Rising Skill Premium?

The Roles of Capital-Skill Complementarity and Sectoral Shifts in a Two-Sector Economy

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Common Challenges in Asia and Europe
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This paper...

- Documents three facts in the Japanese economy
  (1) Declining skill premium

  (2) Expanding sectoral wage gap

  (3) Increasing unskilled labor share in non-manufacturing

- Considers a neoclassical two-sector model with
  - Two types of labor (skilled and unskilled)
  - Capital-skill complementarity

  to explain the three facts

- Estimates the key structural parameters with Bayesian methods

- Performs comparative statics exercises

Stylized Facts

Fact 1 The skill premium has started to decline since the mid-1990s

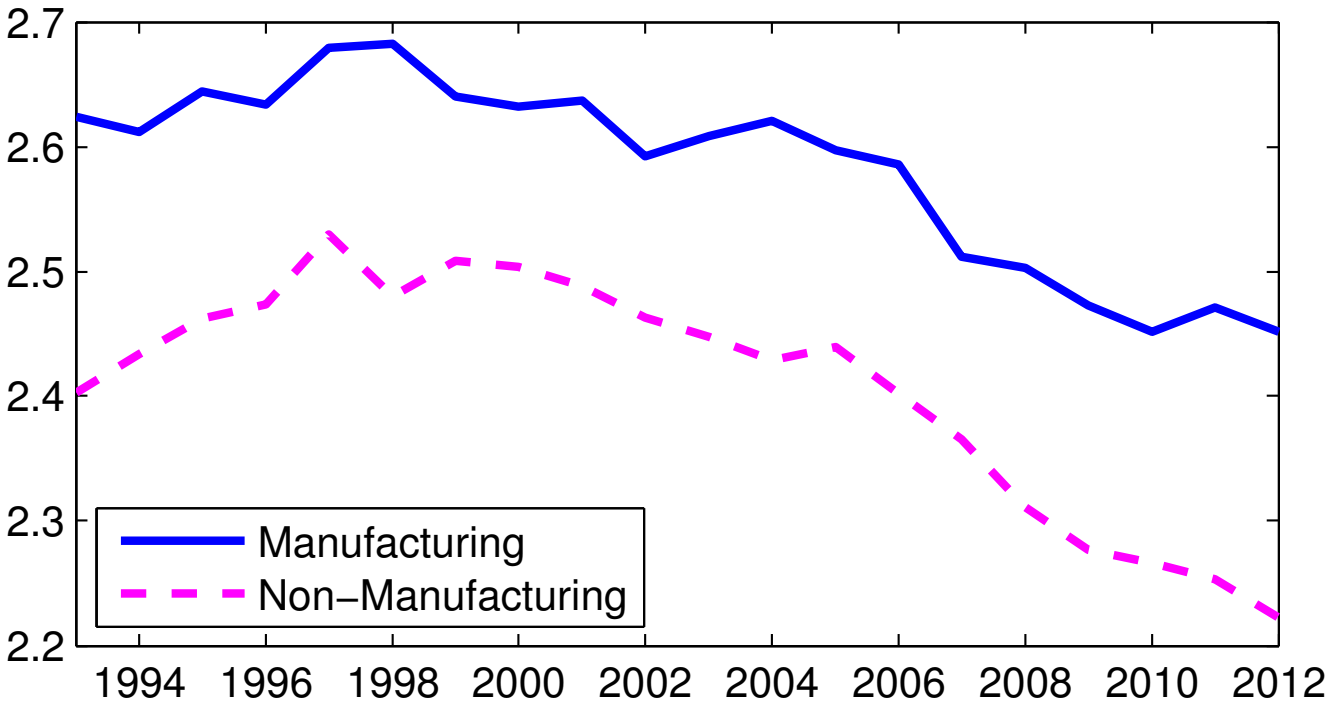

Figure: Skill Premium

Skill premium $\equiv$ Regular workers' wage / part-time workers' wage

Stylized Facts

Fact 2 Sectoral wage gap ↑ since the mid-90s

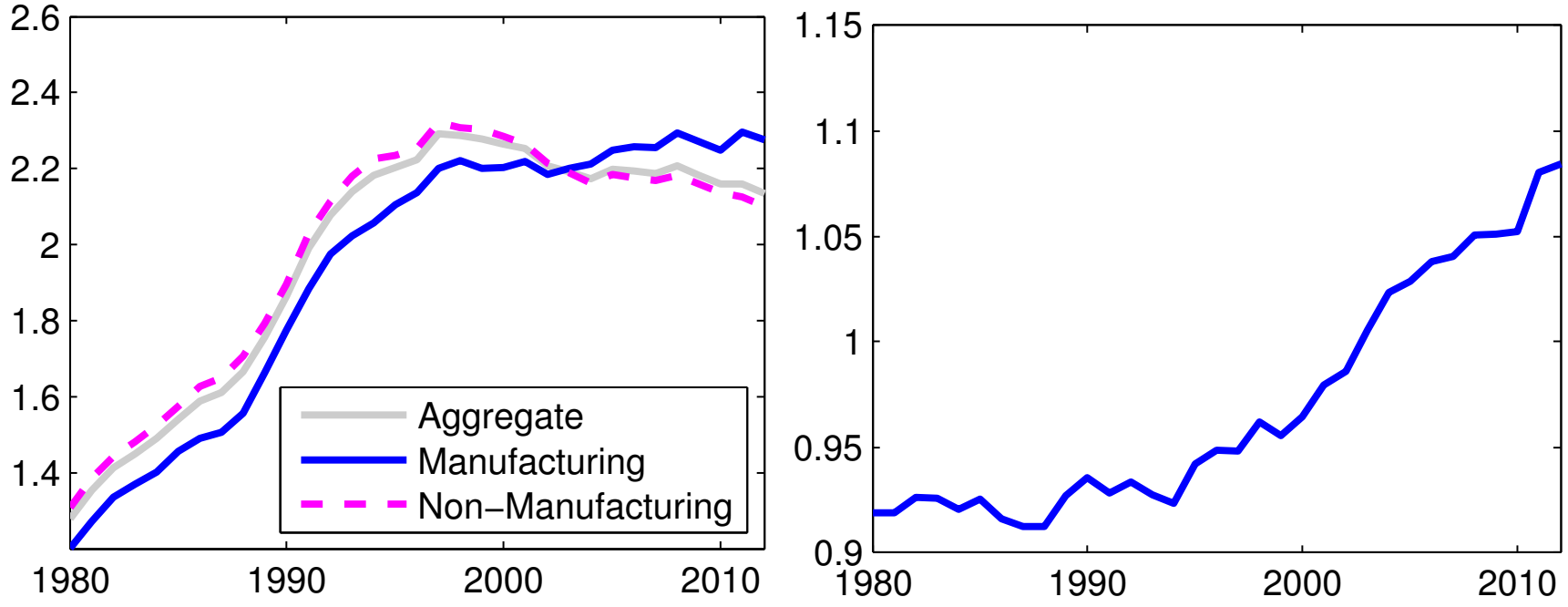

Figure: Sectoral Wages and Wage Gap

Stylized Facts

Fact 3 Unskilled share in non-manufacturing ↑

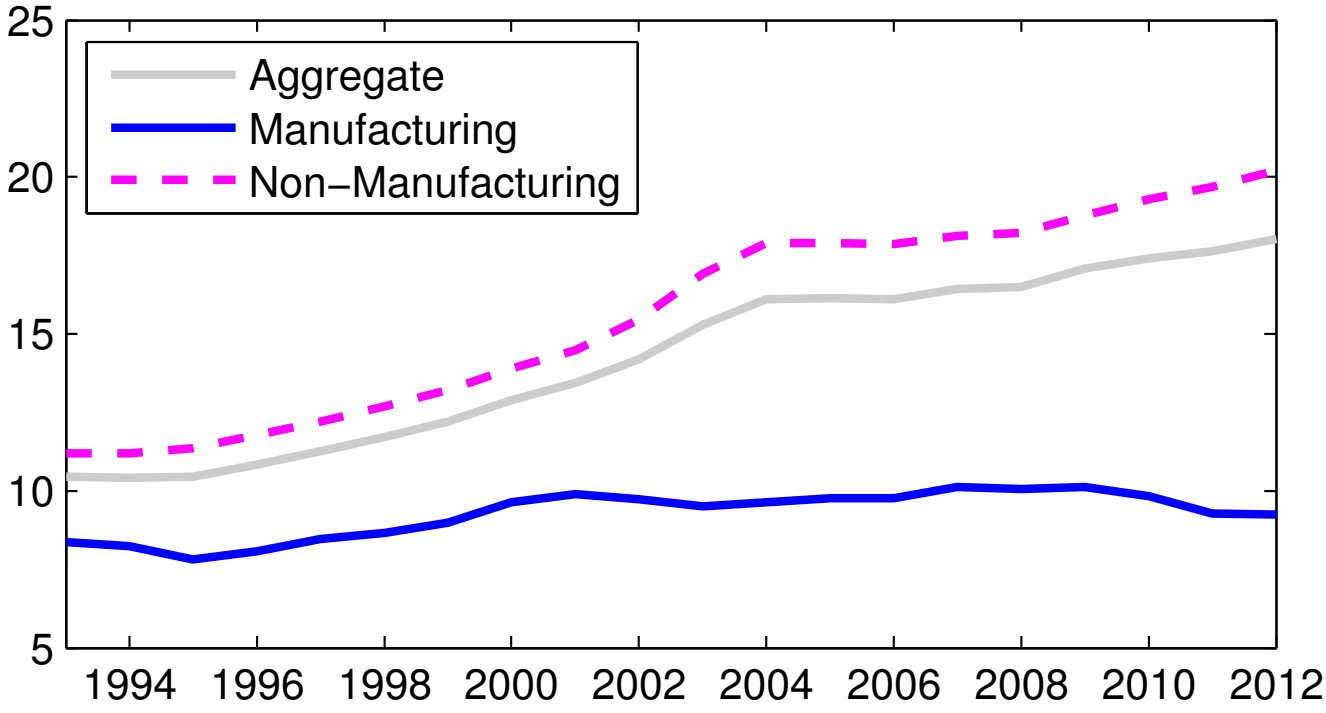

Figure: Unskilled Shares

Skilled / Unskilled Labor

Regular workers

Those who are directly employed and work full time

Precise Def.

Part-time workers

Those who work less than the regular workers per day or per week

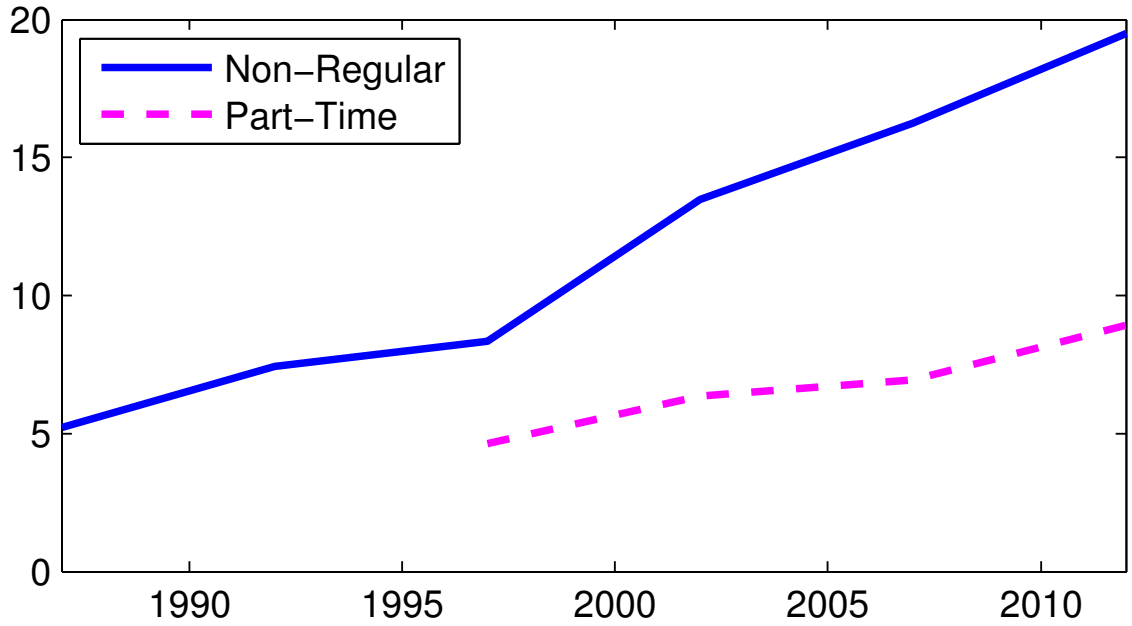

Figure: Fraction of Unskilled Jobs in College-Graduate Employments (%)

Skill Premiums in Other Countries

- Typically, skill premiums have been increasing over time.

TABLE 1—CHANGE IN THE SKILL PREMIUM DURING THE LAST TWO DECADES

