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JUNE 16, 2019 ASIAN MTG ECONOMETRIC SOCIETY

TECHNOLOGY, INEQUALITY, & AGGREGATE DEMAND

Motivation

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▸ **Technological Progress:** Efficiency **(+)** v.s. Inequality **(-)**

  ▸ Labor-Enabling v.s. Labor-Replacing (Acemoglu)

  ▸ Productivity/New task v.s. Displacement (Acemoglu-Restrepo)

  ▸ Routine-Biased Technological Change (RBTC) and Polarization: (Autor-Dorn 2013, Barany-Siegel 2018)

  ▸ Technology and expanding income inequality

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▸ **Question: How technological progress, if biased, impacts**

    ▸ labor market

    ▸ aggregate demand

    ▸ economic growth

Fact 1: Routine Biased Tech. Change and Polarization

	Low skill service	Manufacturing	High skill service
Wage 1980	Low	Middle	High
Routineness	Low	**High**	Low

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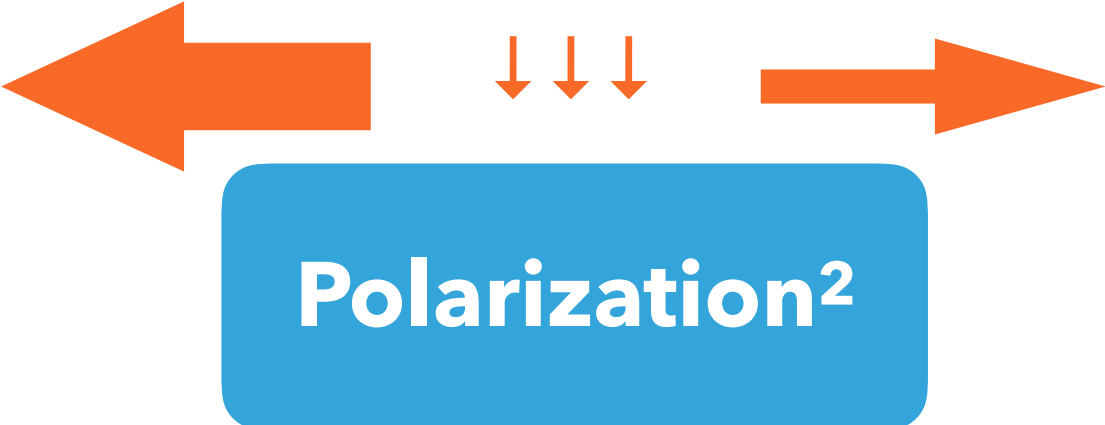
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RBTC[1]	↑	↑↑↑	↑
Wage	↑↑	↑	↑↑
Emp. Share	↑↑	↓↓↓	↑

Polarization[2]

Fact 2: Secular, declining trend in interest rate

US Natural Rate of Interest,
% Laubach and Williams estimates
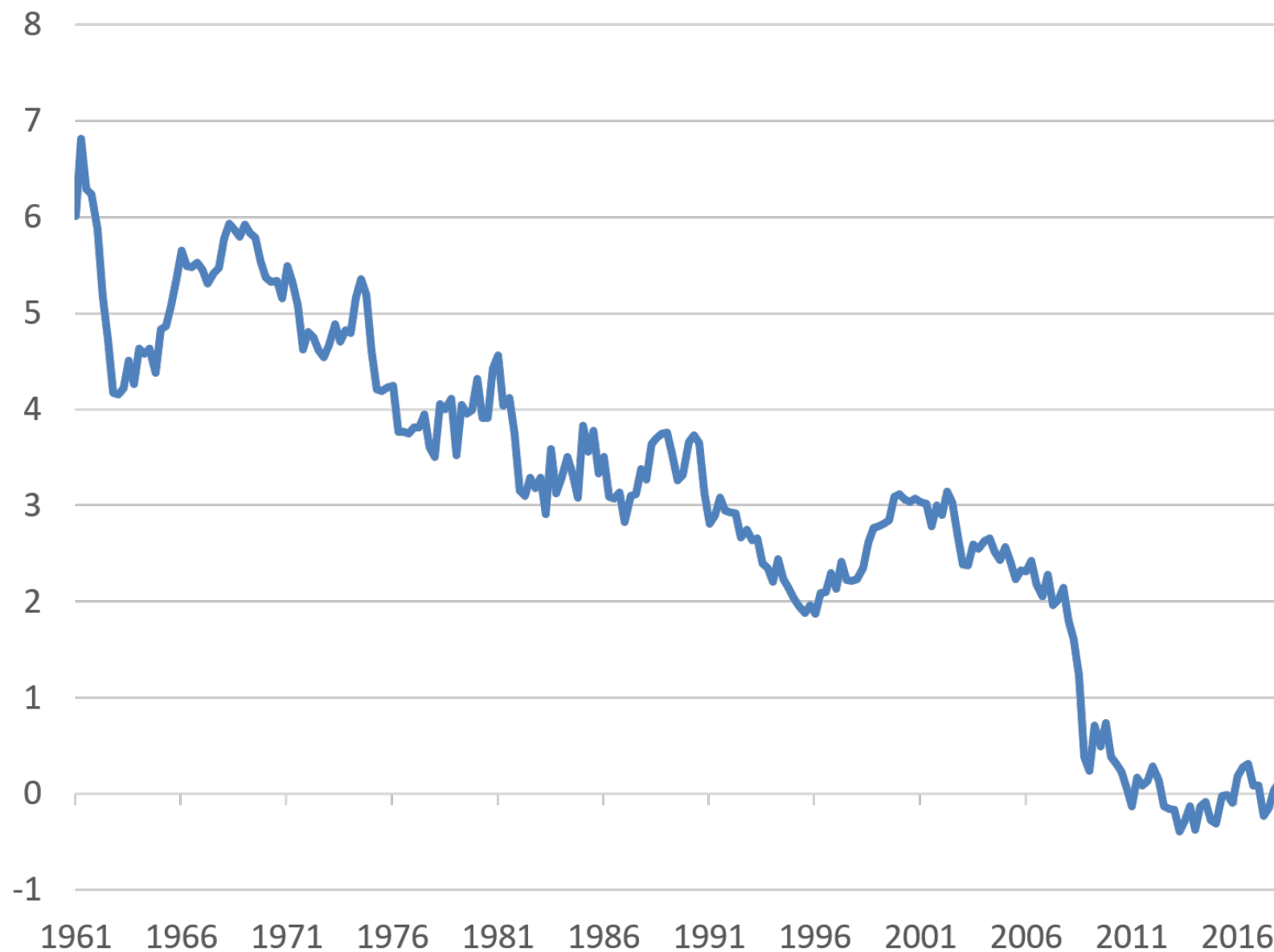
Potential causes:

