# Skill Premium in Wages

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# Outline

- Motivation
- Our Explanation
- The Model
- Other Empirical Evidence
- Alternative Explanations
- Implications

# Motivation

# Facts: Skill Premium in Wage


Source: Author's Computation using UHS data

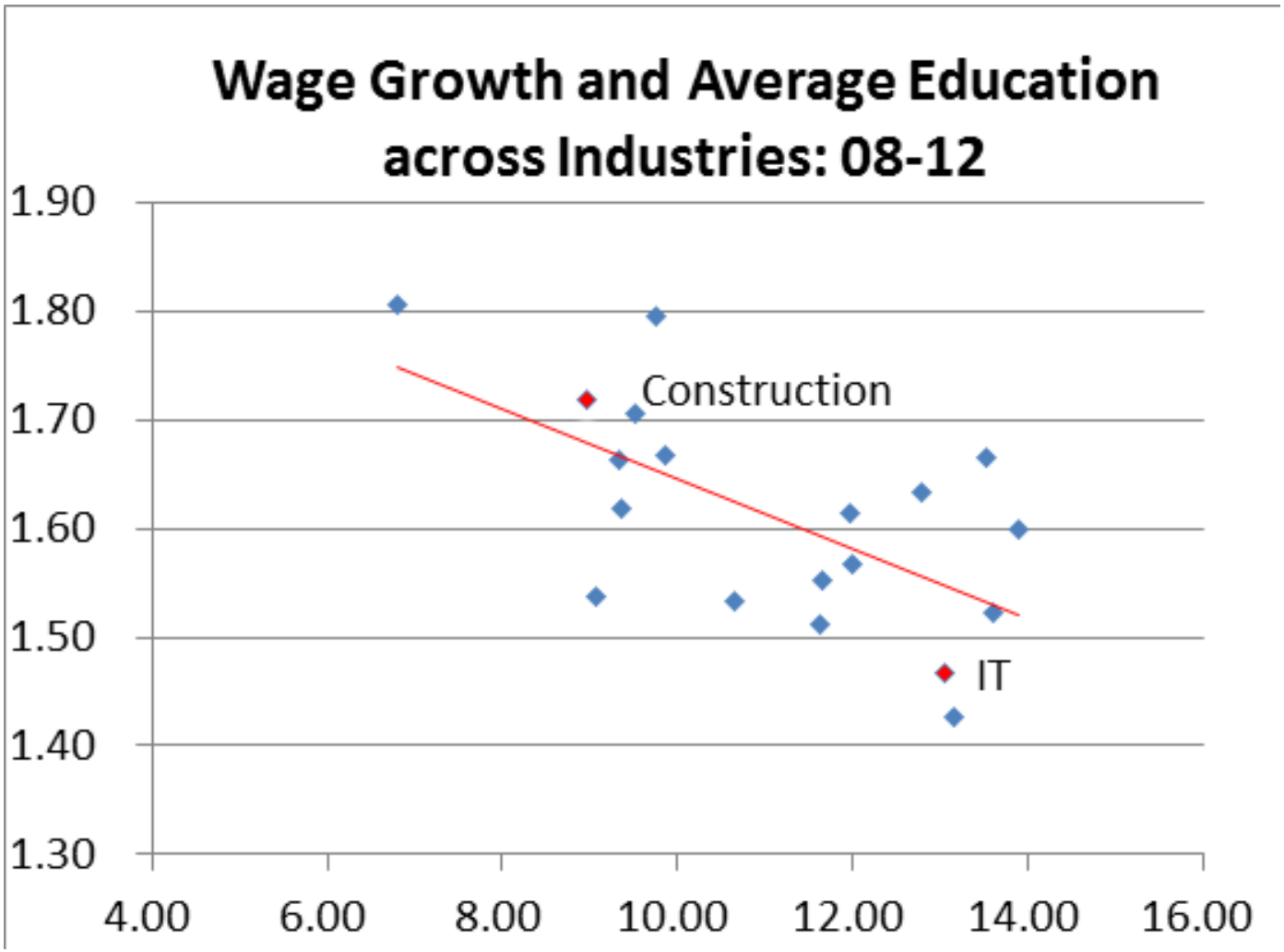
# Skill Premium in Wage

- Following Ge and Yang (2014), we examine the changes in skill premium in wage
- Data: National sample of Urban Household Surveys (1993-2012)
- Specificly, the following regression function is used:

$$\ln w_i^t = \beta_k^t S_{ik}^t + \beta_1^t X_i^t + \beta_2^t X_i^{t^2} + \beta_g^t G_i^t + \sum_n \beta_n^t R_{in}^t + \varepsilon_i^t$$

  - $S_{ik}^t$ : dummy variables for schooling levels (middle school, high school and above)
  - $X_i^t$ : potential experience
  - $G_i^t$ : gender
  - $R_{in}^t$ : dummy variables for regions (province)
- Robustness checks are done

# Facts: Wage Growth and Skill Intensity



# Motivation

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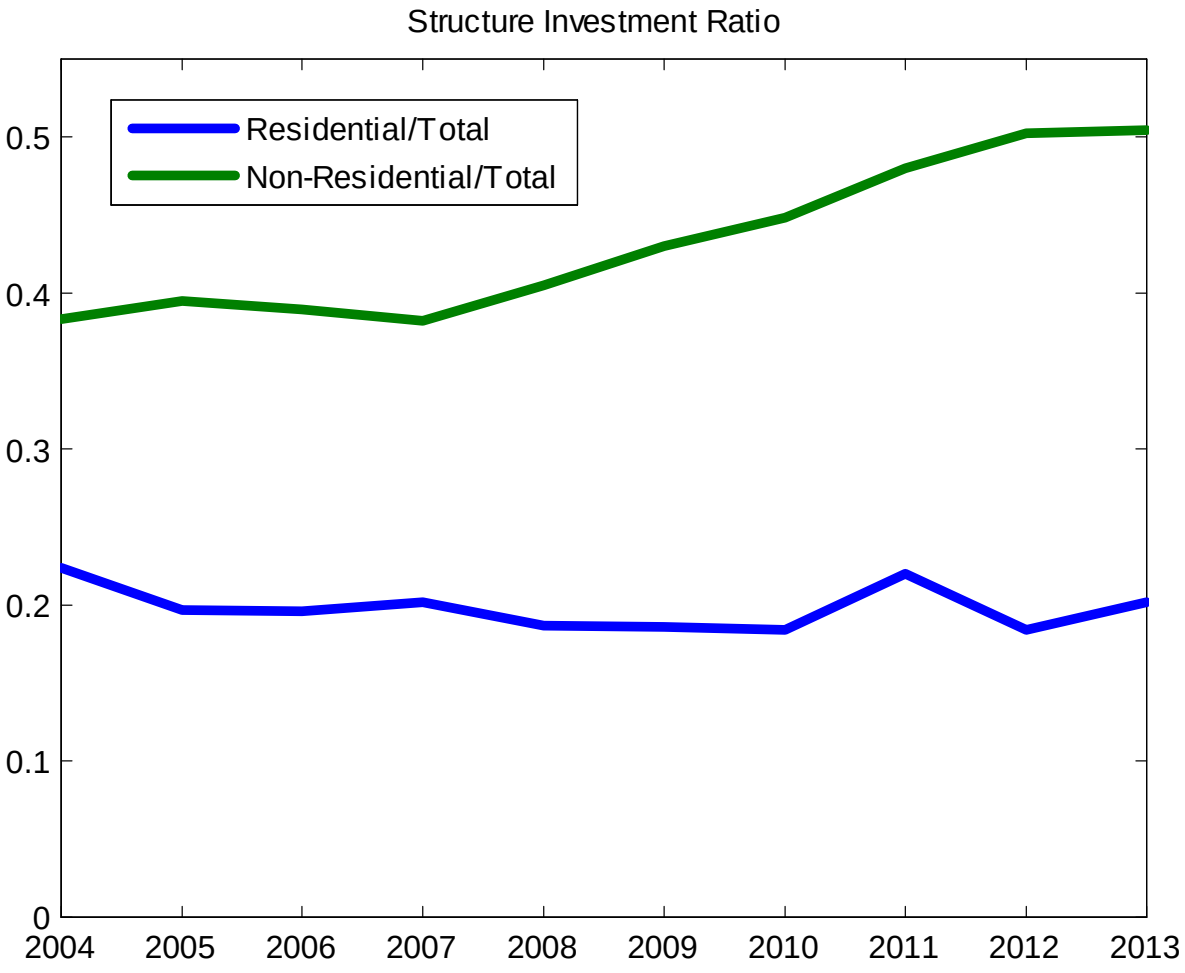
- What does it say about the structure of the economy?