	Observed change in the skill premium (%)	Period	Definition of skill premium
Argentina	2.1	1990–1999	college/high school wage ratio
Austria	−9.9	1990–2005	college/high school wage ratio
Brazil	5.6	1996–2007	nonproduction/production workers wage ratio
Canada	−1.2	1990–2004	college/high school wage ratio
Chile	−5.0	1990–2000	college/high school wage ratio
China	40.2	1992–2006	college/high school wage ratio
Colombia	26.4	1990–2000	nonproduction/production workers wage ratio
Denmark	−2.3	1990–2005	college/high school wage ratio
Finland	1.4	1990–2005	college/high school wage ratio
France	−16.8	1990–2005	college/high school wage ratio
Germany	14.4	1990–2005	college/high school wage ratio
Greece	−2.4	1990–2005	college/high school wage ratio
India	11.9	1987–2004	college/high school wage ratio
Italy	29.8	1990–2005	college/high school wage ratio
Japan	−3.4	1990–2005	college/high school wage ratio
Korea	−6.6	1990–2005	college/high school wage ratio
Mexico	12.5	1990–2001	nonproduction/production workers wage ratio
Peru	23.9	1994–2000	nonproduction/production workers wage ratio
Portugal	12.3	1992–2005	college/high school wage ratio
Philippines	5.0	1988–2006	college/high school wage ratio
Spain	8.2	1990–2005	college/high school wage ratio
Sweden	9.0	1990–2002	college/high school wage ratio
Thailand	17.2	1990–2004	college/high school wage ratio
United Kingdom	2.0	1990–2005	college/high school wage ratio
United States	3.1	1990–2007	nonproduction/production workers wage ratio
Uruguay	11.1	1990–1999	college/high school wage ratio

Figure: Table 1 from Parro (2013, AEJ Macro)

Skill Premiums in Other Countries

- Typically, skill premiums have been increasing over time.