▸ Capital Demand ↓

   ▸ TFP growth ↓

   ▸ Population growth ↓

   ▸ Capital good price ↓

▸ Asset Demand ↑

   ▸ Aging

   ▸ **Inequality ↑ (?)**

- Summer 2015,
Eggertsson et al 2018

What/how **I** do in this paper

What

▸ Examine impact of **Routine Biased Technological Change** on

  ▸ **labor market** - polarization, inequality

  ▸ **interest rate** - aggregate demand

How

▸ Quantitative model to account for these facts:

  ▸ OLG with skill heterogeneity and non-homothetic bequest motive (Benhabib-Bisin-Luo 2019 + Straub 2018) **- The rich save more**

  ▸ 3-sectors, Occupational choice (Barany-Siegel 2018)

▸ Calibrate to the US economy from 1980 to 2010

Preview of the result

1. How does RBTC impact labor market?

   ▶ **RBTC leads to Job/Wage polarization** - consistent with previous literature

2. What are the macro implications for interest rate and economic growth?

   ▶ **RBTC/Polarization accounts for more than half of the decline in interest rate**

   ▶ It can suppress growth under ZLB (WIP, not covered today)

Related Literature (can skip)

‣ **Tech Impacts on Labor Market (Automation, Polarization)**

  ▸ **Theory:** Zeira (1998), Acemoglu-Restrepo (2017,18,19…)

  ▸ **Empirics: Autor-Dorn (2013),** Goos et al (2014)

  ▸ **Quantitative:** Buera-Kaboski (2012), **Barany-Siegel (2018)**…

‣ **Evolution of Inequality:**

  ▸ Kaymak-Poschke (2016), **Benhabib et al (2019)**

‣ **Inequality and Aggregate Demand:**

  ▸ De Nardi (2004), Saez-Zucman (2014), **Straub (2018), Auclert-Rognile (2018)**

‣ **Secular Stagnation (Decline in Interest Rate):**

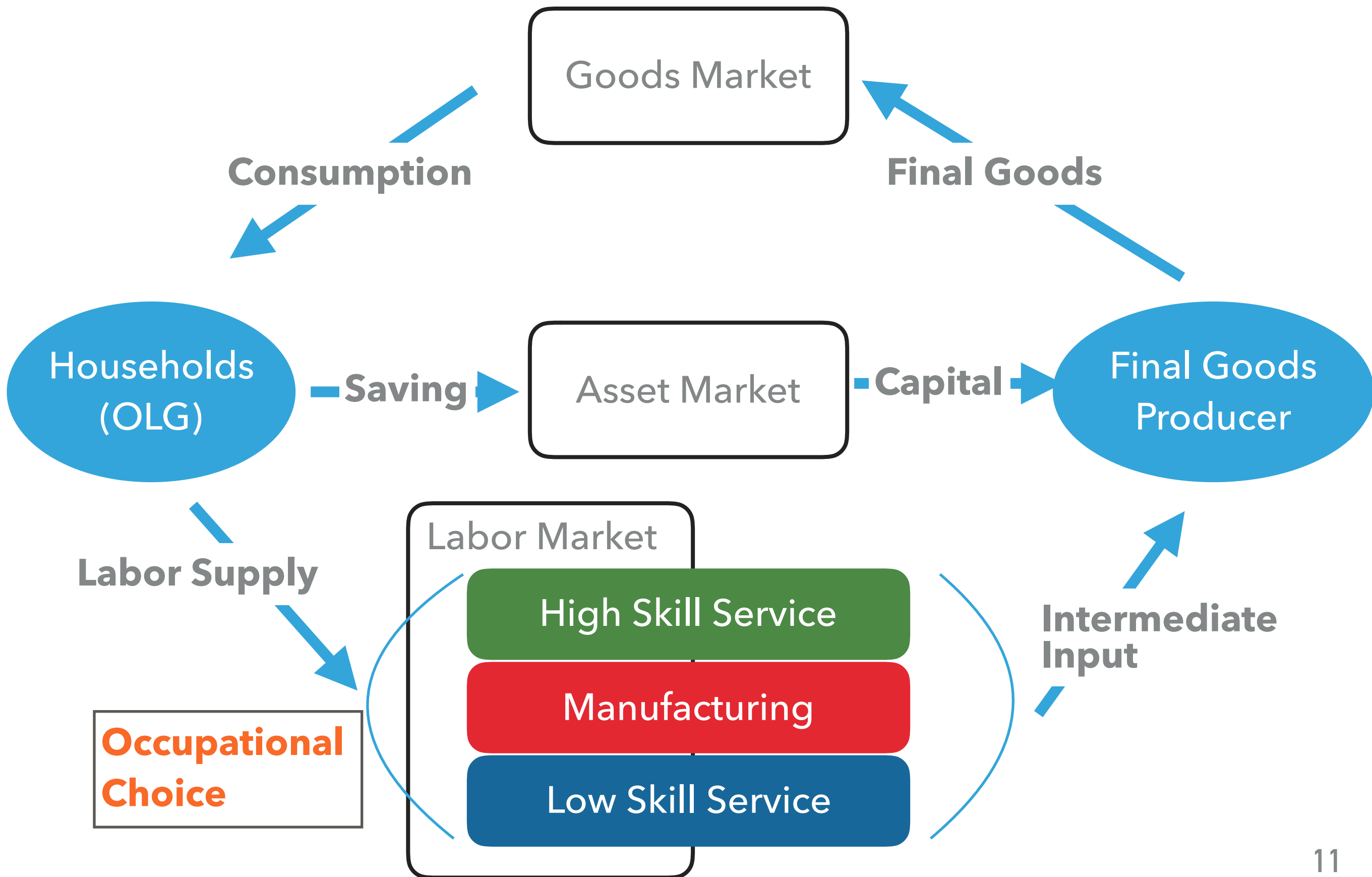 ▸ Summers (2014, 2015), Eggertsson et al (2018)

