Wage Risk and the Skill Premium

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Motivation

Recent decades in the United States:

- Dramatic rise in relative wages of college vs. non-college graduates (skill premium).
- Individual wage risk has also gone up (Gottschalk and Moffitt 1994; 2012, Heathcote et al. 2010, Hong et al. 2015).

This Project

1. Propose a mechanism through which rise in wage risk increases skill premium.

2. Assess significance of mechanism by measuring how much of the rise in US skill premium between 1967 and 2010 it can account for.

Possible interpretation: provide a novel link from within-group inequality to between-group inequality.

Framework and Mechanism

Key ingredients of the framework:

1. *Uninsured* individual wage risk.
2. Capital-skill complementarity.

Mechanism (in counterfactual exercise):

- $\uparrow$ wage risk $\rightarrow \uparrow$ (precautionary) savings $\rightarrow \uparrow$ capital stock $\rightarrow$ $\uparrow$ skill premium, due to capital-skill complementarity.

Rest of the Talk

- Environment.
- Quantitative results.
- Extensions (time permitting).
- Conclusion.

Environment

Environment

Aiyagari (1994) model with *capital-skill complementarity*.

Incomplete markets model with:

- Government, measure 1 of workers and a firm.
- 2 types of capital: equipments and structures.
- 2 types of labor: skilled and unskilled.

Production

- Production Function:

$$F(K_s, K_e, L_s, L_u)$$

- As in KORV (2000), equipment capital-skill complementarity:
  - $\frac{MPL_s}{MPL_u}$ increasing in K_e (independent of K_s).

Firm Problem

- Representative firm solves:

$$\max_{K_s, K_e, L_s, L_u} \quad F(K_s, K_e, L_s, L_u) - r_s K_s - r_e K_e - w_s L_s - w_u L_u$$

Skill-Biased Technological Change (SBTC)

- Aggregate feasibility:

$$C + G + K_s' + qK_e' = F(K_s, K_e, L_s, L_u) + (1-\delta_s)K_s + (1-\delta_e)qK_e.$$

- q is cost of equipment capital in terms of consumption good.

- Following KORV (2000), SBTC modelled as a decline in q.

Government

- Spends G, has debt D.
- Raises revenue with:
  - linear capital income taxes τ_s, τ_e,
  - non-linear labor income taxes $T(y)$, implies partial insurance.
- Gvt BC:

$$RD + G = D + \tau_e(r_e - q\delta_e)K_e + \tau_s(r_s - \delta_s)K_s + T_{agg},$$

where T_{agg} is aggregate labor tax revenue.

Demographics

- Each period a fraction $(1 - \delta)$ of agents born with no assets.
- Agents survive from one age to another with prob δ.
- No accidental bequests: assets of dead distributed among the survivors.
- Agents are born skilled or unskilled (exogenous).
- π_i denotes the total fraction of skill type i.

Individual Wage Risk

- Each period each agent of skill type i draws *idiosyncratic* productivity shock z_i.
- Agent of skill type i and productivity z_i receives a wage rate $\bar{w}_i = w_i \cdot z_i$ per unit of time, with $w_i = MPL_i$.
- The process for z_i is skill specific.

Preferences

- Preferences over stochastic $(c_{i,t}, l_{i,t})_{t=0}^{\infty}$ is given by

$$E_i\Big[\sum_{t=0}^{\infty}(\beta\delta)^t u(c_{i,t}, l_{i,t})\Big].$$

- Endogeneous labor supply allows for partial insurance.

Agent's Problem

In a stationary equilibrium:

$$v_i(z_i, a_i) = \max_{(c_i, l_i, a_i') \geq 0} u(c_i, l_i) + \beta \delta E_i[v_i(z_i', a_i')]$$

s.t.

$$c_i + \delta a_i' \leq w_i z_i l_i - T(w_i z_i l_i) + R a_i,$$

where $R = 1 + (r_s - \delta_s)(1 - \tau_s) = 1 + (r_e - q\delta_e)(1 - \tau_e)/q$ is the after-tax asset return.

The Mechanism

1. $\uparrow$ labor income risk $\rightarrow \uparrow$ (precautionary) savings, because of incomplete insurance markets.
2. $\uparrow$ savings $\rightarrow \uparrow$ stock of equipment capital.
3. $\uparrow$ stock of equipment capital $\rightarrow \uparrow$ skill premium, due to equipment capital-skill complementarity.