# Our Explanation

# Fact: Structure of Investment




Source: National Bureau of Statistics

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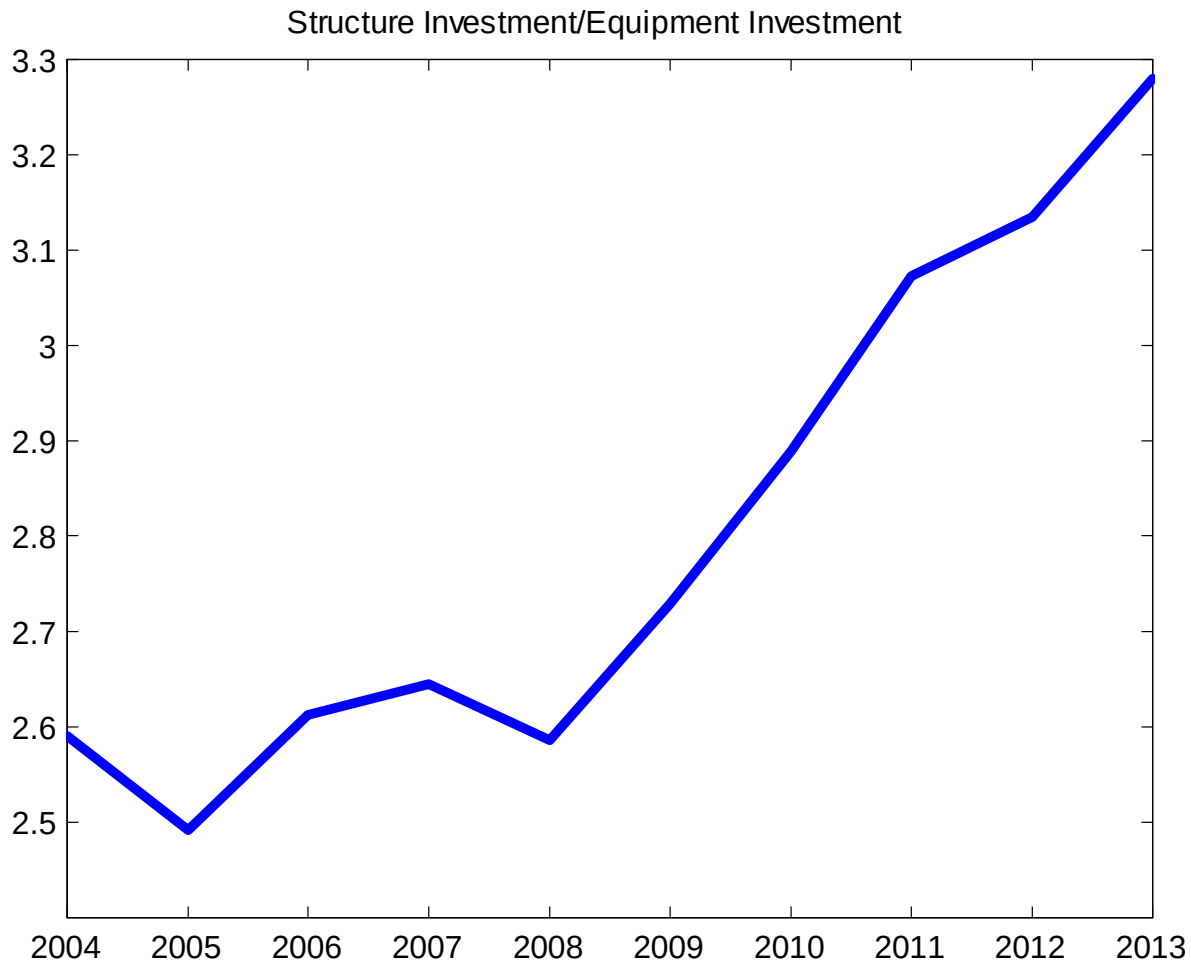
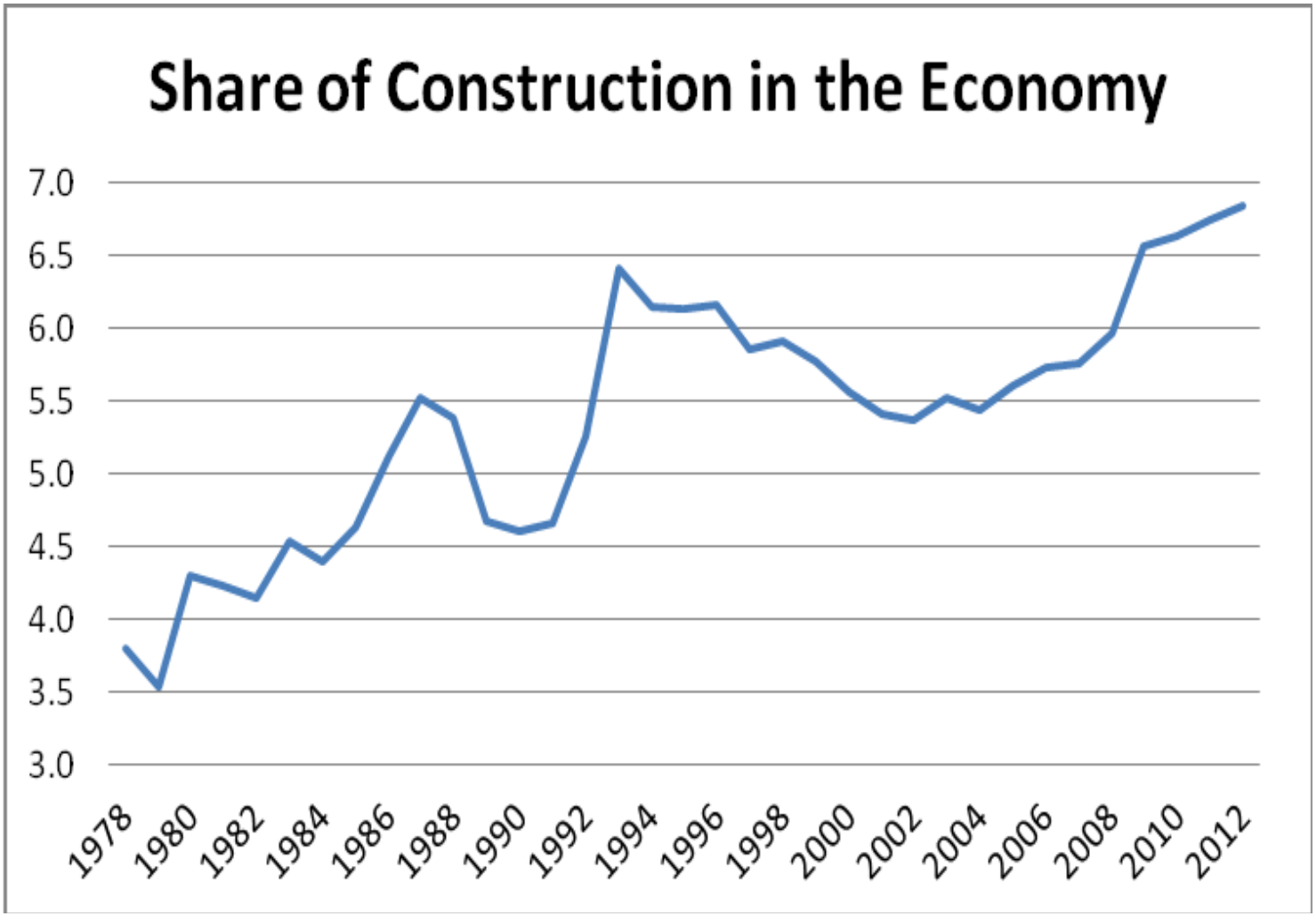



