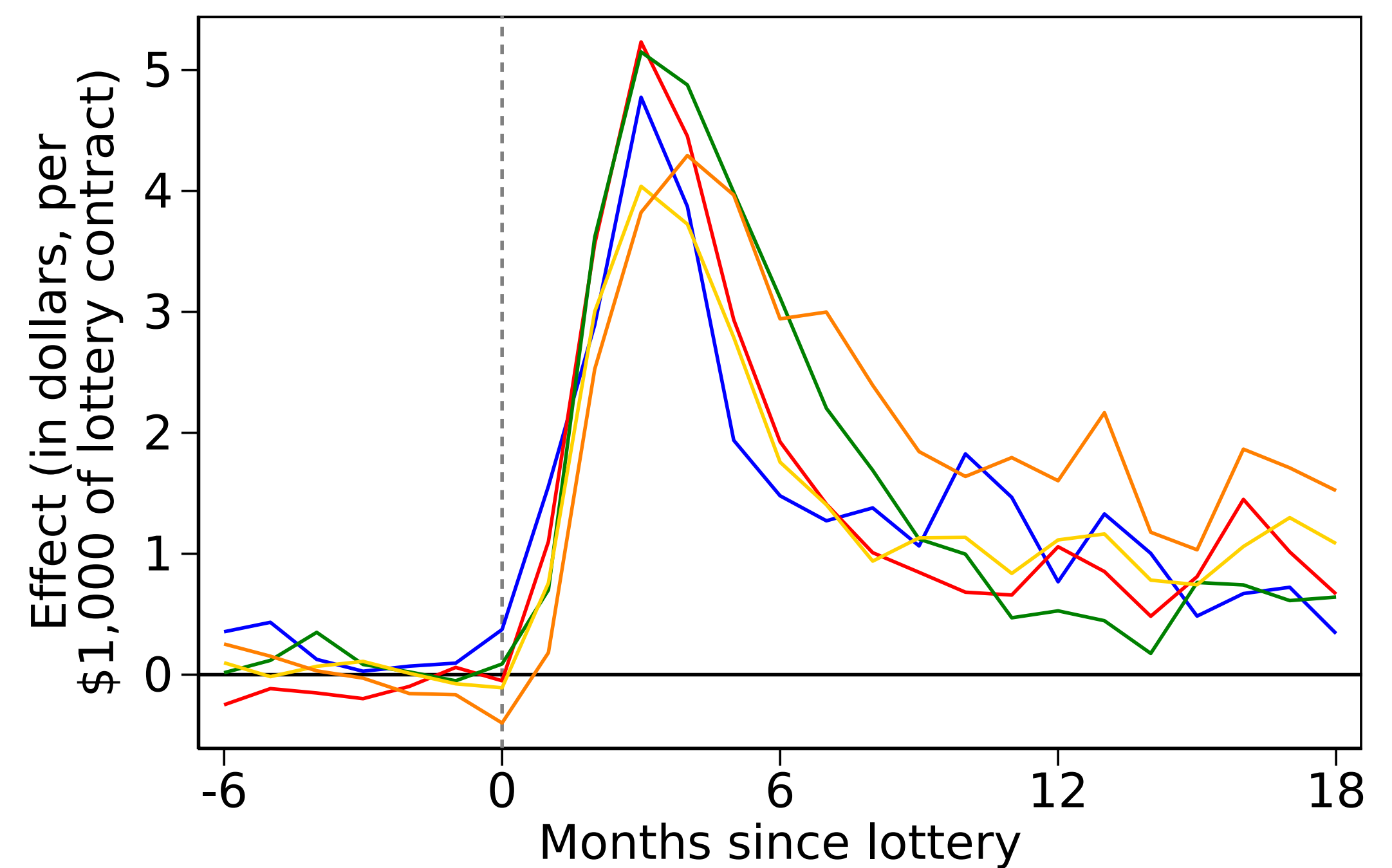
Sales