- Parro (2013, AEJ Macro) looks at 26 countries.
  - Average skill premium growth rates $= 7.25\%$
    (e.g., Germany: 14% 1990–2005, US: 3% 1990–2007)

  - However, there are countries experiencing declining skill premiums, such as Austria, Canada, Chile, Denmark, France, Greece, Japan, and Korea.

Preview of the Results

- We find that there exists a large difference in the degree of capital-skill complementarity between manufacturing and non-manufacturing.
- The reduction of the elasticity between unskilled labor and capital (lower capital-skill complementarity) in non-manufacturing explains the stylized facts.
- Other possible scenarios can alter the skill premium. However, they cannot explain the sectoral wage gap.

The Model

Overview

- Two-sector neoclassical model
  – Manufacturing ($j = 1$) and Non-manufacturing ($j = 2$)
- Two types of labor
  – Skilled (S) and Unskilled (U)
- Production technology features capital-skill complementarity as in Krusell et al. (2000)

What We Want

- Define sectoral wage for $j = 1, 2$ as

$$w_j = (1 - \tau_j) w_s + \tau_j w_u, \tag{1}$$

where $\tau_j = \frac{U_j}{S_j + U_j}$.

- Changes in the sectoral wage gap is then given by

$$dw_1 - dw_2 = \underbrace{(\tau_2 - \tau_1)}_{\substack{\text{typically} \\ > 0}} \underbrace{(dw_s - dw_u)}_{< 0 \text{ in the data}} + \underbrace{(w_u - w_s)}_{\substack{\text{typically} \\ < 0}} \underbrace{(d\tau_1 - d\tau_2)}_{< 0 \text{ in the data}}. \tag{2}$$

Firms

- Two sectors (manufacturing and non-manufacturing)

$$Y_{j,t} = A_{j,t}\Big[\mu_j(\psi_{u,t}U_{j,t})^{\sigma_j} + (1-\mu_j)\big\{\lambda_j(K_{j,t})^{\rho_j} + (1-\lambda_j)(\psi_{s,t}S_{j,t})^{\rho_j}\big\}^{\frac{\sigma_j}{\rho_j}}\Big]^{\frac{1}{\sigma_j}} \quad (3)$$

- σ controls the elasticity of substitution between K and U.
- ρ controls the elasticity of substitution between K and S.
- When $\sigma > \rho$, there exists capital-skill complementarity.
- ψ_s and ψ_u are skill-specific technological progress.

Household

- Preferences

$$u(C_t, H_t) = \log(C_t) - \varphi \frac{\eta}{1+\eta} H_t^{\frac{\eta+1}{\eta}}, \tag{4}$$

where η is the Frisch elasticity of aggregate labor supply.

- C_t consists of goods $C_{1,t}$ and services $C_{2,t}$

$$C_t = \left[\gamma \left(C_{1,t} \right)^{\frac{\kappa-1}{\kappa}} + (1-\gamma) \left(C_{2,t} \right)^{\frac{\kappa-1}{\kappa}} \right]^{\frac{\kappa}{\kappa-1}}, \tag{5}$$

where $\gamma \in [0,1]$ controls a share of a manufacturing good and κ is the elasticity of substitution between manufacturing goods and services.

Household

- Following Horvath (2000), the aggregate labor index is given by

$$H_t = \left[(S_t)^{\frac{\theta+1}{\theta}} + (U_t)^{\frac{\theta+1}{\theta}} \right]^{\frac{\theta}{\theta+1}}, \tag{6}$$

  where θ controls the elasticity of substitution between skilled and unskilled jobs.

- As $\theta \to \infty$, skilled and unskilled jobs become perfect substitutes.

- As $\theta \to 0$, there is no way to change the composition of two types of jobs.

- When $0 < \theta < \infty$, the household prefers having diversity of labor.

Household

- Budget constraint

$$C_{1,t} + p_t C_{2,t} + I_{1,t} + I_{2,t} \leq r_{1,t} K_{1,t} + r_{2,t} K_{2,t} + w_{s,t} S_t + w_{u,t} U_t, \quad (7)$$

- Capital accumulation ($j = 1, 2$)

$$K_{j,t+1} = I_{j,t} \left\{ 1 - \Phi \left(\frac{I_{j,t}}{I_{j,t-1}} \right) \right\} + (1 - \delta) K_{j,t}. \quad (8)$$

The Rest of the Model

- Sectoral wages

$$w_{j,t} = (1 - \tau_{j,t}) w_{s,t} + \tau_{j,t} w_{u,t}, \tag{9}$$

where $\tau_{j,t} = \frac{U_{j,t}}{S_{j,t} + U_{j,t}}$.

- Market clearing conditions

$$\begin{aligned} S_t &= S_{1,t} + S_{2,t} \\ U_t &= U_{1,t} + U_{2,t} \\ Y_{1,t} &= C_{1,t} + I_{1,t} + I_{2,t} \\ Y_{2,t} &= C_{2,t} \end{aligned}$$

Estimation

Setup

- We augment our log-linearized model with sectoral investment-specific technology shocks and skill-specific wage markup shocks.

- Seven observables
  - Output growth (manufacturing and non-manufacturing)
  - Growth rate of total hours worked (skilled and unskilled)
  - Wage inflation (manufacturing and non-manufacturing)
  - Relative price inflation

- Sample: 1975:Q1 – 1995:Q4

- Imposed steady-state shares
  - $w_s/w_u = 2.5$
  - $S_1/U_1 = 11.31$
  - $S_2/U_2 = 7.89$
  - $\frac{S_1}{S_1+S_2} = 0.3$

Prior Distributions

Table: Prior Distributions

Parameter		Dist.	Prior Mean	Prior Std Dev
κ	Elasticity of substitution b/w goods and services	G	1.143	0.4
$\frac{1}{\eta}$	Inverse Frisch labor supply elasticity	N	2	0.75
σ	Controlling elasticity of substitution b/w K and U	B	0.2	0.2
α	Capital-skill complementarity ($\alpha \equiv \sigma - \rho$)	G	0.5	0.5
φ	Investment adjustment cost parameter	G	4	1
ρ_x	Persistence of shocks	B	0.75	0.1
σ_x	Std Dev of shocks	IG	0.025	∞

Posterior Distribution

Table: Posterior Distributions

Parameter		Posterior Distribution Mean	90% Interval	
κ	Elasticity of substitution b/w goods and services	4.21	3.42	5.01
$\frac{1}{\eta}$	Inverse Frisch labor supply elasticity	1.97	1.41	2.53
σ_1	Controling elasticity of substitution b/w K_1 and U_1	0.57	0.49	0.64
σ_2	Controling elasticity of substitution b/w K_2 and U_2	0.00	0.00	0.00
α_1	Capital-skill complementarity in sector 1	4.72	2.86	6.50
α_2	Capital-skill complementarity in sector 2	0.53	0.40	0.65
φ	Investment adjustment cost parameter	3.77	2.22	5.29

Note: $\alpha_j \equiv \sigma_j - \rho_j$

Posterior distributions are from 300,000 Metropolis-Hastings draws (discarding the first 30,000 as burn-in).