Source: China Statistical Yearbook

# Fact: Share of Construction in the Economy

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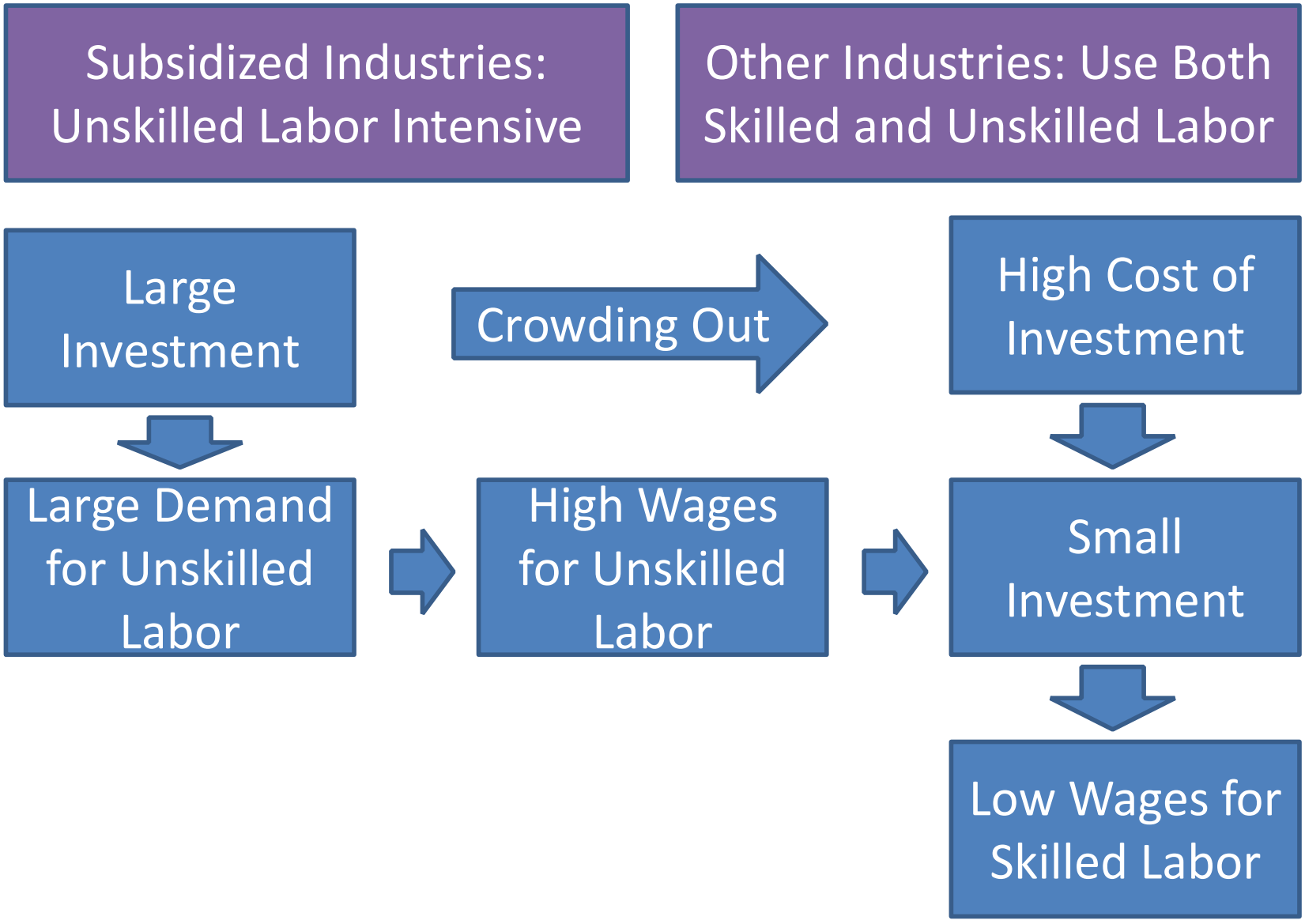
# A Simple Model



# The Model

# Model Environment

- Infinite horizon, representative household
- 2 sectors and 3 production factors
  - Infrastructure sector: unskilled labor and capital, unskilled labor intensive.
  - General good sector: skilled, unskilled labor and capital.
- Competitive banking provides loan for capital accumulation.
- Capital market is distorted:
  - infrastructure sector can rent the capital at a lower rate than the market loan rate
- Labor are freely mobile across the sectors

# Household

- A representative household faces the following problem:

$$\max_{c_t, l_t, s_t, a_{t+1}} \sum_{t=0}^{\infty} \beta^t U(c_t)$$

$$\text{s.t. } c_t + a_{t+1} = w_{Lt} l_t + w_{St} s_t + (1 + r_{dt}) a_t.$$

- Euler equation:

$$\frac{U'(c_t)}{U'(c_{t+1})} = \beta (1 + r_{dt+1});$$

# Production - Infrastructure Sector

- The firm uses unskilled labor $L_{It}$ and capital $K_{It}$ to produce infrastructure good $Y_{It}$

$$Y_{It} = e^{z_{It}} A_I \left(K_{It}\right)^{1-\alpha_I} \left(L_{It}\right)^{\alpha_I};$$

- Given factor prices $\{w_{Lt}, r_{St}, p_{It}\}$, the equilibrium conditions:

$$w_{Lt} = \alpha_I p_{It} e^{z_{It}} A_{It} \left(\frac{K_{It}}{L_{It}}\right)^{1-\alpha_I};$$

$$r_{St} = \left(1-\alpha_I\right) p_{It} e^{z_{It}} A_{It} \left(\frac{K_{It}}{L_{It}}\right)^{-\alpha_I};$$

  - **note that** $r_{st}$ is the government-regulated rate

# Production - General Good Sector

- In addition to $K_{Ct}$&$L_{Ct}$, the general good producer also need $S_{Ct}$ for production

$$Y_{Ct} = e^{z_{Ct}} A_C \left(K_{Ct}\right)^{1-\alpha_C-\beta_C} \left(S_{Ct}\right)^{\beta_C} \left(L_{Ct}\right)^{\alpha_C};$$

  - note that $\alpha_C < \alpha_I$.