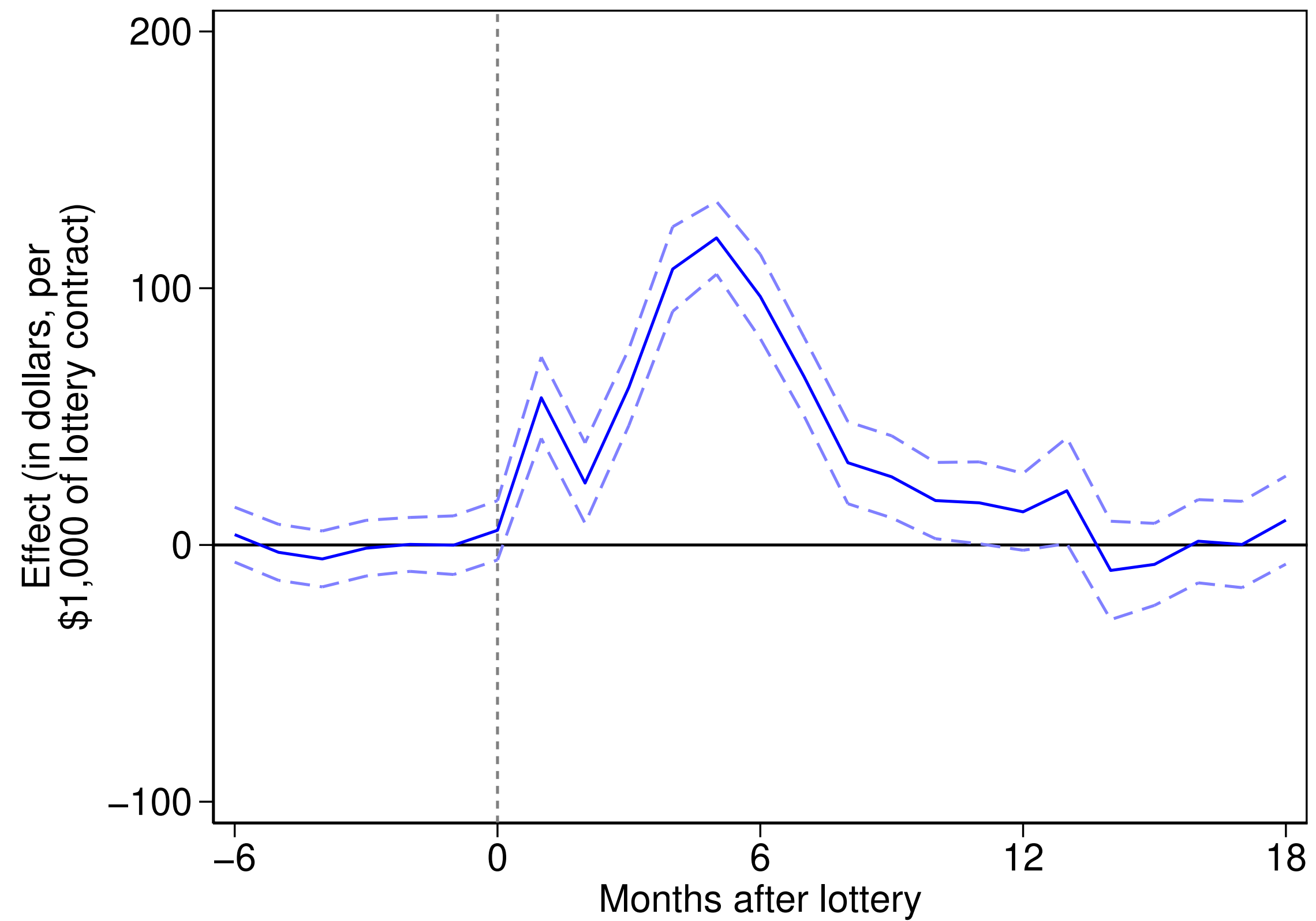
Labor Inputs