1. General Framework

2. Results (Theoretical/Quantitative)

3. Conclusion

4. Appendix + Empirical Follow-ups

GENERAL FRAMEWORK

Model Overview
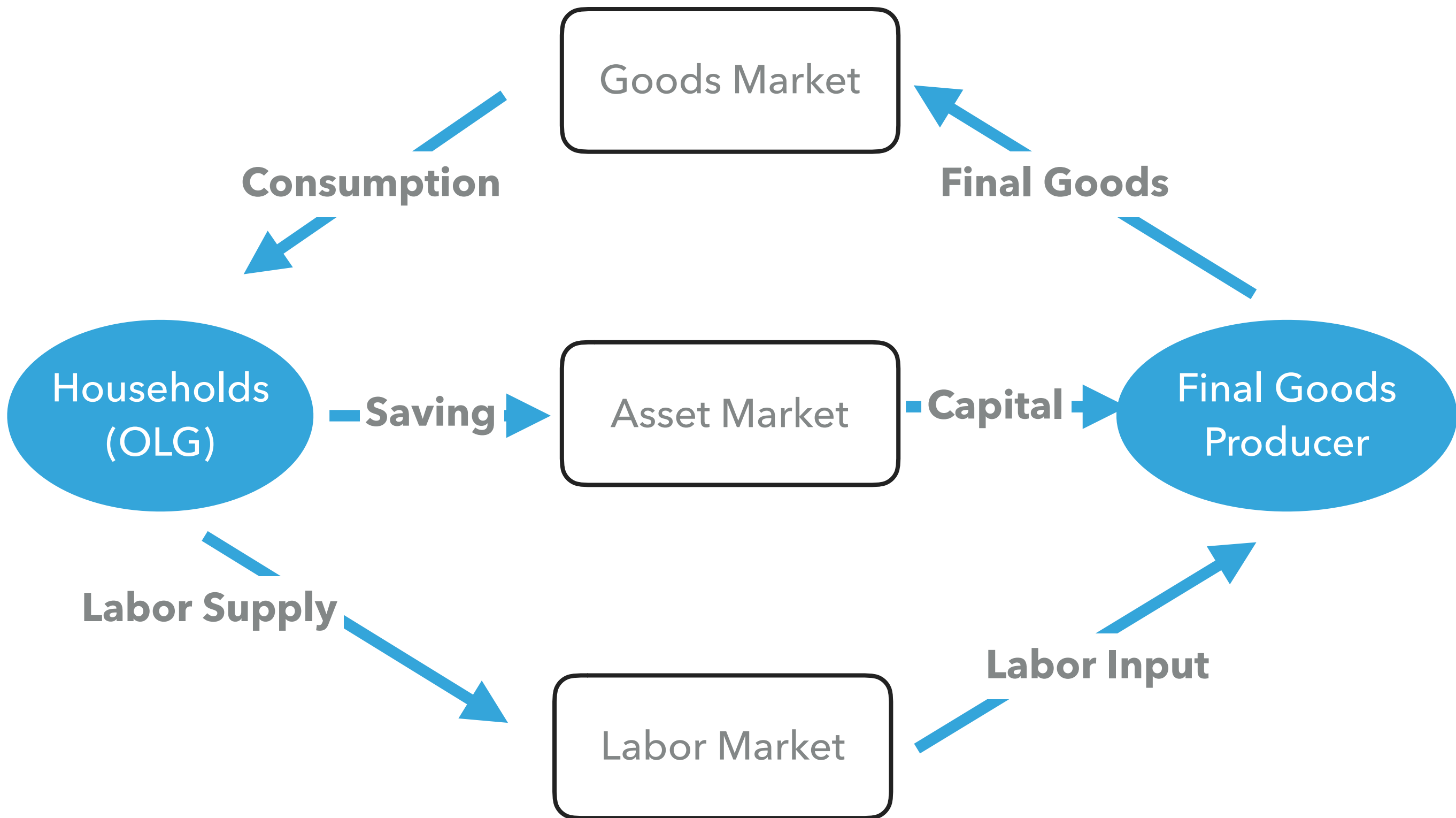
Model Overview

Production

▸ Barany-Siegel 2018 + capital

▸ Final Good Producer $\qquad Y = K^{\alpha} X^{1-\alpha}$

▸ Each Sector $\ j = h, m, l \qquad y_j = A_j N_j$

▸ Aggregation

$$X = \left(y_h^{\frac{\epsilon-1}{\epsilon}} + y_m^{\frac{\epsilon-1}{\epsilon}} + y_l^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon-1}}$$

- ϵ **:** Elasticity of Substitution between factors (sectors)

  $\epsilon < 1$ **:** **Sectors are compliment**

- Labor Demand Function is derived

Household

▸ Benhabib et al 2019 + Straub 2018 + Occupational choice

▸ OLG with Deterministic Life-time with Roy

▸ Heterogeneous in age and skill endowment $(s_{i,h}, s_{i,m}, s_{i,l})$

▸ Households do

  ▸ Choose the best occupation given their skill endowment

  ▸ Receive labor/capital income

  ▸ Consume and Save

  ▸ Leave bequest to their children (warm-glow)

Household: Recursive Problem

▸ Recursive Problem at the age of t

$$V_t(a) = \max_{c,a'} u(c) + \beta V_{t+1}(a') \quad t = 1,...T-1$$

$$V_T(a) = \max_{c,a'} u(c) + e(a') \qquad t = T$$

$$s.t. \quad a' = (1+r)a - c + x$$

$$c \geq 0, \quad a' \geq 0$$

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Non-homothetic utility

$$u(c) = \frac{(c/z)^{1-\sigma} - 1}{1 - \sigma}$$

$$e(a) = \gamma \frac{(a/z)^{1-\Sigma} - 1}{1 - \Sigma}$$

$$\Sigma/\sigma \equiv \phi < 1$$

Bequest is luxury good, and the rich save more

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Stationary Equilibrium

▸ Household Optimization:
Life-time path of Consumption, Saving, and Bequest

▸ Firm Optimization:
Capital-Labor and Labor Allocation

▸ Market Clearing:

   ▸ Goods Market

   ▸ **Asset Market: - Asset Demand, Capital Supply (HH) =Capital Demand (Firm)**

   ▸ Labor Market: (Occupational Choice)

RBTC impact on Labor Market and Interest Rate

RESULT

Theoretical Result 1: RBTC leads to Polarization

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▸ Prop. 1: If goods for three sectors are complements, **rapid productivity growth in manufacturing** sector leads to Job/Wage Polarization