Other Post Dist

Comments on the Estimated Results

- The elasticities of substitution between K and U are quite different across sectors (2.3 vs. 1).
- Capital-skill complementarity differs across sectors.
- The elasticity of substitution between goods and services is greater than unity.
  - This suggests that the data may not support the story of Ngai and Pissarides (2007) for the sectoral reallocation of labor.

Comparative Statics

Setup

- Given the imposed values of w_s/w_u, S_1/U_1, S_2/U_2, and $\frac{S_1}{S_1+S_2}$, pin down the value of θ.
- Given the estimated parameter values, back out μ_1, μ_2, γ, and $\frac{\psi_u}{\psi_s}$ by using the steady-state relationship.
- Investigate how different values of σ's and ρ's affect the steady-state skill premium and sectoral wages.

Changes in the Skill Premium

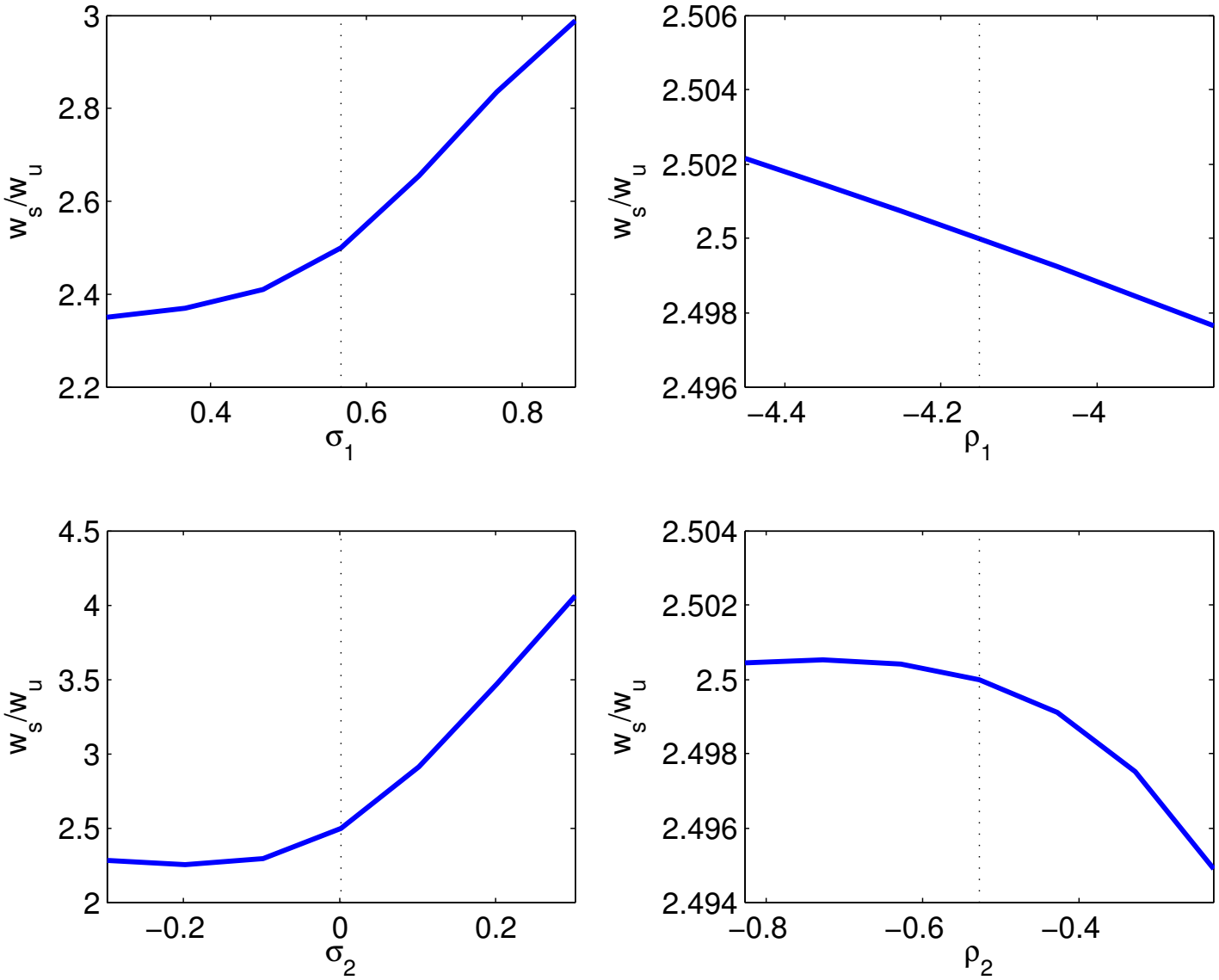

Figure: Changes in the Skill Premium (Dashed vertical lines indicate posterior means.)