- Given factor prices $\{w_{Lt}, w_{St}, r_{Lt}, p_{Ct}\}$, following conditions have to be satisfied in an equilibrium:

$$w_{Lt} = \alpha_C p_{Ct} e^{z_{Ct}} A_{Ct} \left(\frac{K_{Ct}}{L_{Ct}}\right)^{1-\alpha_C} \left(\frac{K_{Ct}}{S_{Ct}}\right)^{-\beta_C};$$

$$w_{St} = \beta_C p_{Ct} e^{z_{Ct}} A_{Ct} \left(\frac{K_{Ct}}{L_{Ct}}\right)^{-\alpha_C} \left(\frac{K_{Ct}}{S_{Ct}}\right)^{1-\beta_C};$$

$$r_{Lt} = \left(1-\alpha_C-\beta_C\right) p_{Ct} e^{z_{Ct}} A_{Ct} \left(\frac{K_{Ct}}{L_{Ct}}\right)^{-\alpha_C} \left(\frac{K_{Ct}}{S_{Ct}}\right)^{-\beta_C};$$

  - note that $r_{Lt}$ is the market rate

# Production - Final Good Producer

- The final goods are produced using infrastructure good and general good:

$$Y_t = \left( \varphi \left( Y_{It} \right)^{\frac{\sigma-1}{\sigma}} + \left( Y_{Ct} \right)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}};$$

- The price of final good is used as the numeraire, and the standard price aggregation holds:

$$\left[ \varphi^{\sigma} \left( p_I \right)^{1-\sigma} + \left( p_C \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} = 1;$$

- Equilibrium condition:

$$\frac{Y_I}{Y_C} = \left( \varphi \frac{p_C}{p_I} \right)^{\sigma}.$$

# Banking Sector

- There exists a representative bank in the economy
- The bank absorbs the deposit at the rate, $r_{dt}$, convert it into capital goods, and then rent the capital to firms in both infrastructure sector and general good sector
  - rental rate for infrastructure sector, $r_{St}$
  - rental rate for general good sector, $r_{Lt}$
- Competitive banking requires:

$$(1 + r_{dt})\, a_t = (1 - \delta + r_s)\, K_{It} + (1 - \delta + r_l)\, K_{Ct}$$

where

$$r_{Lt} \geqslant r_{dt} \geqslant r_{St}.$$

  - Note that the investment in infrastructure sector is implicitly subsidized by the govn.

# Equilibrium

Given initial labor and capital endowment, $L_{t_0}, S_{t_0}$, and $K_{t_0}$, a set of exogenous rental rate, and sectorial *TFP* $\{r_{st}, A_{It}, A_{Ct}\}_{t \geq t_0}$. A *competitive equilibrium* consists of:

- Sequences of good prices and factor prices, $\{p_{It}, p_{Ct}, w_{Lt}, w_{St}, r_{dt}, r_{lt}\}_{t \geq t_0}$;
- Firms allocations, $\{K_{It}, K_{Ct}, L_{It}, L_{Ct}\}_{t \geq t_0}$;
- Household allocations, $\{c_t, a_{t+1}\}_{t \geq t_0}$;

such that:

- Given the sequence of prices, the firm allocation solves $(FP)$;
- Given the sequence of prices, the household allocation solves $(HP)$;
- Market clears:
  - Capital allocation across sectors: $K_{It} + K_{Ct} = K_t$;
  - Unskilled-labor allocation across sectors: $L_{It} + L_{Ct} = L_t$;
  - Goods market: $C_t + I_t = Y_t$
  - Capital accumulation: $K_{t+1} = I_t + (1 - \delta) K_t$
- Competitive banking:

$$(1 + r_{dt}) a_t = (1 - \delta + r_{St}) K_{It} + (1 - \delta + r_{lt}) K_{Ct}.$$

# Variables and Equilibrium Conditions

- The equilibrium is characterized by 16 variables and equations
  - prices and factor prices: $\{p_{It}, p_{Ct}, w_{Lt}, w_{St}, r_{dt}, r_{It}\}$;
  - factor allocations across sectors:$\{K_{It}, K_{Ct}, L_{It}, L_{Ct}, Y_{It}, Y_{Ct}, Y_t\}$;
  - consumption and saving: $\{C_t, I_t, A_{t+1}\}$
- Note that:
  - the first two set of variables are static in the sense that they are functions of $K_t$
  - $\{C_t\}$ involve dynamics and is a function of $K_t \& K_{t+1}$
- The transition path is characterized by:

$$\frac{U'\left[c_t\left(K_t, K_{t+1}\right)\right]}{U'\left[c_{t+1}\left(K_{t+1}, K_{t+2}\right)\right]} = \beta\left[1 + r_{dt+1}\left(K_{t+1}\right)\right].$$

# Effects on Output and Factor Allocations

Suppose more subsidies to infrastructure sector, i.e., $r_{St} \downarrow$

## Theorem (1)

*In equilibrium, the factor allocations and sectoral output depend on $r_{St}$. When infrastructure sector receives more subsidies, i.e., facing a falling $r_{St}$, it attacts more capital and labor. As the results, the infrastructure sector expands, while the general good sector shrink. More formally, we have:*

*i)* $\frac{d\tilde{k}_{It}}{dr_{st}} = -\phi\left(1+\omega_{p_{It}}\right)\left[\left(1-\alpha_I\right)\sigma + \left(1-\alpha_C\right)\sigma\omega_{L_{It}} + \alpha_I + \alpha_C\omega_{L_{It}}\right] < 0;$

$\frac{d\tilde{k}_{Ct}}{dr_{st}} = -\omega_{K_{It}}\frac{d\tilde{k}_{It}}{dr_{st}} > 0;$

*ii)* $\frac{d\tilde{l}_{It}}{dr_{st}} = -\phi\left(1+\omega_{p_{It}}\right)(\sigma-1)\left[\left(1-\alpha_I\right) + \omega_{K_{It}}\left(1-\alpha_C-\beta_C\right)\right] < 0;$

$\frac{d\tilde{l}_{Ct}}{dr_{st}} = -\omega_{L_{It}}\frac{d\tilde{l}_{It}}{dr_{st}} > 0;$

