Trading Up and the Skill Premium

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Motivation: Income inequality

- U.S. income inequality has increased in the last four decades.
- This increase has motivated a number of policy proposals aimed at narrowing the gap between rich and poor.
  - Making income taxes more progressive
    - e.g. Diamond and Saez (2001) and Landais, Picketty and Saez (2011)
  - Introducing wealth taxes
    - e.g. Saez and Zuckman (2019)
  - Subsidizing college tuition for low-income students
    - e.g. Chetty et al. (2017)
  - Investing in neighborhoods to promote upward mobility
    - e.g. Chetty and Hendrem (2018)

Motivation: Income inequality

- To evaluate these and other policy proposals, it is useful to understand the dynamics of income inequality.

- Are there forces that narrow the gap between rich and poor?
  - One such force is the likely rise in relative supply of skilled workers, which lowers the skill premium and income inequality.
  - In this paper, we argue that this stabilizing force is likely to be weaker than suggested by the canonical model.

Trading up

- As income rises, people want higher quality of consumption.
- We show that increases in quality leads to a rise in skill premium.
  - High-quality goods are intensive in skilled labor.
  - As households trade up, they increase the demand for skilled labor, contributing to a rise in the skill premium.
- Bils and Klenow (2001) estimate that quality grew on average 3.8 percent per year in the 1980-1996 period.

What we do

1. Empirically show:
   - Household spending on high-quality goods rises with income.
   - High-quality goods are more intensive in skilled labor.

2. Propose a model with quality choice:
   - Any shock that boosts income increases the demand for quality. Since quality is skill intensive, there is an endogenous rise in the skill premium.
   - One implication is that less skill-biased technical change is needed to explain the skill premium.

The past of the skill premium

- Use Fernald's (2014) estimates of the rate of HNTC (0.87 percent).
- Compute the rate of SBTC consistent with the change in the quality of goods consumed estimated by Bils and Klenow (2001).
- Our model accounts for the rise in the skill premium in the last four decades with an annual rate of SBTC of 1.05% per year.
- The canonical model requires a rate of SBTC of 5.5% per year.

Related literature

Technical change:

- Skill-biased technical change: e.g., Katz & Murphy (1992), Acemoglu (2003), Acemoglu & Autor (2011), Burnstein, Cravino and Vogel (2012), ...
- Investment-specific technical change: e.g., Krusell et al (2000), Polgreen and Silos (2008), ...

Skill-biased structural change:

- Across sectors or countries e.g., Verhoogen (2008), Buera, Kaboski and Rogerson (2015), Burnstein and Vogel (2016), ...

Between-firm income inequality:

- Automation, ICT, offshoring e.g., Bloom et al (2019), Acemoglu-Restrepo,...

Quality of Consumption:

- Rises with income e.g., Kugler and Verhoogen (2012), Fieler, Eslava and Xu (2017), Faber and Fally (2017), Jaravel (2018), Hottman, Redding and Weinstein (2018), ...

Measuring quality

1. Relative price within product categories or sectors.
2. Market shares, prices and quantities, combined with utility functional form assumptions.
   - e.g. Bils and Klenow (2001), Hottman, Redding and Weinstein (2016), Faber and Fally (2017), ...
3. Cost of materials and wages.
   - e.g. Veerhoogen (2008), Kugler and Verhoogen (2012),...

Strong evidence that relative prices are positively correlated with quality measures produced by the other two approaches.

1. Composition of consumption

Higher income households consume higher quality goods.

- Well-established fact in existing literature.

  e.g., Bils and Klenow (2011), Kugler and Verhoogen (2012), Fieler, Eslava and Xu (2017), Faber and Fally (2017), Jaravel (2018), ...

- Corroborating evidence:

  - Nielsen Homescan Data: Price and quantity data on groceries over 2004-10. 613 product modules. About 113K households.
  - CEX Data: Durable expenditures over 1980-2007.
  - Yelp! data for each establishment

1. Composition of consumption: Nielsen data

- Construct a price index per product module m:

$$\log P_{hmt} = \sum_i w_{himt} \log P_{himt}$$

where

$$\log \bar{P}_{imt} = \sum_{i \in m} w_{iht} \log \bar{P}_{it}$$

for household h, period t, UPC-store item i.

- The weight w_{iht} is the expenditure weight for item i

$$w_{iht} = \frac{p_{iht} c_{iht}}{\sum_{j \in m} p_{jht} c_{jht}}$$

and average price

$$\bar{P}_{it} = \sum_h \frac{p_{iht} c_{iht}}{\sum_h p_{iht} c_{iht}} p_{iht}.$$

- P_{hmt} reflect differences in composition of goods bought, or prices paid for the same item (due to sales, coupons, etc)

1. Composition of consumption: Nielsen data

- Construct a price index per product module m:

$$\log P_{hmt} = \sum_i w_{himt} \log \bar{P}_{imt}$$

- P_{hmt} reflect differences in composition of goods bought; **not** prices paid for the same item (due to sales, coupons, etc).