Changes in Sectoral Wages

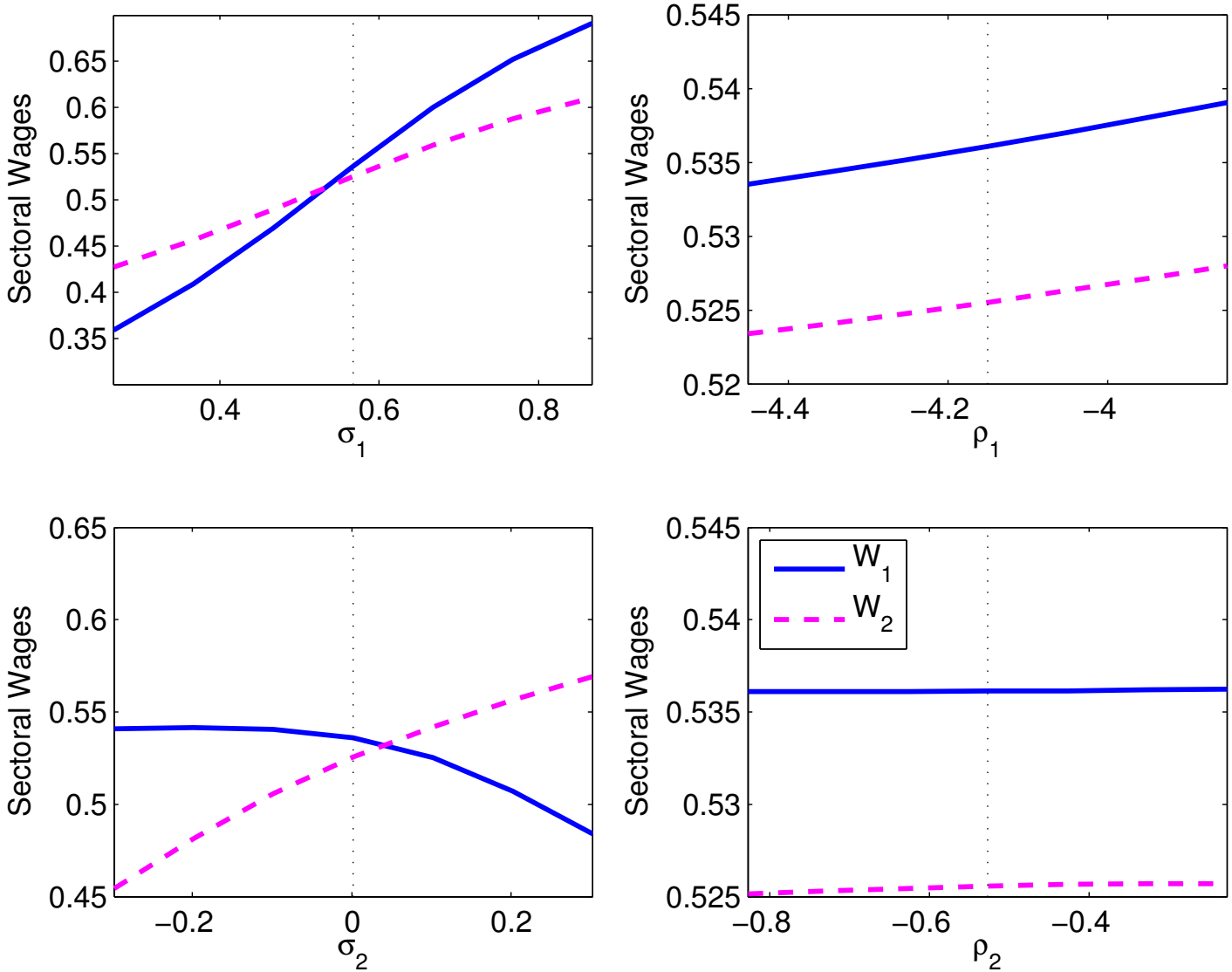

Figure: Changes in Sectoral Wages (Dashed vertical lines indicate posterior means.)

Changes in Skilled and Unskilled Wages

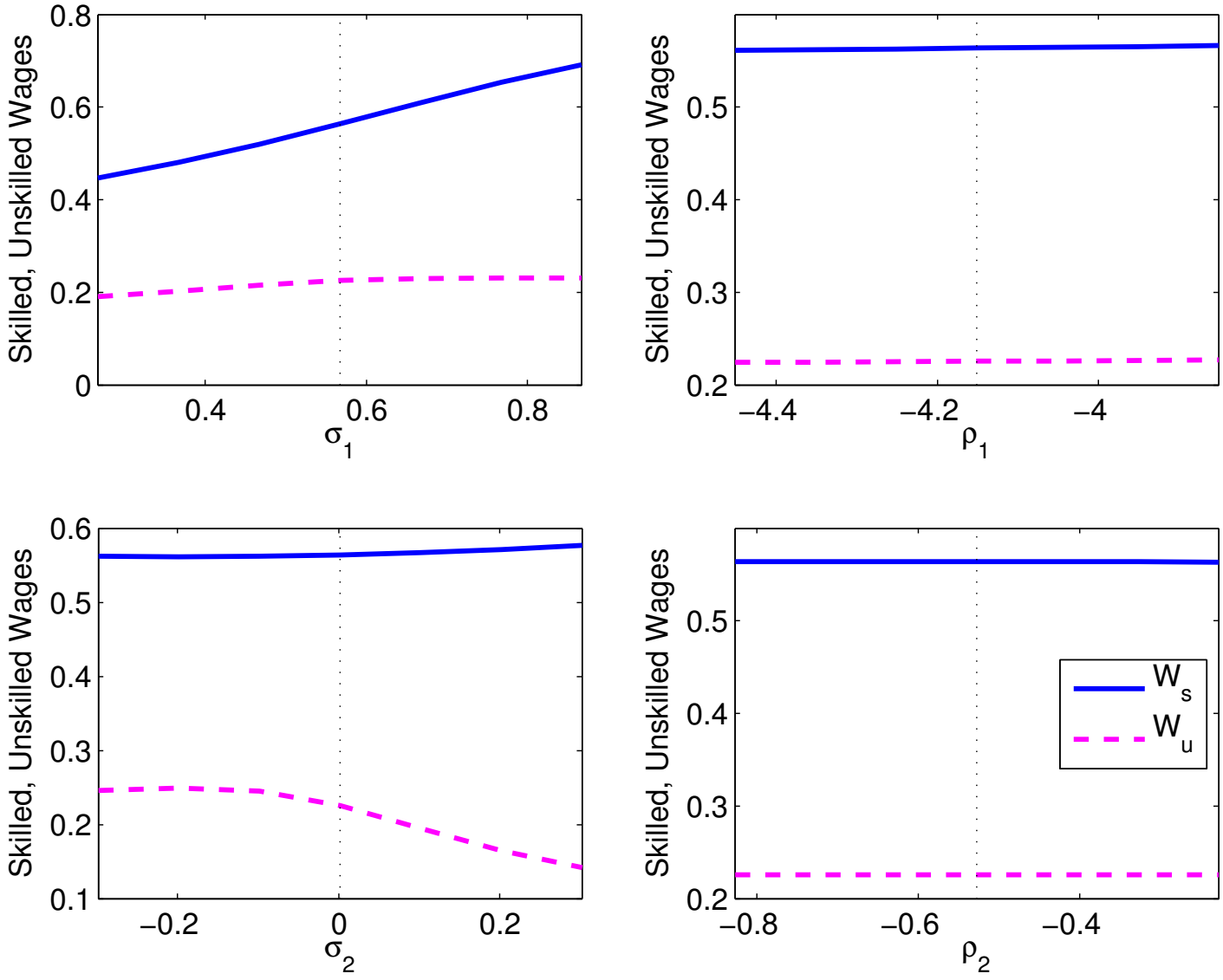

Figure: Changes in Skilled and Unskilled Wages (Dashed vertical lines indicate posterior means.)