*iii)* $\frac{d\tilde{y}_{It}}{dr_{st}} = \left(1-\alpha_I\right)\frac{d\tilde{k}_{It}}{dr_{st}} + \alpha_I\frac{d\tilde{l}_{It}}{dr_{st}} < 0;$

$\frac{d\tilde{y}_{Ct}}{dr_{st}} = \left(1-\alpha_C-\beta_C\right)\frac{d\tilde{k}_{Ct}}{dr_{st}} + \alpha_C\frac{d\tilde{l}_{Ct}}{dr_{st}} > 0;$

$\frac{d\tilde{y}_t}{dr_{st}} = \omega_{Y_{It}}\frac{d\tilde{y}_{It}}{dr_{st}} + \left(1-\omega_{Y_{It}}\right)\frac{d\tilde{y}_{Ct}}{dr_{st}} < 0, \text{ if } \omega_{Y_{It}} > \bar{\omega}.$

# Effects on Factor Prices

Suppose more subsidies to infrastructure sector, i.e., $r_{St} \downarrow$

## Theorem (2)

*In equilibrium, the factor prices also depend on $r_{St}$. When facing a lower $r_{St}$, infrastructure sector crowds out capital for other sectors and dive up the market rental rate, $r_{It}$. Meanwhile, skilled premium in wage decreases. More formally, we have:*

*i)* $$\frac{d\tilde{r}_{It}}{dr_{st}} = \frac{d\tilde{p}_{Ct}}{dr_{st}} + \alpha_C \left( \frac{d\tilde{l}_{Ct}}{dr_{st}} - \frac{d\tilde{k}_{Ct}}{dr_{st}} \right) - \beta_C \frac{d\tilde{k}_{Ct}}{dr_{st}} < 0;$$

*ii)* $$\frac{d(w_{st}/w_{Lt})}{dr_{st}} = \phi\omega_{L_{It}} (1 + \omega_{p_{It}}) (\sigma - 1) [(1 - \alpha_I) + \omega_{K_{It}} (1 - \alpha_C - \beta_C)$$
$$> 0;$$

# Other Empirical Evidence

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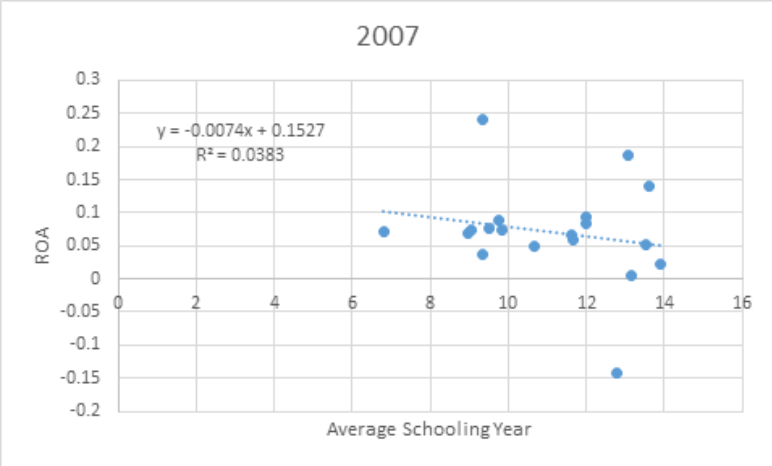
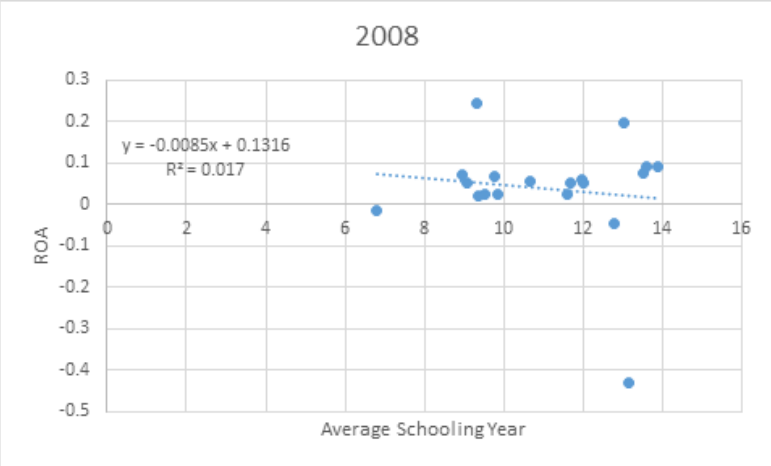
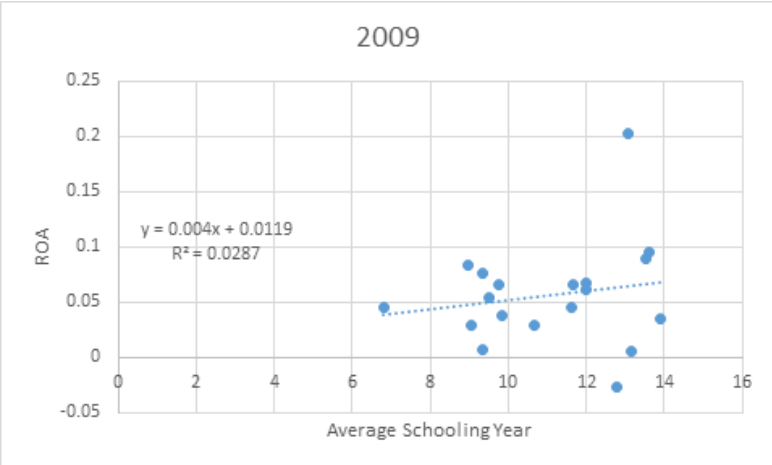
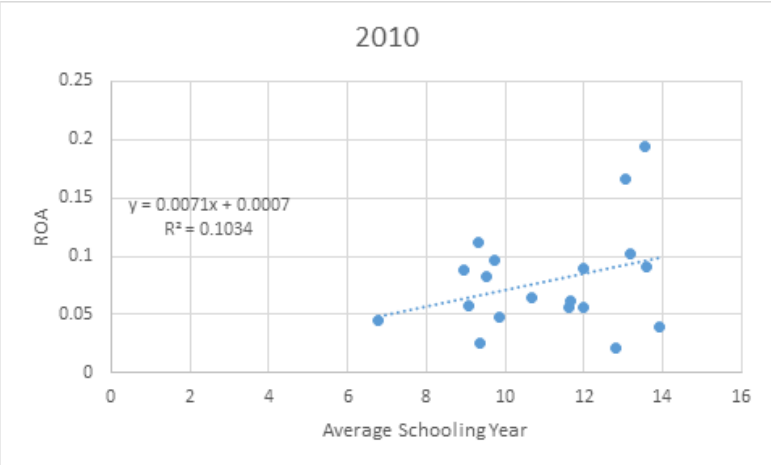
- The relationship between the rate of return to capital and the skill intensity
  - Our prediction: lower rate of return to capital in the unskilled-labor-intensive sectors