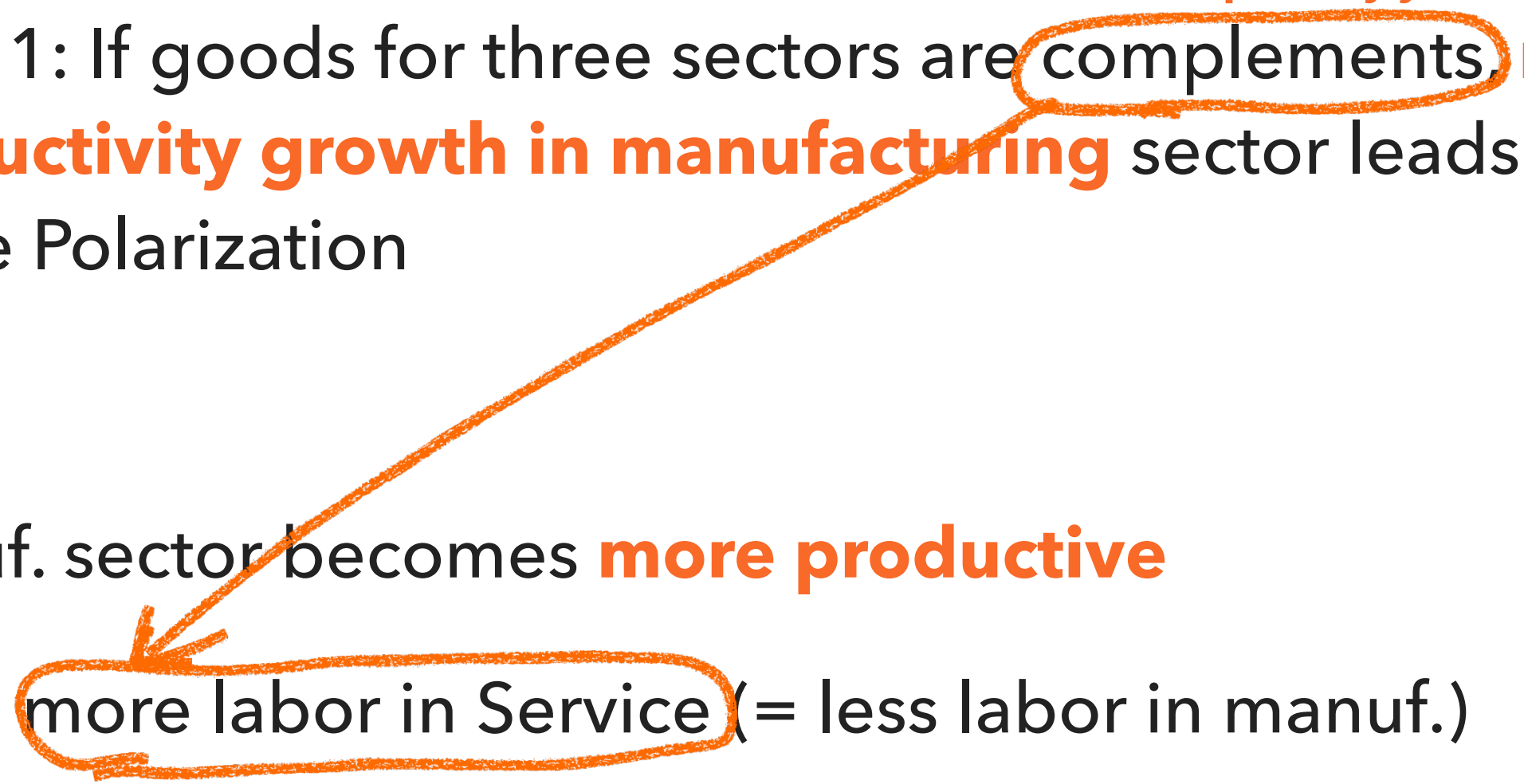# Theoretical Result 1: RBTC leads to Polarization

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Empirically yes

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▸ Need more labor in Service (= less labor in manuf.)

▸ Relative wage in service sector must increase

▸ Consistent with literature (Autor-Dorn 2013, Goos et al 2014, Barany-Siegel 2018...)

Theoretical Result 2: Higher Saving Rate for the Rich

▸ Prop. 2: If $\Sigma/\sigma \equiv \phi < 1$, **saving rate is increasing** function of income level (**MPC is decreasing** in income level)

MPC across income level
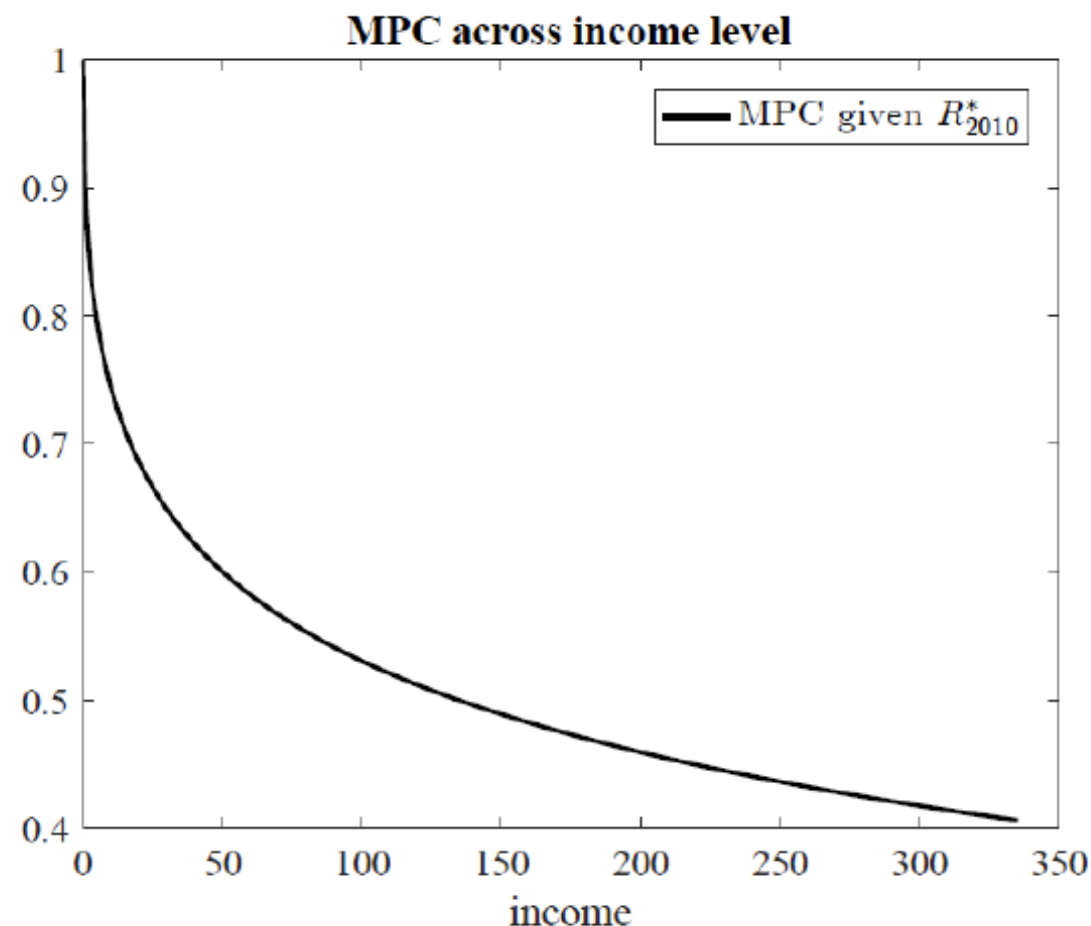
▸ Consistent with literature (Dynan et al 2004, Saez-Zucman 2016, Straub 2018, Benhabib et al 2019…)