Changes in Unskilled Shares

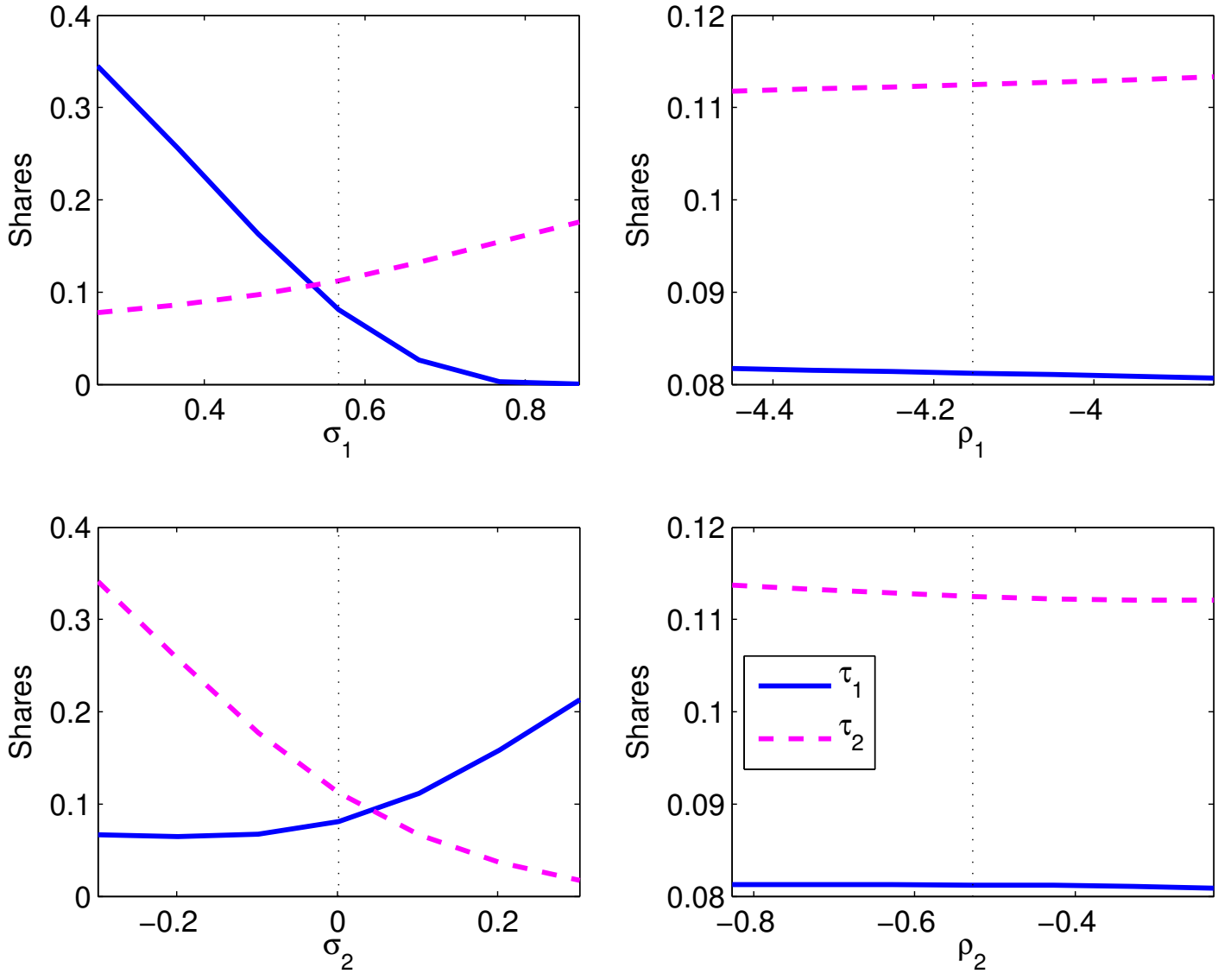

Figure: Changes in Unskilled Shares (Dashed vertical lines indicate posterior means.)

Summary of Comparative Statics

- Lower capital-skill complementarity can explain the declining skill premium.

- $\downarrow$ in σ_2 mainly accounts for the three observations:
  - **(i)** Lower skill premium
  - **(ii)** Wider sectoral wage gap between manufacturing and non-manufacturing
  - **(iii)** Higher unskilled share in non-manufacturing

- Varying other parameter values do not replicate changes in sectoral wages. Others

- When we let $\sigma_2 = -0.098$, we have

$$\frac{w_s}{w_u} = 2.3 \quad \text{and} \quad \frac{w_1}{w_2} = 1.069 \text{ (vs. 1.084 in 2012).}$$

Conclusion

Conclusion

- Documents (i) the declining skill premium, (ii) wider sectoral wage gap, and (iii) increasing unskilled share in non-manufacturing.
- Presents a simple two-sector neoclassical model with two types of labor and capital-skill complementarity.
- The estimated parameter values suggest that there is significant difference in sectoral characteristics with respect to capital-skill complementarity.
- The lower elasticity of substitution between unskilled and capital in non-manufacturing accounts for the observed changes in the labor market in Japan.

Definition of Regular Workers

Regular workers Those who satisfy one of the following conditions:

(1) Persons hired for an indefinite period or for longer than one month

(2) Persons hired by the day or for less than one month and who were hired for 18 days or more in each month of the two preceding months

Details of Data

- No sectoral output data is available at quarterly frequency.
- Assume that manufacturing produces goods that are used for
  - Durable goods consumption
  - Business fixed investment
  - Residential investment
- Similarly, we assume that output from non-manufacturing is consumed as
  - Non-durable consumption
  - Services

Posterior Distribution

Table: Posterior Distributions

Parameter		Posterior Distribution		
		Mean	90% Interval	
ρ_{a_1}	Persistence of TFP in sector 1	0.70	0.57	0.83
ρ_{a_2}	Persistence of TFP in sector 2	0.94	0.91	0.98
ρ_{ψ_s}	Persistence of skilled-specific shock	0.70	0.56	0.82
ρ_{ψ_u}	Persistence of unskilled-specific shock	0.79	0.68	0.90
ρ_{ξ_1}	Persistence of investment-specific shock in sector 1	0.69	0.44	0.92
ρ_{ξ_2}	Persistence of investment-specific shock in sector 2	0.82	0.67	0.97
ρ_{μ_s}	Persistence of wage markup shock for skilled	0.96	0.93	0.98
ρ_{μ_u}	Persistence of wage markup shock for unskilled	0.81	0.72	0.89

Posterior Distribution

Table: Posterior Distributions

Parameter		Posterior Distribution		
		Mean	90% Interval	
σ_{a_1}	Std Dev of TFP shock in sector 1	0.02	0.02	0.03
σ_{a_2}	Std Dev of TFP shock in sector 2	0.01	0.01	0.01
σ_{ψ_s}	Std Dev of skilled-specific shock	0.03	0.03	0.04
σ_{ψ_u}	Std Dev of unskilled-specific shock	0.23	0.17	0.29
σ_{ξ_1}	Std Dev of investment-specific shock in sector 1	0.05	0.01	0.12
σ_{ξ_2}	Std Dev of investment-specific shock in sector 2	0.09	0.02	0.16
σ_{μ_s}	Std Dev of wage markup shock for skilled	0.03	0.02	0.03
σ_{μ_u}	Std Dev of wage markup shock for unskilled	0.06	0.05	0.07