# Facts: Capital Return and Skill Intensity



# Supporting Facts: Firm Level Evidence

| Dependent variables | Return to Capital | |
|---|---|---|
| | (1) | (2) |
| ASY $_{t=2007}$ | 0.02827** | 0.02644** |
| | (0.00083) | (0.00084) |
| ASY $_{t=2008}$ | 0.01781** | 0.01849** |
| | (0.00074) | (0.00075) |
| ASY $_{t=2009}$ | **0.05318**** | **0.05457**** |
| | (0.00064) | (0.00064) |
| ASY $_{t=2010}$ | **0.06364**** | **0.06495**** |
| | (0.00061) | (0.00061) |
| ASY $_{t=2011}$ | 0.02814** | 0.02928** |
| | (0.00060) | (0.00060) |
| 2008.year | 0.07267** | 0.06357** |
| | (0.01125) | (0.01128) |
| 2009.year | -0.26042** | -0.27524** |
| | (0.01059) | (0.01062) |
| 2010.year | -0.32752** | -0.34029** |
| | (0.01045) | (0.01048) |
| 2011.year | -0.02996** | -0.03745** |
| | (0.01034) | (0.01037) |
| Market Concentration | 0.55035** | 0.55649** |
| | (0.02000) | (0.02005) |
| LOG(capital stock) | 0.05034** | 0.05109** |
| | (0.00016) | (0.00016) |
| Province Dummy | YES | YES |
| Cons | -0.71722** | -0.71897** |
| | (0.00859) | (0.00862) |
| $R^2$ | 0.07 | 0.07 |
| $N$ | 2,987,528 | 2,987,528 |

Note: * p<0.05; ** p<0.01

*Note*:***Significant at the 1 percent level.

# Other Empirical Evidence

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- The relationship between the rate of return to capital and the skill intensity
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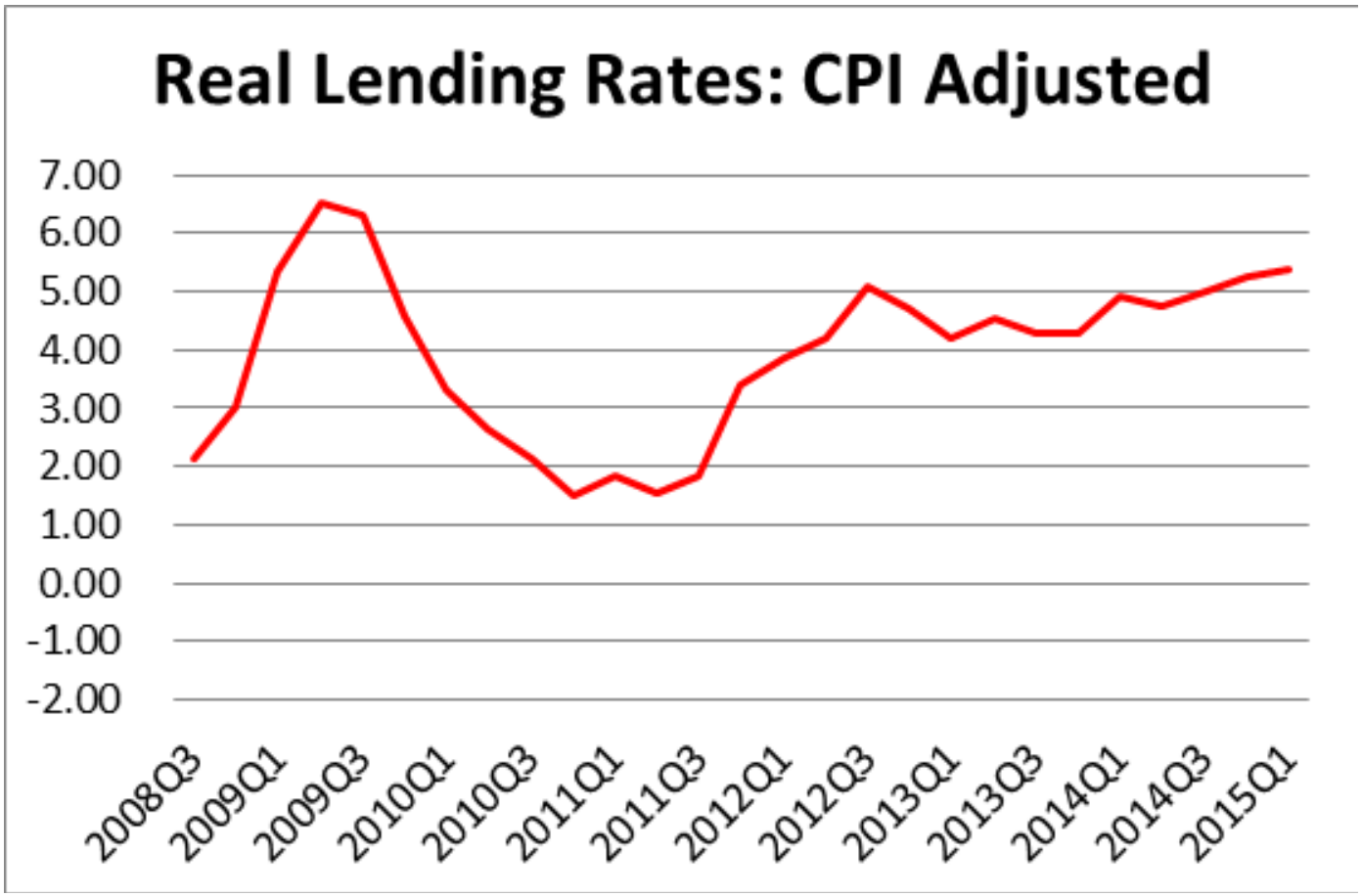
- Real market interest rate rises
  - Our prediction: more subsidies lead to higher real market interest (see Theroem 2)