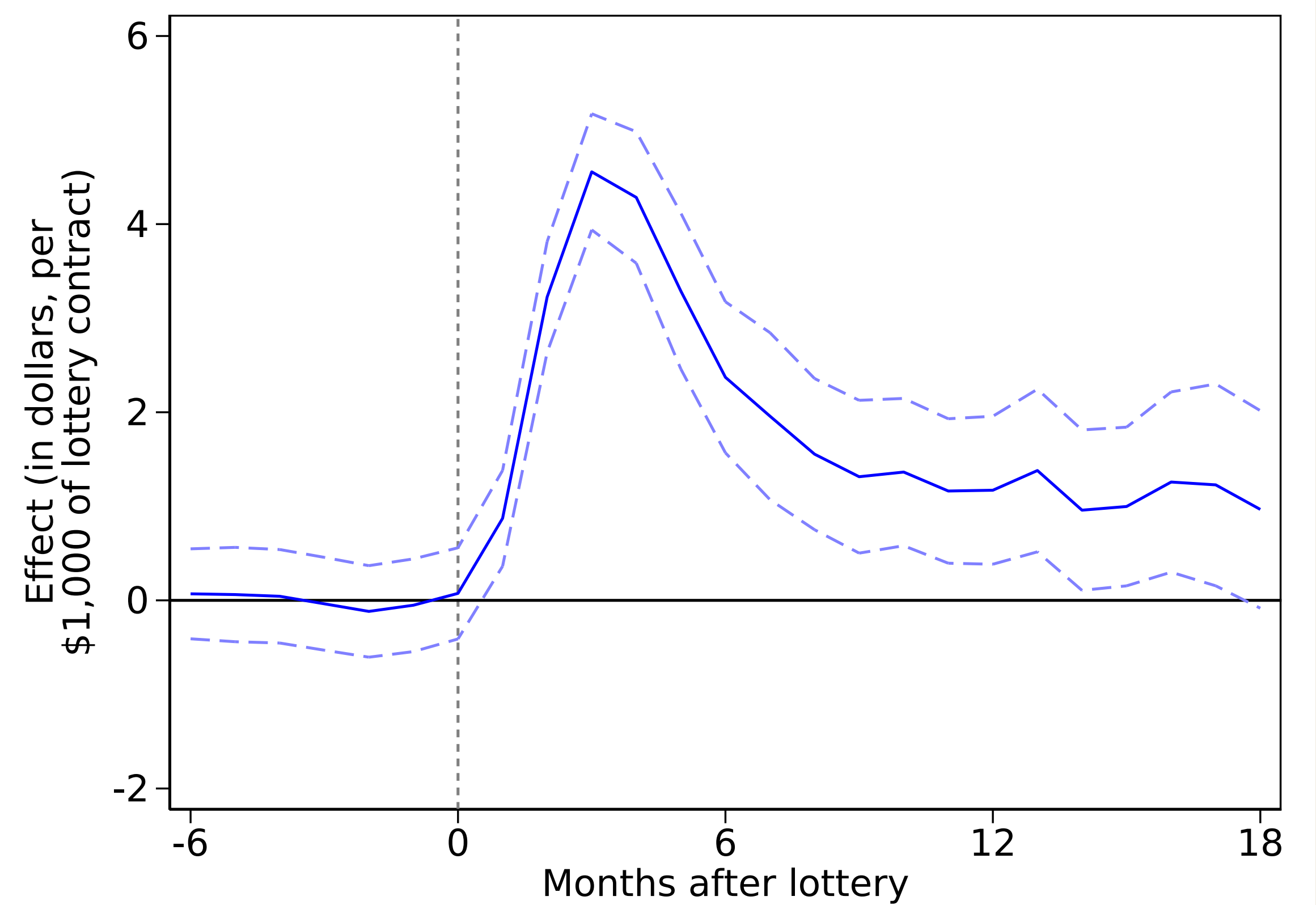
Heterogenous Responses by Firm Size