- Estimate

$$\log P_{hmt} = \beta_0 + \sum_k \beta_k 1(y_{ht} \in k) + \gamma X_{ht} + \lambda_t + \lambda_m + \epsilon_{hmt}$$

where y_{ht} denotes income quintile of household h.

1. Composition of consumption: Nielsen data

	log (Price, item-store)	
	(I)	(II)
Relative to income quintile 1:		
Income quintile 2	0.0399***	0.0398***
Income quintile 3	0.0911***	0.0908***
Income quintile 4	0.151***	0.150***
Income quintile 5 (top)	0.227***	0.224***
Time fixed effects	Yes	Yes
Product module fixed effects	Yes	Yes
Demographic controls		Yes

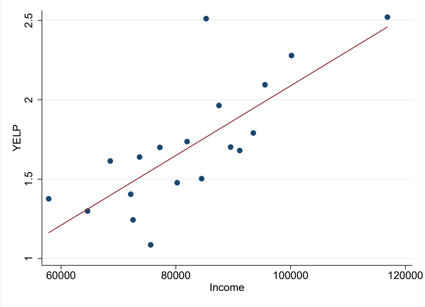
Example: Tide Plus Ultra Stain Release vs. White Cloud Laundry.

1. Composition of consumption: CEX

Consumer Expenditure Survey Durables	log(Price, Category)	
	(I)	(II)
Relative to income quintile 1:		
Income quintile 2	0.205***	0.197***
Income quintile 3	0.368***	0.353***
Income quintile 4	0.533***	0.513***
Income quintile 5 (top)	0.834***	0.82***
Time fixed effects	Yes	Yes
Category fixed effects	Yes	Yes
Demographic controls	Yes	

Examples: automobiles, mattresses, sofas, refrigerators and freezers, microwaves, ovens, carpeting and rugs, watches, ...

1. Composition of consumption: Credit card data and Yelp



- For each establishment, Yelp! provides relative price information: $ (low), $$ (middle), $$$ or $$$$ (high)

Examples: restaurants, hairdressers, auto repairs, movers, ...

2. Skill composition of labor

A greater share of workers in high-quality firms are high-skilled.

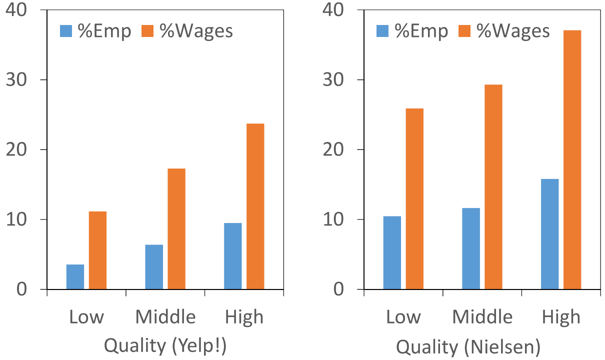
- Microdata of Occupational Employment Statistics (BLS)
  - # employees for 12 wage bins per occupation-establishment
  - Over 800 detailed SOC occupation classifications
  - 1.1 million establishments; covering 62% total employment
  - Establishments span all sectors based on NAICS 6-digit code.

- Classify workers as high skill if their wage is above the average wage of college graduates in the industry (matched to CPS data). Details

2. Skill composition of labor: E.g. Restaurants

- Key occupations in OES data:
  - Managers and executives
  - Chefs and head cooks
  - First-line supervisors of food preparation
  - Cooks and food preparation workers
  - Waiters and waitresses, serving workers
  - Marketing and sales
- Chefs account for: 2% of workers in limited-service places vs. 20% in full-service restaurants and 30% at Alinea Chicago.

2. Skill composition of labor: Share of high-skill workers



- Share of high-skill workers is about 1.2-2.6 times higher in high quality firms than low quality firms.

Yelp! sectors: information, professionals, finance, health care, entertainment, real estate, retail and accommodation. **Nielsen sector:** food manufacturing. ▸ Details

Tasks: Abstract, Routine and Manual

Sample	#Firms	Routine		Non-Routine Manual		Non-Routine Abstract	
		Emp	Wage	Emp	Wage	Emp	Wage
By Price Tier:							
Low	384	76.66	62.78	5.24	3.36	18.10	33.87
Middle	339	80.62	62.77	2.35	1.57	17.03	35.66
High	374	69.16	51.44	7.60	3.95	23.24	44.60

As the firm's price of the product rises:

- Share of workers doing routine tasks falls and share of workers doing abstract tasks rises. Back

Summary of motivating empirical facts

1. Quality of consumption rises with income.

2. Firms that produce these high-quality items require a larger share of high-skill workers.

We now construct a model consistent with these empirical findings to explore the implications for the rise in skill premium.