Only Exogenous Path: **Biased Labor Productivity Growth**

Log Sectoral Productivities

- lnA_l
- lnA_m
- lnA_h
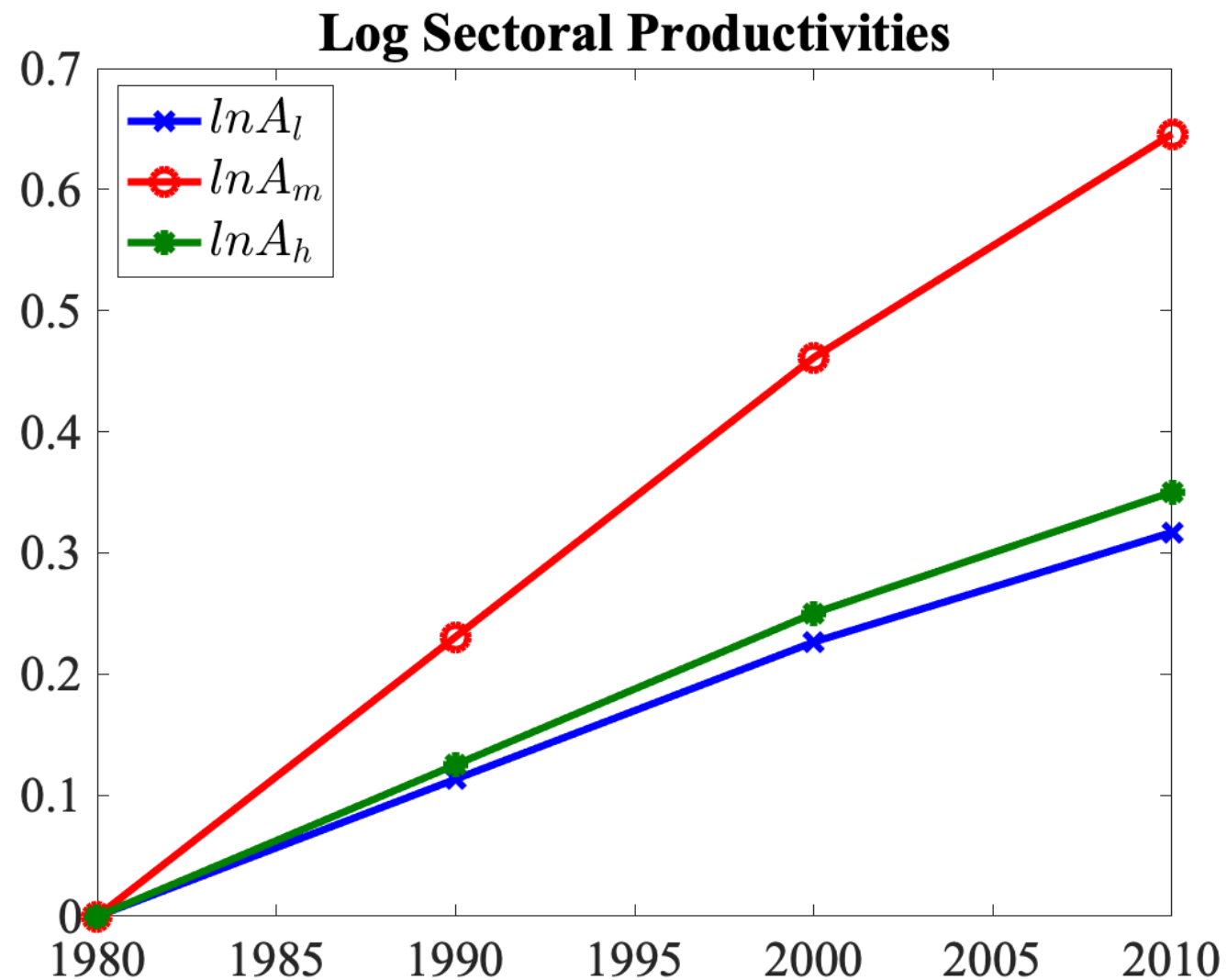
- ▸ Relative Wage
- ▸ Employment Share
- ▸ Interest Rate