Sales
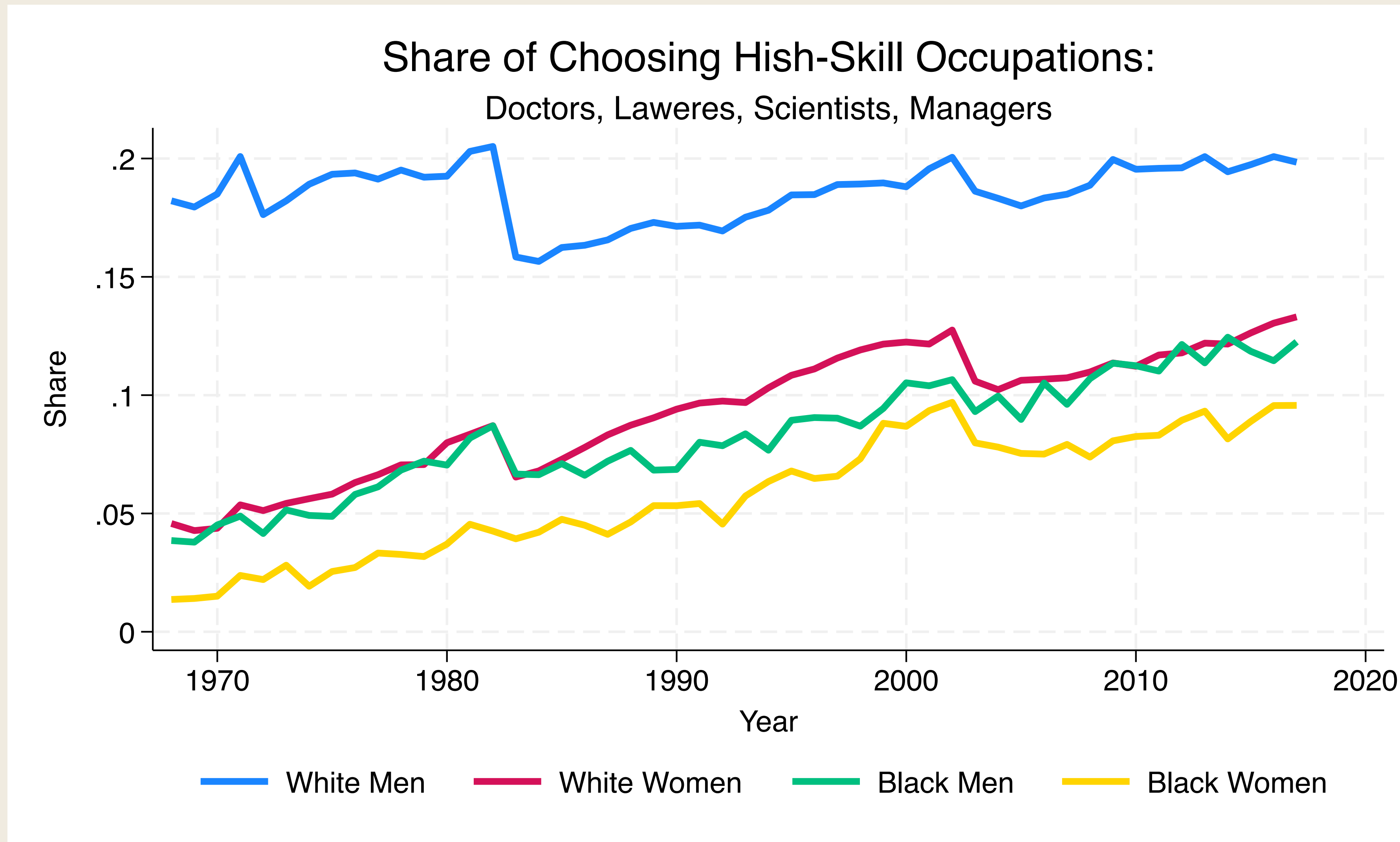
Labor Inputs

Negligible Cost of Misallocation

- Very little heterogeneity in dy_i or dl_i

- This suggests that very little differences in $MPL_i = dy_i/dl_i$ across firms

- Full calculation implies that removing misallocation increases output by 1.6%

- Compare this number to 100-140% in Hsieh-Klenow (2009)!

Misallocation of Talent and Growth – Hsieh, Hurst, Jones & Klenow (2019)

Disappearing Discrimination?

Share of Choosing Hish-Skill Occupations:
Doctors, Laweres, Scientists, Managers

Legend: White Men, White Women, Black Men, Black Women

Sandra Day O'Connor

Source: https://www.nytimes.com/2023/12/01/us/sandra-day-oconnor-dead.html

- Sandra Day O'Connor was the first woman to serve on the Supreme Court justice

- She graduated from Stanford Law School in 1952, ranked 3rd in her class

- The only job she could get in 1952 was as a legal secretary

Model with Discrimination

- Suppose there are

  - N occupations (lawyers, doctors, nurses, secretaries, etc)

  - K groups of people (white men, black men, white women, black women, etc)