$$\frac{d\tilde{r}_{lt}}{dr_{st}} < 0.$$

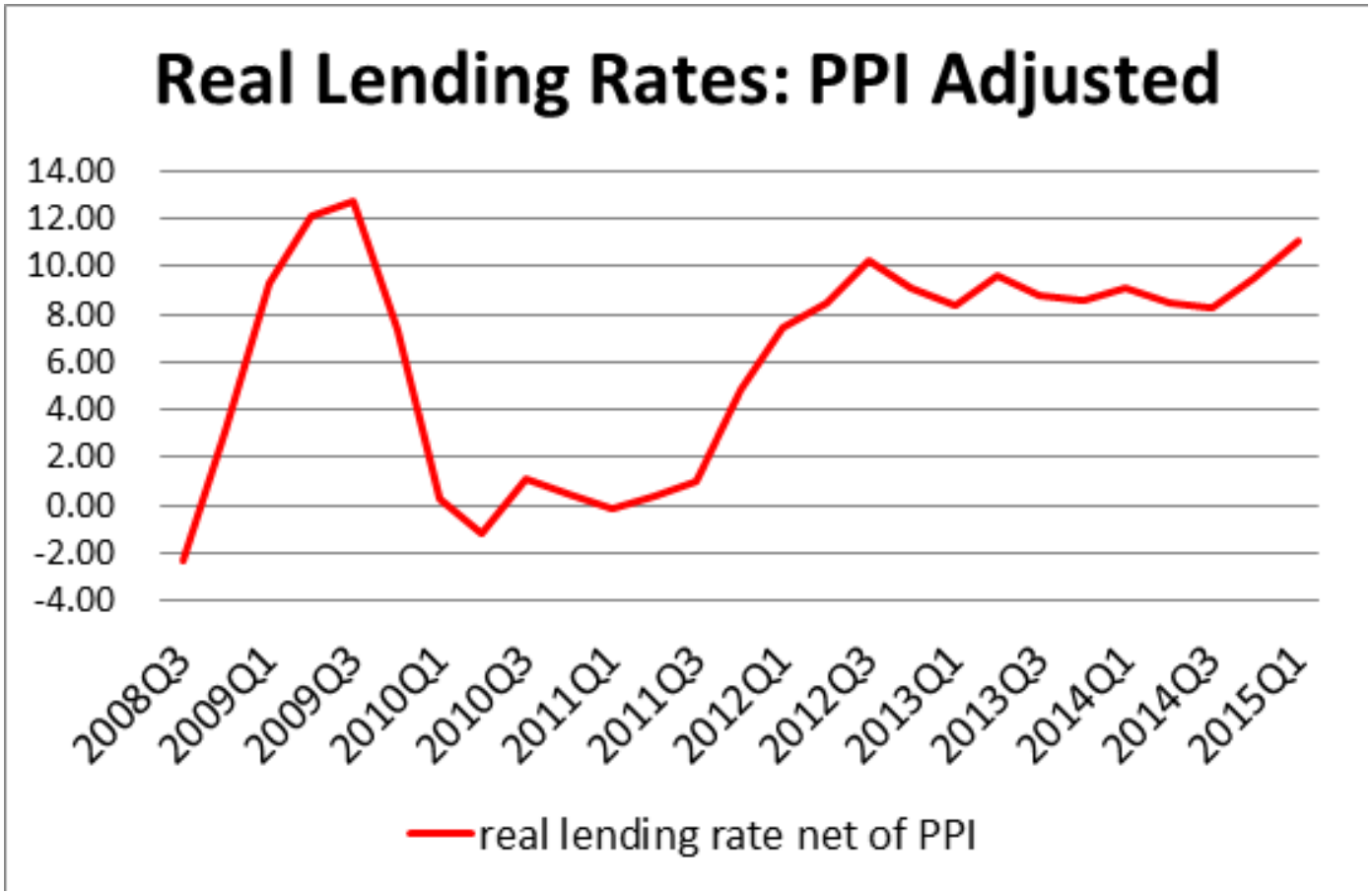
# Other Empirical Evidence: Real Lending Rates




Data Source: National Bureau of Statistics for CPI & PPI;

PBOC for lending rates

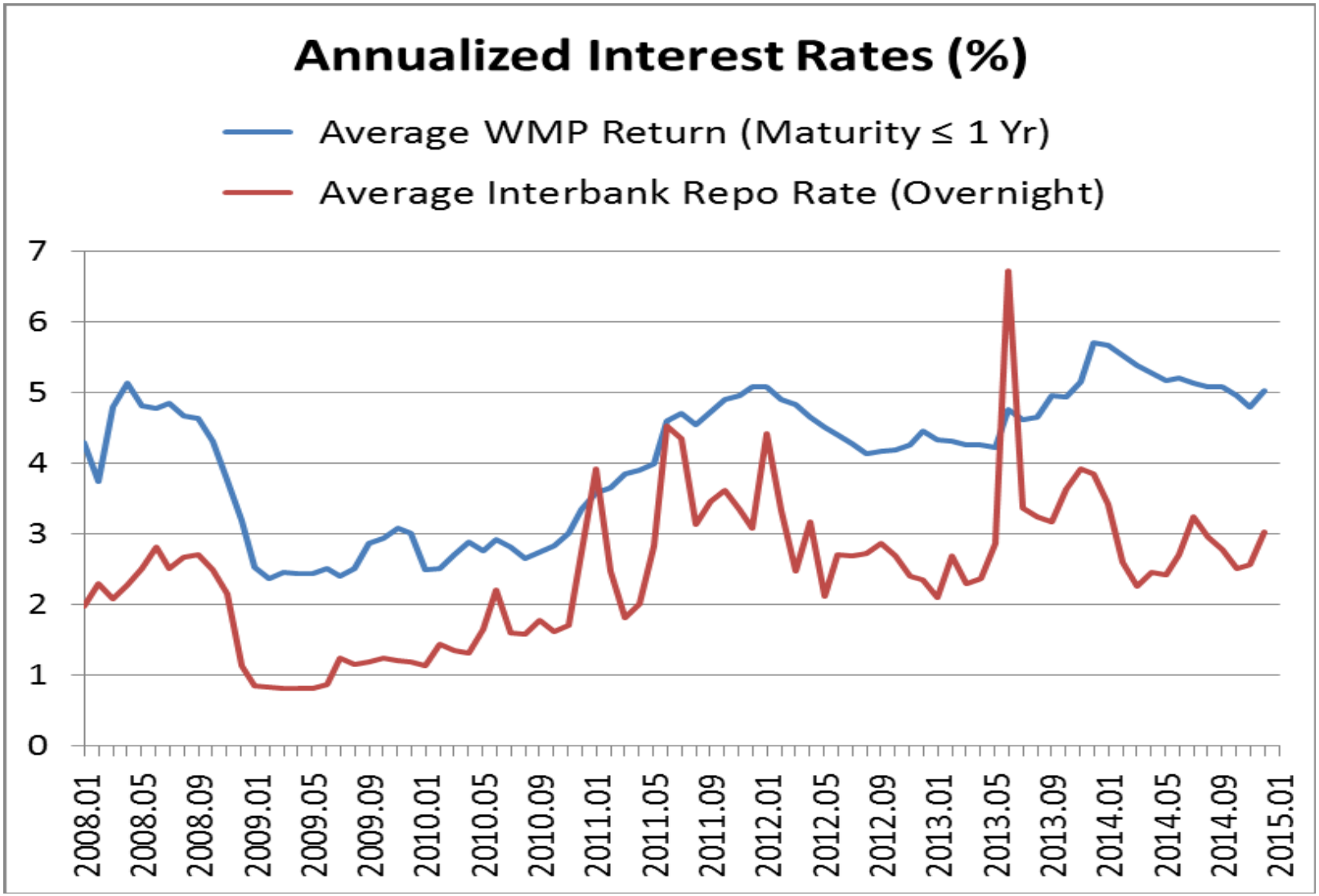
# Other Empirical Evidence: Real Lending Rates




Data Source: National Bureau of Statistics for CPI & PPI;