Our model

- High- and low-skill workers, exogenous supply.
- Structural change model incorporating 2 key features:
  1. Endogenous quality choice.
  2. Higher-quality goods employ more high-skill workers.
- Consider (i) homogenous household model, and (ii) heterogeneous household model.

Household choice

- Consider first a model where low-skill and high-skill workers belong to the same household and pool their income to buy consumption goods.
- Households consume one unit and can choose only one quality, q.

$$Max_q U = V(q)$$

s.t.

$$P(q) = HW_H + LW_L$$

where

$$V' > 0, V'' \leq 0$$

Production function

- Production function for a good with quality q:

$$Y_q = A\left[\alpha\left(SH\right)^{\rho} + q^{-\gamma\rho}(1-\alpha)\left(L\right)^{\rho}\right]^{\frac{1}{\rho}}$$

- Two key features (for $0 < \rho < 1$ and $0 < \gamma < 1$):

1. Prices increase with quality

$$P_q = \frac{1}{A}\left[\alpha^{\frac{1}{1-\rho}}\left(S\right)^{\frac{\rho}{1-\rho}} W_H^{\frac{\rho}{\rho-1}} + (1-\alpha)^{\frac{1}{1-\rho}}\left(q\right)^{\frac{\gamma\rho}{\rho-1}} W_L^{\frac{\rho}{\rho-1}}\right]^{\frac{\rho-1}{\rho}}.$$

2. Quality is intensive in high-skill labor:

$$\frac{W_H}{W_L} = \frac{\alpha q^{\gamma\rho}\left(S\right)^{\rho}}{(1-\alpha)}\left(\frac{H}{L}\right)^{\rho-1}.$$

Production function

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2. Quality is intensive in high-skill labor:

$$\Delta\log\left(\frac{W_H}{W_L}\right) = \rho\Delta\log\left(S\right) + \gamma\rho\triangle\log(q) + (\rho-1)\Delta\log\left(\frac{H}{L}\right)$$

How does the model work?

$$\Delta \log\left(\frac{W_H}{W_L}\right) = \rho\Delta \log(S) + \gamma\rho\triangle \log(q) + (\rho-1)\Delta \log\left(\frac{H}{L}\right)$$

where

$$q = \left[A(1-\alpha)^{1/\rho}\left(\frac{W_H}{W_L}H + L\right)\left(\frac{W_H H}{W_L L}+1\right)^{(1-\rho)/\rho}\right]^{1/\gamma}.$$

Role of quality choice:

1. Amplifies the effect of $\triangle S$.
2. $\triangle A$ leads to $\triangle q$ and therefore W_H/W_L.
3. $\triangle q$ dampens the effect of a rise in H/L on W_H/W_L.

Quantitative results

From data:

- $\frac{W_H}{W_L} = 1.57$ in 1970 and $\frac{W_H}{W_L} = 1.95$ in 2008.
- $\frac{H}{L+H} = 0.31$ in 1970 and $\frac{H}{L+H} = 0.58$
- $\triangle A$ of 0.87% per year (Fernald (2014)).

Parameters

- $\rho = 0.4118$ (Acemoglu and Autor (2010)).
- γ to match rise in quality of 3.8% per year from 1970 and 2008 (Bils and Klenow (2001)).

Infer $\triangle S$ from the model.

Quantitative results

		Cumulative $\Delta(W_H/W_L)$	
ΔA	ΔS	Trading-up model	Canonical model
0.00	0.00	-46%	-65%

1. If $\triangle A = \triangle S = 0$, then skill premium falls.
   - Smaller fall in skill-premium in trading-up model because quality rises due to larger supply of skilled workers.

Quantitative results

		Cumulative $\Delta(W_H/W_L)$	
ΔA	ΔS	Trading-up model	Canonical model
0.00	0.00	-46%	-65%
0.87	5.50		25%

2. Large rise in S to account for rise in skill premium in canonical model.

- $\triangle A$ plays no role.

Quantitative results

		Cumulative $\Delta(W_H/W_L)$	
ΔA	ΔS	Trading-up model	Canonical model
0.00	0.00	−46%	−65%
0.87	5.50		25%
0.87	1.05	25%	

3. Smaller rise in S to account for rise in skill premium in trading-up model.
   - $\triangle q$ amplifies effects of $\triangle S$, $\triangle A$ and $\triangle H/L$.