- Firms in occupation i hiring group k workers produces

$$y_{ik} = A_i l_{ik}^{1-\alpha}$$

- Firms can hire a group k workers with wage w_k

- However, firms have to pay extra $(1 + \tau_k)$

  - captures discrimination or barriers that a group k faces

- Firms in occupation i hiring group k workers solve

$$\max_{l_{ik}} A_i l_{ik}^{1-\alpha} - (1 + \tau_{ik}) w_k l_{ik}$$

Market Clearings

- The labor market clears for each group:

$$\sum_{i=1}^{N} l_{ik} = L_k$$

- The total output in this economy is

$$Y = \sum_{k=1}^{K} \sum_{i=1}^{N} A_i l_{ik}^{1-\alpha}$$

Discrimination and MPL

- The first-order conditions for each i, k are

$$(1 - \alpha)A_i l_{ik}^{-\alpha} = (1 + \tau_{ik})w_k$$

- For each group k,

$$\underbrace{(1 - \alpha)A_1 l_{1k}^{-\alpha}}_{MPL_{1k}} \quad \underbrace{\frac{1}{1 + \tau_{1k}}}_{\text{discrimination in occ. 1}} = \cdots = \underbrace{(1 - \alpha)A_N l_{Nk}^{-\alpha}}_{MPL_{Nk}} \quad \underbrace{\frac{1}{1 + \tau_{Nk}}}_{\text{discrimination in occ. N}} = w_k$$

- Each group k workers is allocated across occupations to equalize MPL ... adjusted with discrimination term

- Higher τ_{ik} (more discrimination) $\Rightarrow$ higher MPL_{ik}

Occupational Choice

- Solving for l_{ik}

Share of group k workers choosing occupation i

$$\frac{l_{ik}}{L_k} = \frac{[A_i/(1 + \tau_{ik})]^{1/\alpha}}{\sum_{j=1}^{N} [A_j/(1 + \tau_{jk})]^{1/\alpha}}$$

- If there were no discrimination, $\tau_{ik} = 0$, for all i, k:

$$\frac{l_{i1}}{L_1} = \cdots = \frac{l_{iK}}{L_K} = \cdots = \frac{A_i^{1/\alpha}}{\sum_{j=1}^{N} A_j^{1/\alpha}}$$

  - The same share of black women and white men should choose to be lawyers

- If black women face more discrimination as lawyers than as janitors
  $\Rightarrow$ black women more likely to choose janitors than lawyers