Changes in γ

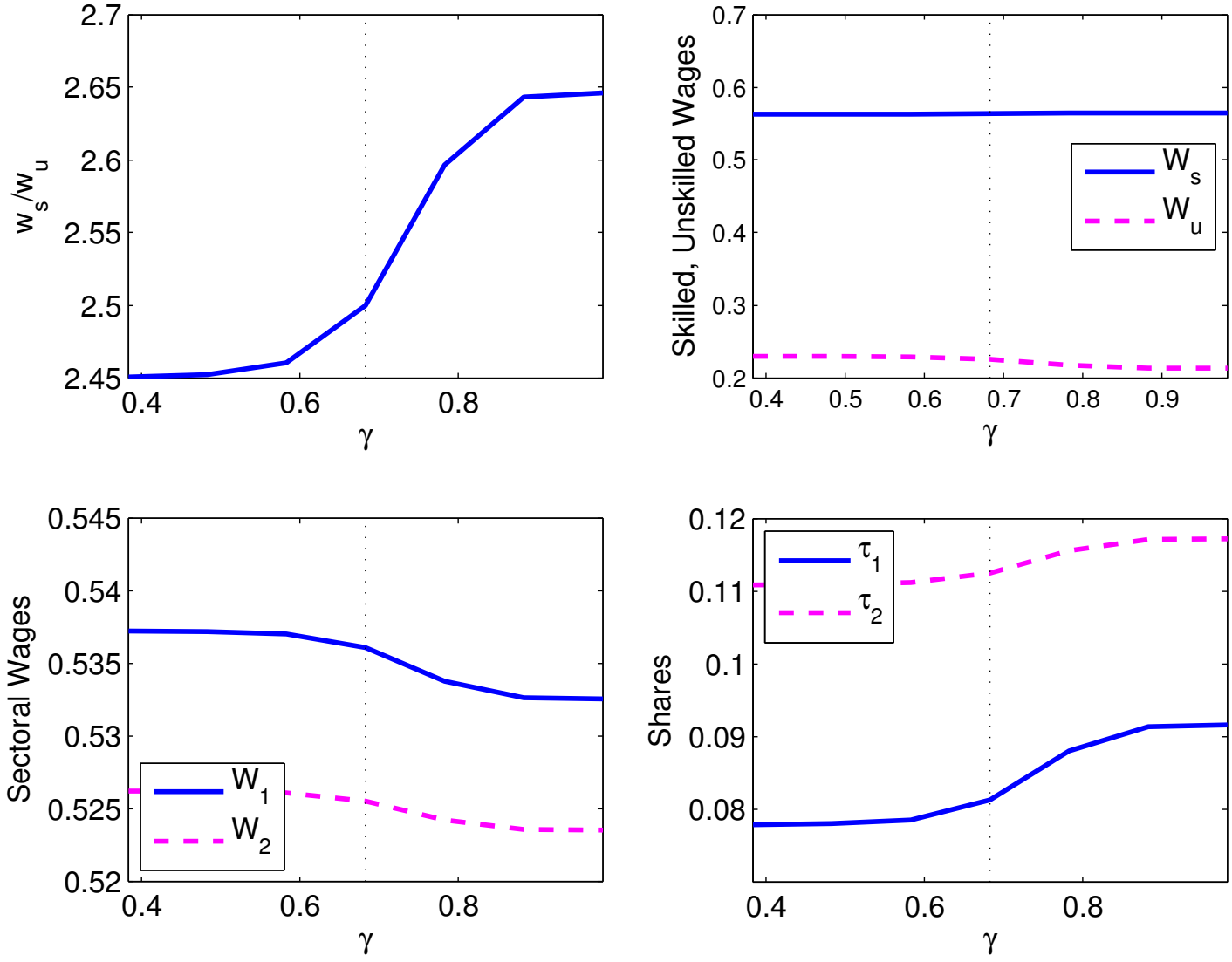

Figure: Changes in γ (Dashed vertical lines indicate posterior means.)

Changes in κ

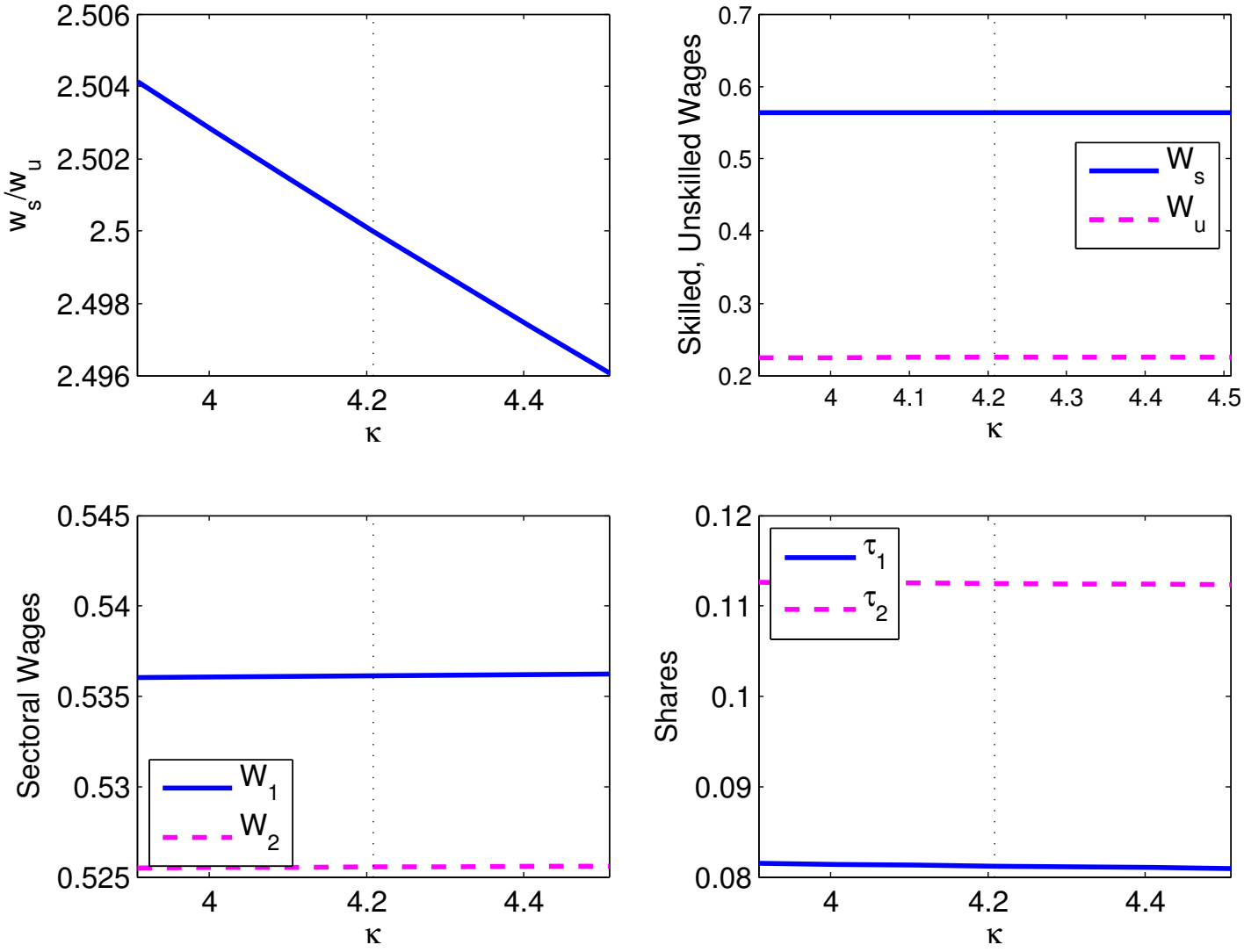

Figure: Changes in κ (Dashed vertical lines indicate posterior means.)