Barany and Siegel 2018

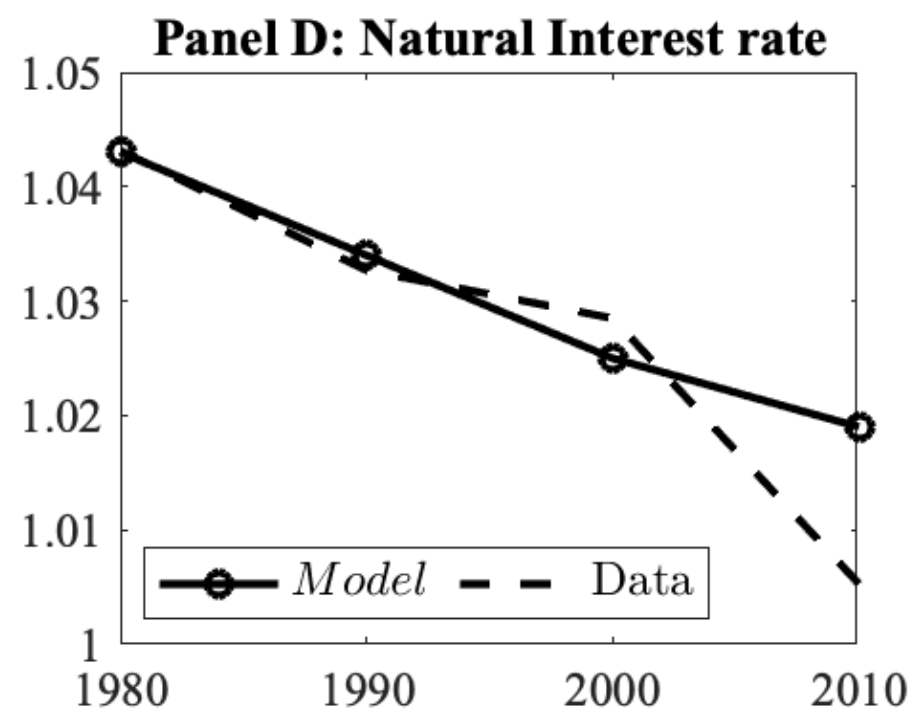>> Sector Definition
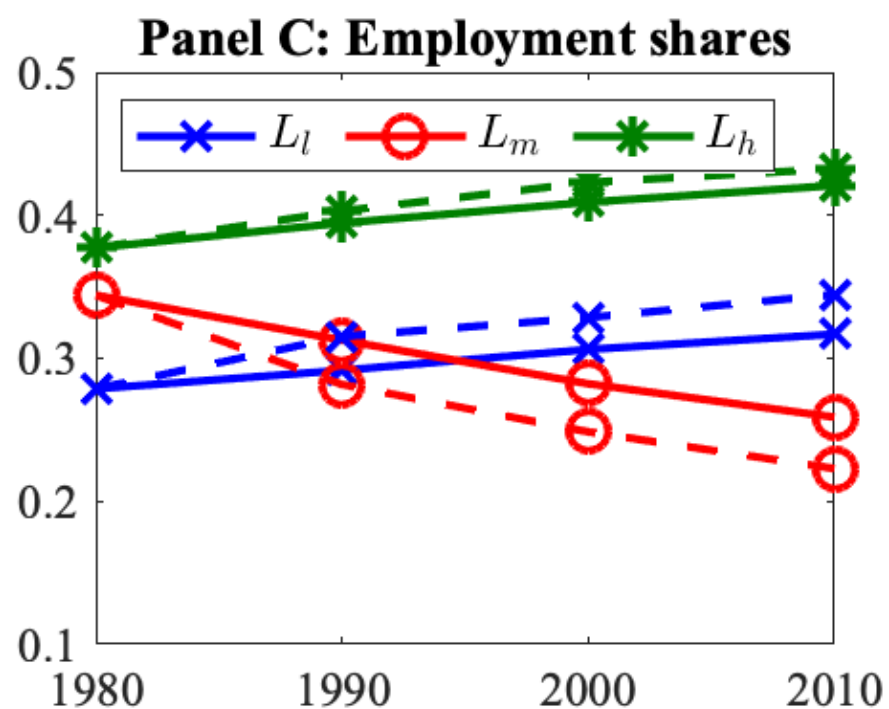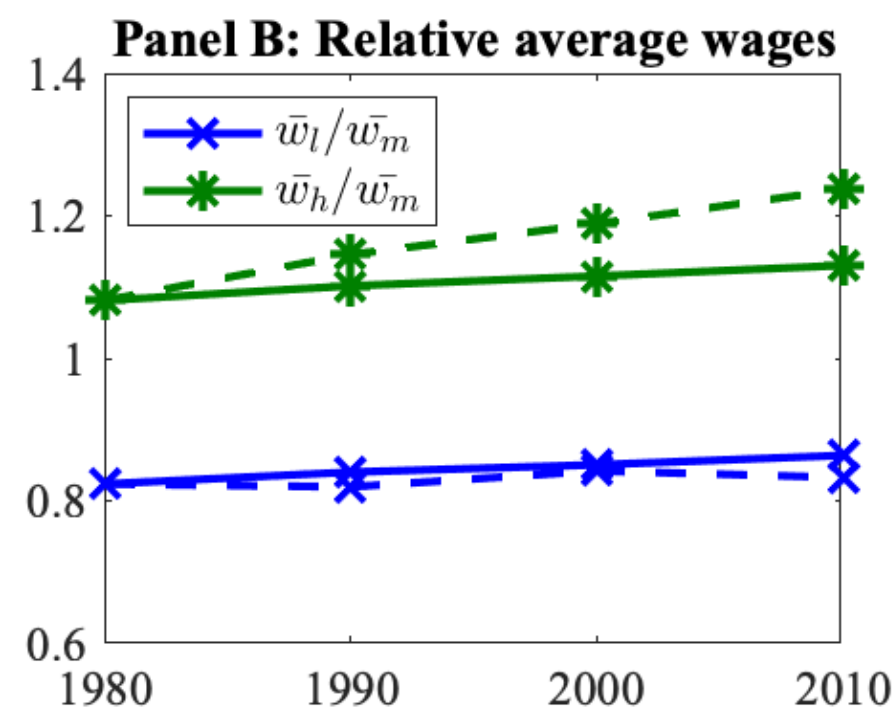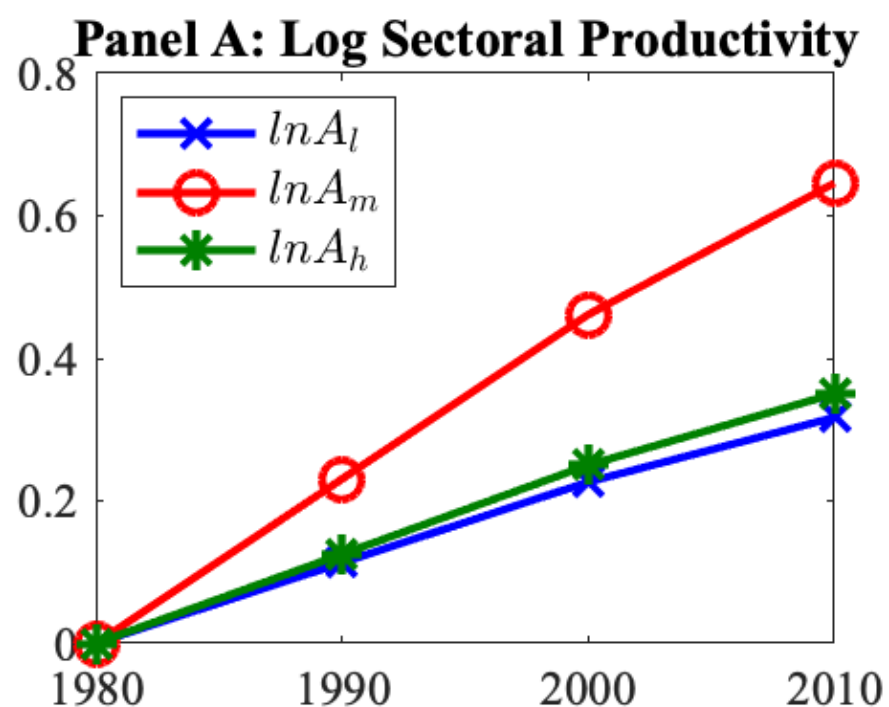
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Quantitative analysis: Parameter

▸ Target: Initial moments of labor market and interest rate

Table 2: Calibration for time-invariant parameters

Parameter	Description	Value	Source/Target
Production			
$f(a)$	Skill endowment distribution	log-normal	Bárány and Siegel (2018)
ϵ	CES between L, M, and H	0.002	Bárány and Siegel (2018)
α	Capital share	0.36	Standard. De Nardi (2004)
δ	Depreciation rate	0.06	Standard. De Nardi (2004)
Preference			
β	Discount rate	0.97	Benhabib et al. (2018)
σ	EIS for u	2	Benhabib et al. (2018)
Σ	EIS for e	0.6	Benhabib et al. (2018)
ϕ	Weight on Bequest Motive	0.006	Target $r_{1980} = 0.043$

1. Mean and Var-Cov matrix is calibrated to target the initial relative wage and employment share   2. Saez-Zucman 2016

Dotted: Data;   Solid: Model

Panel A: Log Sectoral Productivity
- lnA_l
- lnA_m
- lnA_h

Panel B: Relative average wages
- $\bar{w}_l/\bar{w}_m$
- $\bar{w}_h/\bar{w}_m$

Panel C: Employment shares
- L_l L_m L_h

Panel D: Natural Interest rate
- $Model$ Data

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Why Technological Progress lowers Interest Rate?

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Why?

Why Technological Progress lowers Interest Rate?

▸ Technological Progress

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Why?

if biased

▸ **Expanding Inequality**

▸ **Higher Asset Demand (=Capital Supply)**

Why Technological Progress lowers Interest Rate?

▸ Technological Progress

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▸ ~~Higher~~ Interest Rate

Why?