This is a counterfactual, in reality other factor changes as well.

Quantitative Analysis

Quantitative Analysis

Overview:

- Calibrate model (stationary equilibrium) to 1967 U.S. economy.
- Model fit: Feed in observed changes in all factors between 1967 and 2010 and compute skill premium in 2010.
- Counterfactual: Feed in the change in wage risk only and compute skill premium.

Production Function

- Production function: KORV (2000)

$$Y = K_s^{\alpha}\left(\nu\left[\omega K_e^{\rho} + (1-\omega)L_s^{\rho}\right]^{\frac{\eta}{\rho}} + (1-\nu)L_u^{\eta}\right)^{\frac{1-\alpha}{\eta}}$$

  Use α, η, ρ, δ_s, δ_e from KORV. Calibrate ω and ν.

- q normalized to one in 1967.

Agents

- Cobb-Douglas utility function:

$$u(c, l) = \frac{\left[c^{\phi}(1-l)^{(1-\phi)}\right]^{\frac{1-\sigma}{\phi}} - 1}{\frac{1-\sigma}{\phi}}.$$

- In benchmark, use $\sigma = 2$, and calibrate β and ϕ.

- Survival probability $\delta = 0.978$ (CDR, 2003).

- $\pi_s = 13.56\%$ (CPS 1967, males aged 25-60, with earnings).

Productivity Shocks: 1967

- Hong, Seok, You (2015) estimate skill specific wage processes:

$$\log z_{i,t} = \theta_{i,t} + \varepsilon_{i,t},$$
$$\theta_{i,t} = \xi_i \theta_{i,t-1} + \kappa_{i,t}.$$

Variable	Skilled	Unskilled
Variance of ε	0.0116	0.0177
Variance of κ	0.0037	0.0052
ξ	0.9834	0.9859
Var of θ for entrants	0.1172	0.1488

Government Policy: 1967

- As in HSV (QJE, 2017) approximate progressive labor taxes by $T(y) = y - \chi \cdot y^{1-\tau_l}$, $\tau_l = 0.181$, let χ clear the budget.
- Capital income taxes 15% at consumer level, differential taxes at corporate level (Auerbach, 1983): $\tau_s = 0.57, \tau_e = 0.50$.
- Govt. expenditure $G/Y = 0.16$.
- Govt. debt $D/Y = 0.25$ in 1967 (St. Louis FED).

Internal Calibration

Parameter	Value	Target	Data & SRCE	Source
ω	0.7886	Labor share	0.67	NIPA
ν	0.4530	Skill premium in 1967	1.51	HPV
ϕ	0.4088	Labor supply	1/3	
β	0.9907	Capital-to-output ratio	2.0	NIPA, FAT
χ	0.8778	Gvt. budget balance		

Changes in Factors

Between 1967 and 2010

Changes in Wage Risk between 1967 and 2010

Hong et al. (2015):

Variable	1967	2010
Variance of ε_s	0.0116	0.0673
Variance of ε_u	0.0177	0.0627
Variance of κ_s	0.0037	0.0304
Variance of κ_u	0.0052	0.0157

- Wage risk has gone up for both groups.
- Risk has increased more for skilled.

Changes in Other Factors between 1967 and 2010

- Relative price of equipments decreases from 1 in 1967 to 0.1577 in 2010 (St. Louis FRED data base).
- Fraction of skilled workers increase from 13.56% in 1967 to 31.36% in 2010.
- Capital taxes have decreased from $\tau_s = 0.57, \tau_e = 0.50$ (Auerbach, 1983) to $\tau_s = 0.42$ and $\tau_e = 0.37$ (Gravelle, 2011).
- Gvt debt increased from 25% in 1967 to 36% in 2010.
- Rest of parameters remains the same.
- Recalibrate χ to clear gov. budget in new SS.

Main Quantitative Results

Change in Skill Premium from 1967 to 2010

- Model matches the change in skill premium quite well.