Discrimination $\Rightarrow$ Lower TFP

- Discrimination manifests as misallocation

- Like before

$$Y \approx \sum_{k=1}^{K} \bar{A} {\color{red} M_k} L_k^{1-\alpha}$$

$$\bar{A} = \left(\sum_{i=1}^{N} A_i^{1/\alpha} \right)^{\alpha}$$

$$M_k = \exp \left[-\frac{1}{\alpha} \mathrm{Var}_i (\log MPL_{ik}) \right]$$

- Discrimination implies $\mathrm{Var}_i(\log MPL_{ik}) > 0 \Rightarrow M_k < 1$
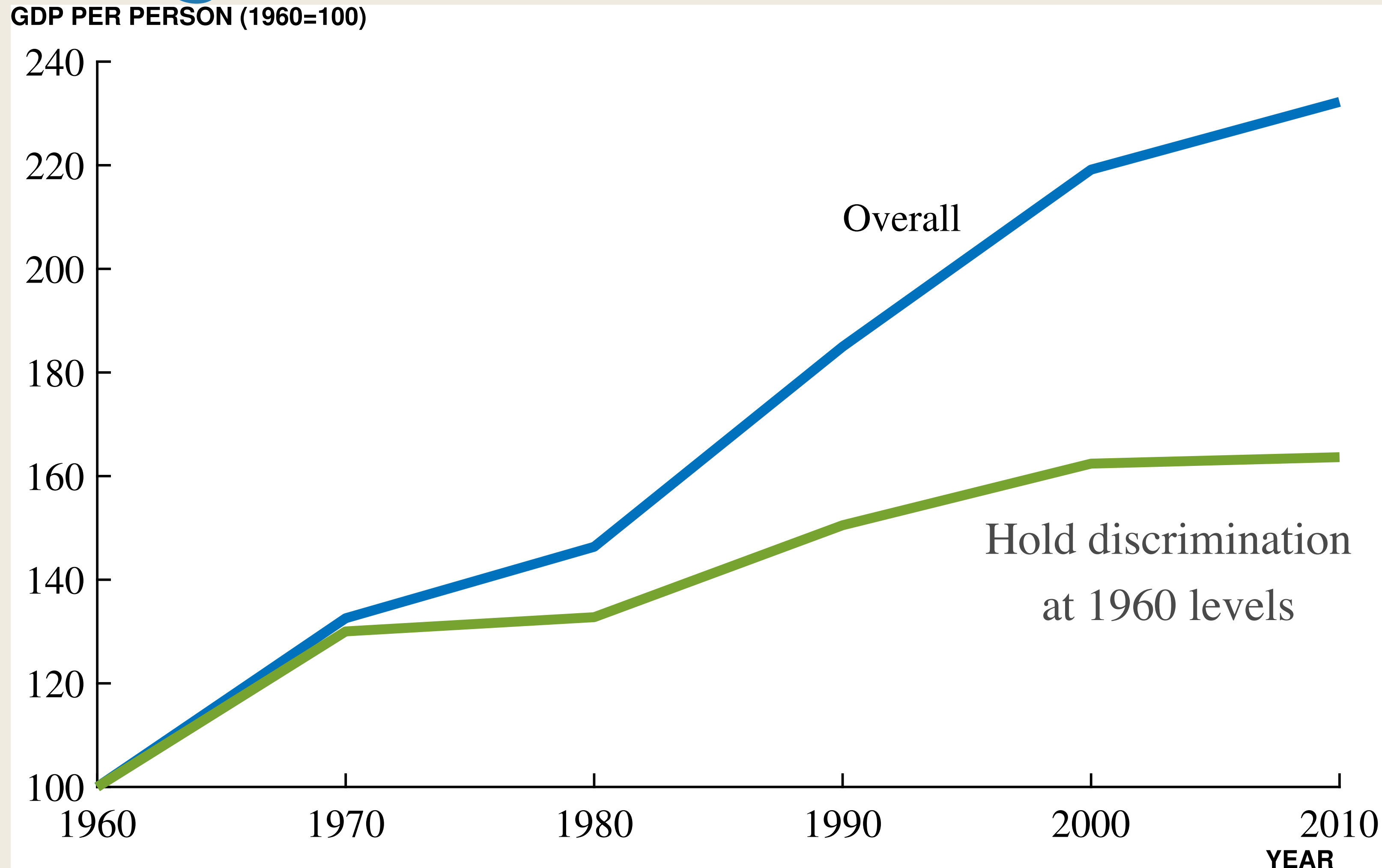
Quantifying Macro Consequence of Discrimination

- Reductions in discrimination over the past 60 years have led to economic growth

- How do we quantify it?

- Suppose that white men face no discrimination, $\tau_{ik} = 0$ for all i and $k = $ WM

- We also normalize $\tau_{1k} = 0$ for all k (what matters is the dispersion in τ_{1k}!)

- Then occupational choice reveals the discrimination:

$$\frac{\dfrac{l_{ik}/L_k}{l_{1k}/L_k}}{\dfrac{l_{iWM}/L_{WM}}{l_{1WM}/L_{WM}}} = \frac{1}{1 + \tau_{ik}}$$

- Choose $\{A_i\}$ to match observed l_{iWM}/L_{WM} and assume $\alpha = 1/3$

Declining Discrimination ⇒ Economic Growth

GDP PER PERSON (1960=100)

Overall

Hold discrimination at 1960 levels

240
220
200
180
160
140
120
100

1960   1970   1980   1990   2000   2010

YEAR

- Around 20% of US economic growth comes from a reduction in discrimination

Takeaway

■ Economics often starts from an assumption that markets allocate resources efficiently

■ In reality, various frictions prevent the efficient allocation of resources
- Regulations, corruption
- Market power, financial friction
- Certain groups of people face barriers and discrimination

■ Frictions may systematically vary across countries
$\Rightarrow$ potentially explain cross-country income differences

■ Frictions may have been reduced in the past
$\Rightarrow$ potentially explain economic growth