Changes in θ

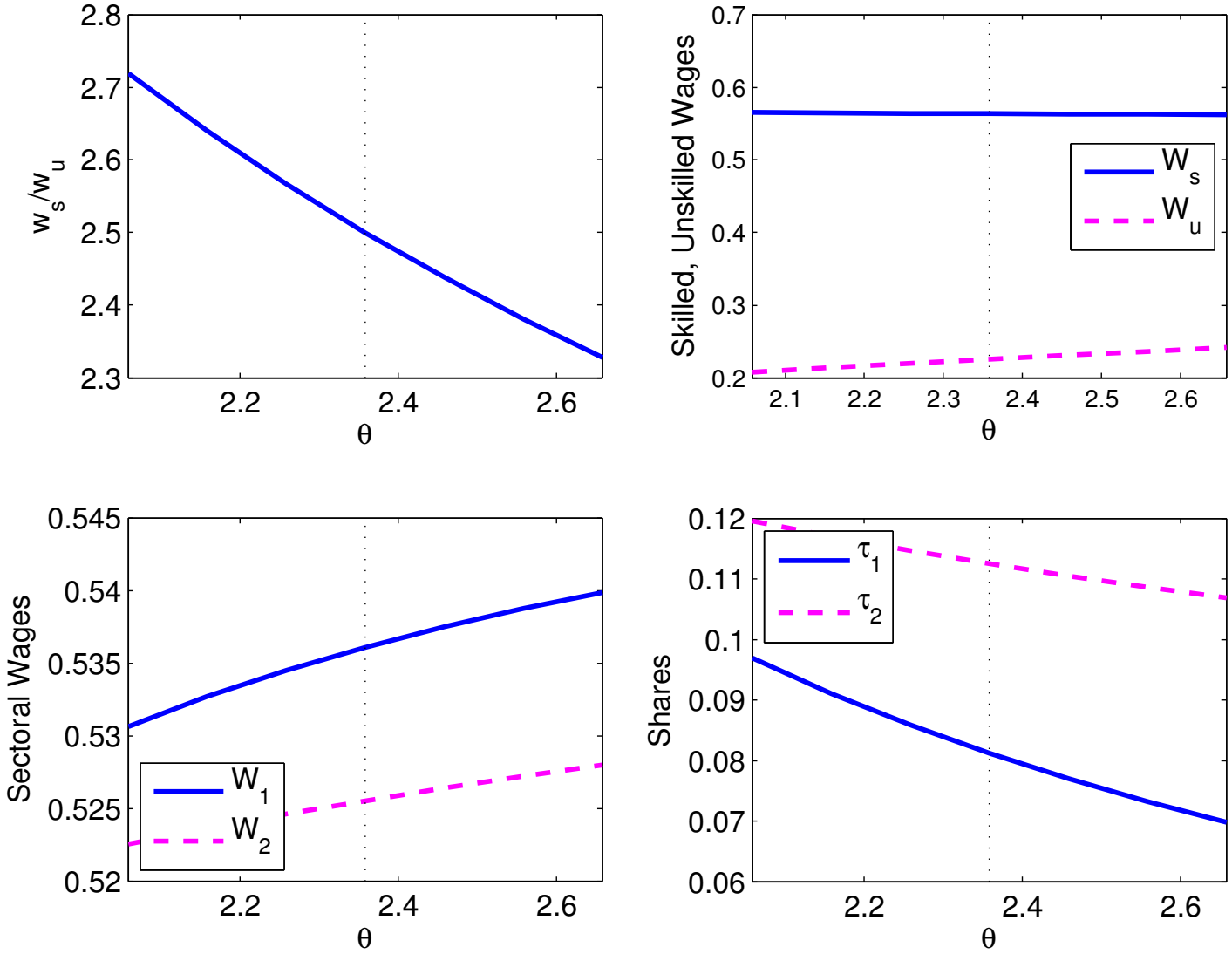

Figure: Changes in θ (Dashed vertical lines indicate posterior means.)

Changes in b

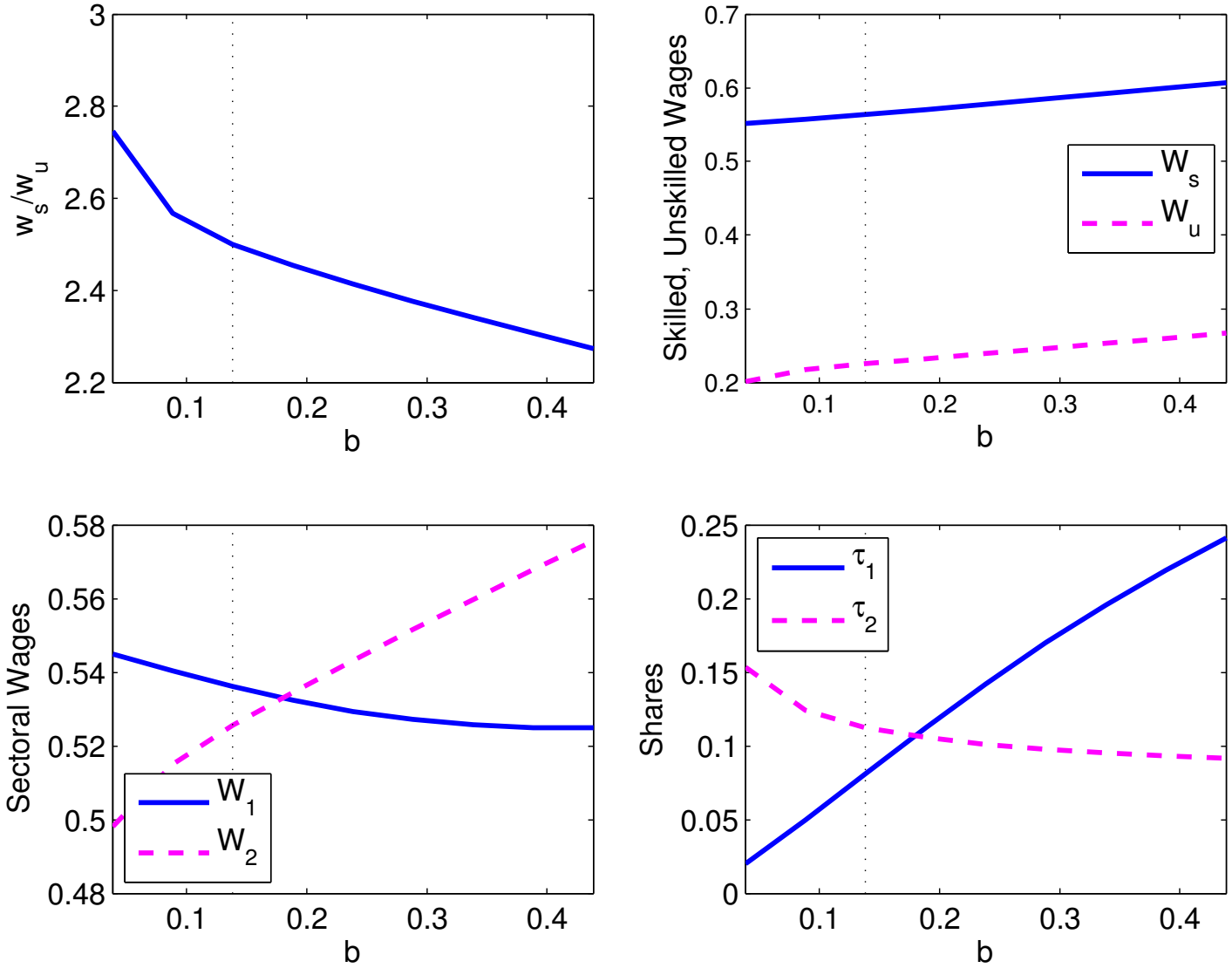

Figure: Changes in b (Dashed vertical lines indicate posterior means.)