PBOC for lending rates

# Other Empirical Evidence: Other Interest Rates



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- The relationship between the rate of return to capital and the skill intensity
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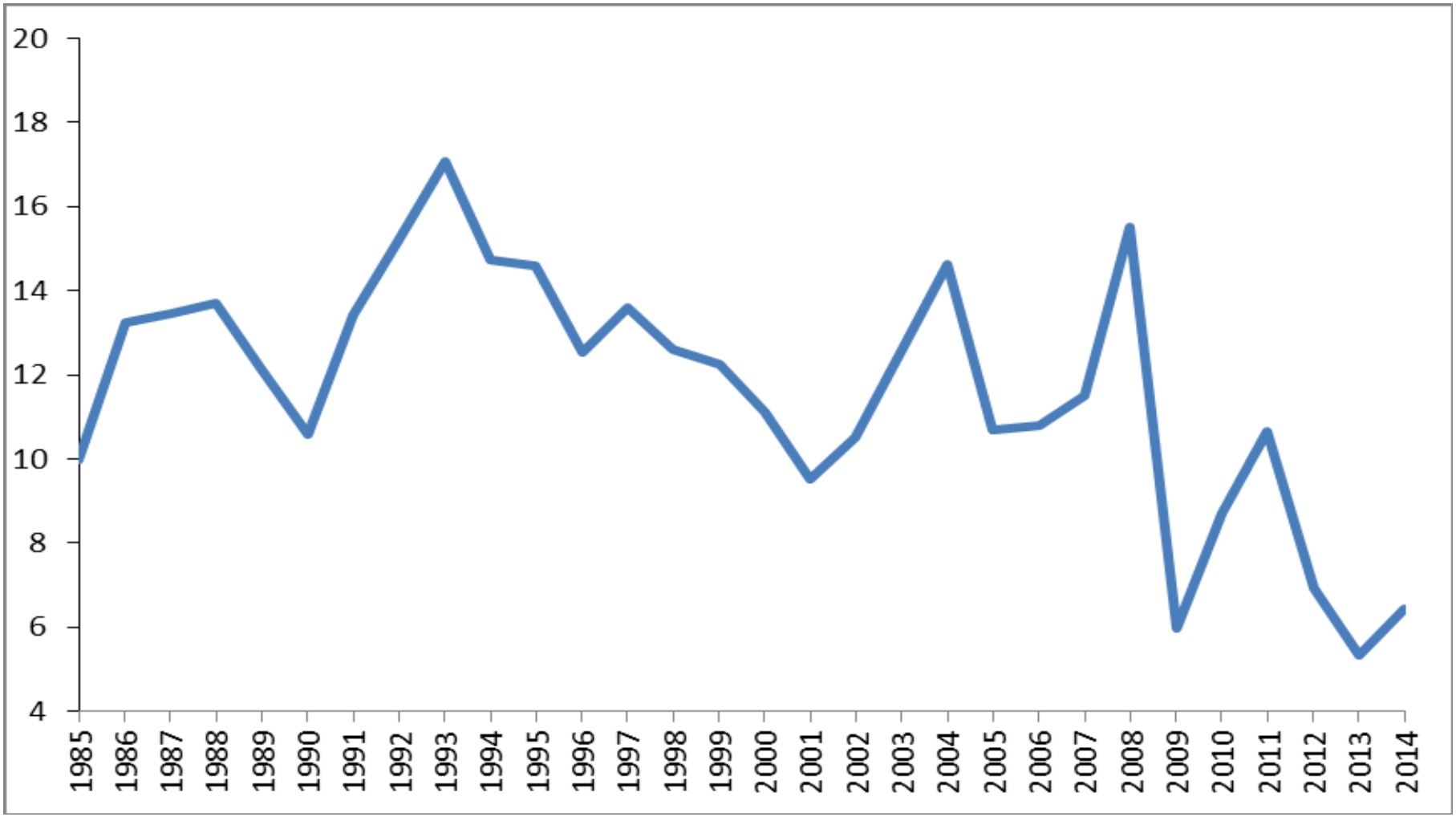
$$\frac{d\tilde{r}_{lt}}{dr_{st}} < 0.$$

- Average return to capital declines

# Rate of Return to Investment (after taxes and Depreciation)



# Alternative Explanations

# Relative Labor Supply Change

- The supply of skilled labor increases relative to that of the unskilled labor, reducing the skill premium in wages

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- Implications of this explanation
  - If this is the case, skilled-labor intensive sectors should expand faster than unskilled-labor intensive sector

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- The supply of skilled labor increases relative to that of the unskilled labor, reducing the skill premium in wages
- Implications of this explanation
  - If this is the case, skilled-labor intensive sectors should expand faster than unskilled-labor intensive sector
- Evidence: the relationship between the growth rate of value added and skill intensity

# Supporting Facts: Firm Level Evidence

| | Return to Capital | | **Value-Added Growth** |
|---|---|---|---|
| Dependent variables | (1) | (2) | (3) |
| ASY $_{t=2007}$ | 0.02827** | 0.02644** | -0.05432** |
| | (0.00083) | (0.00084) | (0.00825) |
| ASY $_{t=2008}$ | 0.01781** | 0.01849** | -0.00106* |
| | (0.00074) | (0.00075) | (0.00723) |
| ASY $_{t=2009}$ | **0.05318**** | **0.05457**** | **-0.10908**** |
| | (0.00064) | (0.00064) | (0.00649) |
| ASY $_{t=2010}$ | **0.06364**** | **0.06495**** | **-0.08818**** |
| | (0.00061) | (0.00061) | (0.00644) |
| ASY $_{t=2011}$ | 0.02814** | 0.02928** | |
| | (0.00060) | (0.00060) | |
| 2008.year | 0.07267** | 0.06357** | -0.54689** |
| | (0.01125) | (0.01128) | (0.10862) |
| 2009.year | -0.26042** | -0.27524** | 0.73753** |
| | (0.01059) | (0.01062) | (0.10400) |
| 2010.year | -0.32752** | -0.34029** | 0.46321** |
| | (0.01045) | (0.01048) | (0.10358) |
| 2011.year | -0.02996** | -0.03745** | |
| | (0.01034) | (0.01037) | |
| Market Concentration | 0.55035** | 0.55649** | 0.03923 |
| | (0.02000) | (0.02005) | (0.21718) |
| LOG(capital stock) | 0.05034** | 0.05109** | 0.02420** |
| | (0.00016) | (0.00016) | (0.00181) |
| Province Dummy | YES | YES | YES |
| Cons | -0.71722** | -0.71897** | 0.79498** |
| | (0.00859) | (0.00862) | (0.08440) |
| $R^2$ | 0.07 | 0.07 | 0.01 |
| $N$ | 2,987,528 | 2,987,528 | 715,284 |

Note: * p<0.05; ** p<0.01

# Relative Productivity Change

- If the productivity of skilled-labor intensive sectors increases slower than that of the unskilled-labor intensive sectors, than the skill premium in wages would decline

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# Relative Productivity Change

- If the productivity of skilled-labor intensive sectors increases slower than that of the unskilled-labor intensive sectors, than the skill premium in wages would decline
- If this is the case, than the rate of return to capital in the skilled-labor intensive sectors should not be higher than that in the unskilled-labor intensive sectors
- Our empirical finding is that skilled-labor intensive sectors generate higher rate of return to capital

# Relative Demand Change

- If the demand for skilled-labor intensive products declines relative to that for unskilled-labor intensive products, than the skill premium in wages would decline

# Relative Demand Change

- If the demand for skilled-labor intensive products declines relative to that for unskilled-labor intensive products, than the skill premium in wages would decline
- This case is similar to that of relative productivity change

# Implications

# Facts: Labor Cost Rose Faster than GDP