	Data			Model		
	1967	2010	Change	1967	2010	Change
Skill premium	1.51	1.9	0.39	1.51	1.92	0.41

Counterfactual: Change Wage Risk Only

	1967	Risk	2010 (model)	2010 (data)
Skill premium	1.51	1.70	1.92	1.90
Change		0.18	0.41	0.39

- Increase in residual wage risk increases skill premium by 18 pp.
- Mechanism: Risk $\uparrow \rightarrow$ 20% increase in equipment capital, which $\uparrow$ skill premium due to capital-skill complementarity.

Alternative Counterfactual

Feed in changes in other factors first, and then change in risk.

	1967	All but Risk	2010 (model)	2010 (data)
Skill premium	1.51	1.80	1.92	1.90
Change		0.29	0.41	0.39

- Increase in wage risk increases skill premium by 12 pp.
- Magnitude of mechanism depends on order of decomposition due to non-linearities, but important in either case.

Note: Mechanism quantitatively important for range of σ.

Additional Results 1

Decomposing change in skill premium coming from change in risk:

1. $\uparrow$ persistent component volatility (much) more important than $\uparrow$ in transitory component volatility.

   Reason: Transitory shock well insured even if their volatility $\uparrow$.

2. $\uparrow$ in risk for skilled more important than $\uparrow$ in risk for unskilled.

   Reason: Skilled risk $\uparrow$ more.

Additional Results 2

Role of borrowing constraints (in benchmark $a \geq 0$):

- Results with exogeneous borrowing limit (as in HSV, 2010, $\sim$15% have negative wealth) almost identical.

Conclusion

- Novel mechanism through which inequality leads to inequality: $\uparrow$ wage risk $\rightarrow \uparrow$ skill premium.
- Mechanism is quantitatively important: increases skill premium by 18 pp. between 1967 and 2010.
- Mechanism also significant under open economy and endogenous labor supply extensions.

Additional Results

Sensitivity to Risk Aversion

Results sensitive to degree of risk aversion, σ.

σ	1967	2010	Only Risk	Contribution (in pp.)
1	1.51	1.88	1.62	0.10
2	1.51	1.92	1.70	0.18
3	1.51	1.98	1.81	0.29

- Mechanism quantitatively important for range of σ.
- Rise in risk creates up to 29 pp. rise in skill premium for values of σ within plausible range.

Extensions

Open Economy

Closed vs. Open Economy

- Risk changes matter because they affect capital accumulation.
- In a closed economy: risk $\rightarrow$ savings $=$ investment.
- In an open economy: risk $\rightarrow$ savings $\neq$ investment.
- How strong is the mechanism in an open economy?
- Answer depends on the extent to which foreign countries can absorb the rise in domestic savings.

Open Economy

- Two-country model: U.S. vs. rest of the world (ROW).
- ROW modelled as a similar incomplete market economy.
- International dimension:
  - Frictionless international trade in (single) good.
  - No labor mobility.
  - Perfect international capital mobility.

Open Economy Results

	1967	2010	Risk	Risk with savings glut
Skill premium	1.51	1.92	1.63	1.66
Contribution (pp.)			11	14

- Effect of rise in wage risk on skill premium significant: 11 pp.
- Mechanism weaker than in closed economy since part of the rise in savings absorbed by ROW.
- With 'Savings glut' foreigners do not absorb as much of the U.S. savings.

Endogenous Skill Supply

Exogenous vs. Endogenous Skill Supply

- In baseline environment, fraction of skilled exogenous.
- Reason: In counterfactual, interested in understanding effect of rise in risk on skill premium given observed supply of skilled.
- Alternative: How much does rise in risk increase skill premium when people can alter their education decisions in response?

Environment

Environment same as before except people choose skill level:

- Newborns draw utility cost $\psi \geq 0$, distributed acc. to $F(\psi)$.
- Reduced form way of capturing cross sectional variation in psychological and pecuniary costs of acquiring a degree.
- Get educated iff $E_{s,0}[v_s(z,0)] - E_{u,0}[v_u(z,0)] \geq \psi$.

Significance of Mechanism with Endogenous Skills

- Rise in wage risk increases skill premium by 24 pp.
- More than in case with exogenous skills: 18 pp. vs. 24 pp.
- Fraction of skilled declines because risk $\uparrow$ more for skilled: from 13.56% to 12.58%, even though skill premium$\uparrow$.