▸ **Lower** Interest Rate!

if biased

▸ **Expanding Inequality**

▸ **Higher Asset Demand (=Capital Supply)**

CONCLUSION

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⇒ plausibly account for the **US economy from 1980-2010**

Conclusion

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▸ Next…

  ▸ Impact on Economic growth

  ▸ More (empirically) Realistic Life-cycle Features (Demographics, Income profile, Age-specific EIS)

  ▸ Optimal Policy to Biased Tech Progress/Shock

APPENDIX

Log Sectoral Productivities

Legend:
- lnA_l (blue, ×)
- lnA_m (red, ○)
- lnA_h (green, ✱)
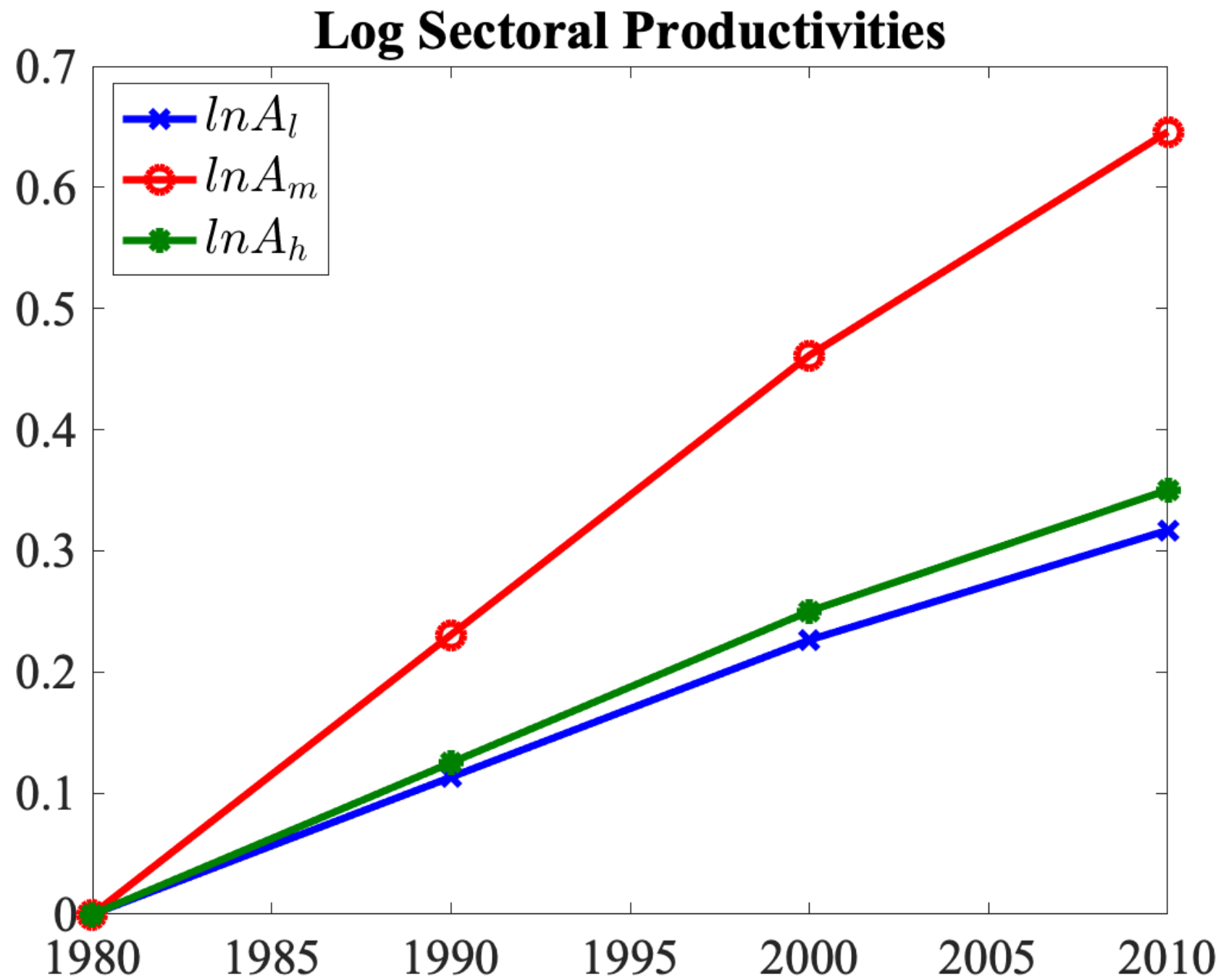
Fact: Labor market is polarized (Autor-Dorn 2013)

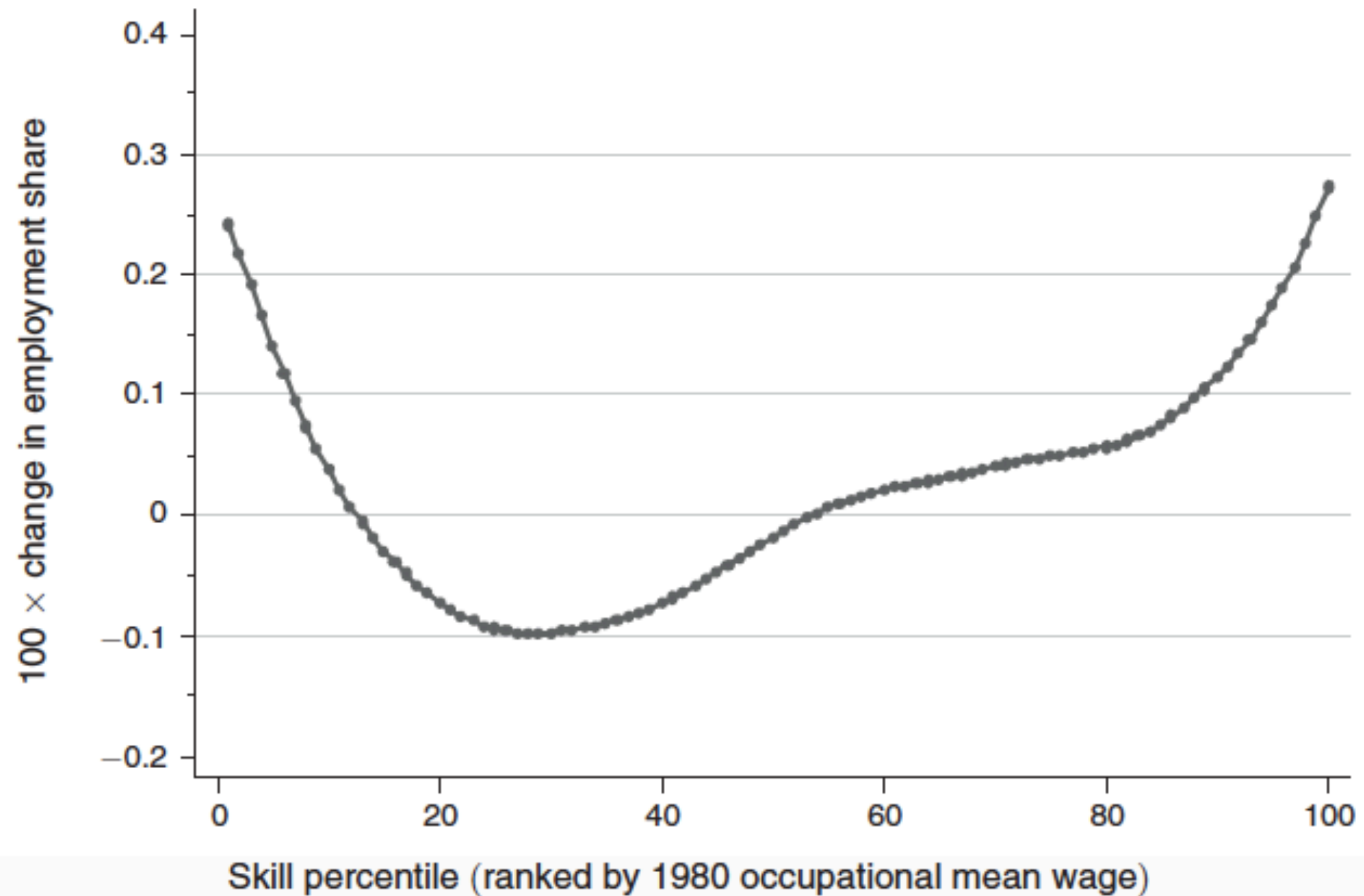Panel A. Smoothed changes in employment by skill percentile, 1980–2005

Figure from Autor-Dorn 2013

Sectoral Definition

▸ **Low-skill Service:** personal services, entertainment, low-skilled transport (bus service and urban transit, taxicab service, trucking service, warehousing and storage, services incidental to transportation), low-skilled business and repair services (automotive rental and leasing, automobile parking and carwashes, automotive repair and related services, electrical repair shops, miscellaneous repair services), retail trade, wholesale trade

▸ **Manufacturing:** mining, construction, manufacturing

▸ **High-skill Service:** professional and related services, finance, insurance and real estate, communications, high-skilled business services (advertising, services to dwellings and other buildings, personnel supply services, computer and data processing services, detective and protective services, business services not elsewhere classified), communications, utilities, high-skilled transport (railroads, U.S. Postal Service, water transportation, air transportation), public administration.

EMPIRICAL FOLLOW-UPS

Driving Forces for Decline in the Natural Rate of Interest

	Forcing Variables	Eggertsson*	
Demographic Factors	Mortality rate ↓	43%	
	Fertility rate ↓	43%	
Macro Economy	Productivity growth ↓	44%	Decline in NIR
	Debt to GDP ↑	-49%	
Other Factors	Inequality ↑	??	
	Foreign Deficit ↑	??	

*1970-2015 Decomposition from Eggertsson et al, 2018

What I am doing: Panel Data Analysis (Fixed Effect*)

Sample: 36 OECD countries from 1980-2016

1. First Differences $\quad \Delta r_{i,t} = \Delta X_{i,t}\beta + c_i + year_t + u_{i,t}$

2. 5-year average $\quad \overline{r_{i,\tau}} = \overline{X_{i,\tau}}\beta + c_i + period_\tau + u_{i,\tau}$

Variable	Explanation	Source
r	Real interest rate (%)	World Bank
top10share	income share of top 10%	World Inequality Database
top1share	income share of top 1%	World Inequality Database
nca	Net capital account (BoP, current US$)	World Bank
debt	DEBT (% of GDP)	IMF
prod	GDP per hour worked, constant prices	OECD
pg	Population growth (annual %)	World Bank
Life	Life expectancy at birth, total (years)	World Bank
frate	Fertility rate, total (births per woman)	World Bank

*I choose FE over RE model after Hausman test

	(1) dif_r	(2) dif_r	(3) dif_r	(4) dif_r	(5) dif_r	(6) dif_r
D.dif_r	0.492***	0.493***	0.491***	0.487***	0.491***	0.487***
	(0.018)	(0.017)	(0.025)	(0.025)	(0.025)	(0.025)
year	-0.004	-0.002	-0.013	-0.014	-0.015	-0.017
	(0.006)	(0.006)	(0.013)	(0.013)	(0.013)	(0.013)
dif_top10share	-0.102		-0.206**		-0.202**	
	(0.078)		(0.100)		(0.100)	
dif_top1share		-0.162*		-0.456***		-0.454***
		(0.097)		(0.121)		(0.121)
dif_ncagrowth			-0.000*	-0.000*	-0.000	-0.000*
			(0.000)	(0.000)	(0.000)	(0.000)
dif_debt			0.003	-0.010	0.006	-0.006
			(0.023)	(0.023)	(0.023)	(0.023)
dif_prod			0.070*	0.058	0.073*	0.061
			(0.042)	(0.041)	(0.042)	(0.041)
dif_pg			0.257	0.310		
			(0.391)	(0.384)		
dif_Life					0.003	0.036
					(0.480)	(0.472)
dif_frate					1.728	2.005
					(2.084)	(2.046)
_cons	7.828	3.805	25.881	28.437	30.309	33.472
	(12.575)	(12.871)	(25.998)	(25.568)	(26.866)	(26.430)
N	506	528	312	312	312	312
R^2	0.604	0.615	0.601	0.614	0.601	0.615

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Inequality matters

Slow Tech Growth pushes down interest rate

Low Fertility rate insignificantly decrease interest rate

	(1) r5	(2) r5	(3) r5	(4) r5	(5) r5	(6) r5
period	0.077***	0.073***	0.022	0.056	0.017	0.157
	(0.025)	(0.026)	(0.046)	(0.052)	(0.122)	(0.131)
top10share5	-0.307***		-0.556***		-0.559***	
	(0.110)		(0.170)		(0.177)	
top1share5		-0.482***		-0.890***		-0.884***
		(0.182)		(0.256)		(0.260)
ncagrowth5			0.002	0.002	0.002	0.002
			(0.002)	(0.002)	(0.002)	(0.002)
debt5			0.016	0.011	0.021	0.015
			(0.016)	(0.016)	(0.015)	(0.015)
prod5			0.262	0.368	0.289	0.294
			(0.235)	(0.230)	(0.262)	(0.259)
pg5			-1.990*	-2.252**		
			(1.002)	(1.006)		
Life5					-0.040	-0.539
					(0.540)	(0.528)
frate5					-3.565	-3.989*
					(2.154)	(2.152)
_cons	-139.050***	-136.565***	-21.462	-97.521	-3.253	-254.227
	(47.082)	(50.484)	(88.116)	(101.086)	(204.508)	(222.694)
N	137	142	93	93	93	93
R^2	0.085	0.070	0.366	0.378	0.355	0.369

Standard errors in parentheses

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Inequality matters

Opposite?

Productivity Growth in the US

Legend: yoy, 10y average

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