Quantitative results

		Cumulative $\Delta(W_H/W_L)$	
ΔA	ΔS	Trading-up model	Canonical model
0.00	0.00	−46%	−65%
0.87	5.50		25%
0.87	1.05	25%	
0.87	0.00	−25%	−65%

4. Considering the role of $\triangle A$:
   - $\triangle A$ accounts for 30% of the rise in skill premium.

$$[-25 - -(46)]/[25 - (-46)] = 30\%$$

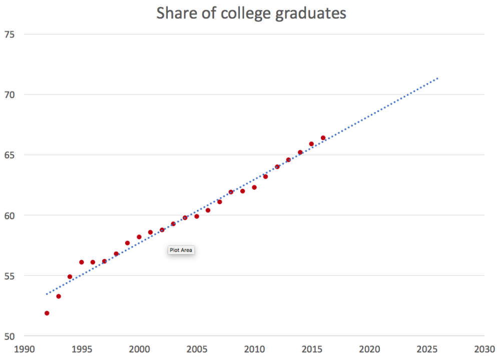
Quantitative results

		Cumulative $\Delta(W_H/W_L)$	
ΔA	ΔS	Trading-up model	Canonical model
0.00	0.00	−46%	−65%
0.87	5.50		25%
0.87	1.05	25%	
0.87	0.00	−25%	−65%

Key implications:

- Smaller changes in $\triangle S$ can lead to large changes in skill premium.
- Skill premium can continue to rise in the future, even absent any $\triangle S$.

The future of the skill premium



- Suppose the fraction of college-educated workers continues its long-term trend: 2008 = 62%, 2026 = 71%.
- Combine with forecast of rate of HTBC (Fernald, 2016).

The future of the skill premium

ΔA	ΔS	Cumulative $\Delta(W_H/W_L)$ (percent)	
		Trading-up model	Canonical model
0.0	0.0	−14	−21
0.8	0.0	25	−21

- Labor supply response reduces the skill premium and inequality.
- Quality response is a force that pushes up the skill premium.

Robustness

1. Heterogeneous households and multiple qualities of goods:
   - Consider a simple extension of the model for two types.

2. Quantity and quality choice:
   - Consider two goods: homogenous good and quality.
     - Bils-Klenow set-up

$$max_{C,q} \frac{C^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} + \frac{\nu \times q^{1-\frac{1}{\sigma_q}}}{1-\frac{1}{\sigma_q}}$$

   - Same production function. For homogenous good, $\gamma = 0$.
   - Implied SBTC required to match rise in SP: 1.42% Details

Conclusion

Quantitatively:

- Less SBTC to rationalize the observed rise in skill premium.
- Any shock that boost income leads to a rise in skill premium.

Implications:

- Policies that increase the supply of high skilled workers reduces the skill premium and inequality, based on the canonical model.
- Our paper suggests that these policies are less effective than we thought for lowering the skill premium because of endogenous quality choice.

Model 2: Multiple qualities

- The empirical findings were relevant for multiple qualities and goods
- Consider a simple extension of the model for two types
- Reassuringly, similar findings

Model 2: consumer

For high skilled:

$$Max_{q_H} U = V(q_H)$$

s.t.

$$P(q_H) = HW_H$$

For low skilled:

$$Max_{q_L} U = V(q_L)$$

s.t.

$$P(q_L) = LW_L$$

Model 2: production function

- Per each quality $j \in \{L, H\}$:

$$Y_{q_j} = A\left[\alpha\,(SH_j)^{\rho} + q_j{}^{-\rho}(1-\alpha)\,(L_j)^{\rho}\right]^{\frac{1}{\rho}}$$

$$P_{q_j} = \frac{1}{A}\left[\alpha^{\frac{1}{1-\rho}} S^{\frac{\rho}{1-\rho}} W_H^{\frac{\rho}{\rho-1}} + q_j{}^{\frac{\rho}{\rho-1}}(1-\alpha)^{\frac{1}{1-\rho}} W_L^{\frac{\rho}{\rho-1}}\right]^{\frac{\rho-1}{\rho}}$$

$$\frac{W_H}{W_L} = \frac{\alpha}{1-\alpha}\,(q_j \times S)^{\rho}\left(\frac{H_j}{L_j}\right)^{\rho-1}$$

Model 2: equilibrium

- Given observed changes in skill premium and inputs:
  - Search for combination of A, S that is consistent with change in the skilled premium and the change in the relative supply of skilled workers.
- Allocation across the two sectors is endogenous and part of the equilibrium solution
  - Ratio of wage bill in high to low quality: 2.5 in the model vs. 2 in the data

Quality and skilled workers

Yelp!: High-quality firms employ a larger share of high-skill workers.

Sample	#Est.	Skilled 1		Skilled 2		Skilled 3	
		Emp	Wage	Emp	Wage	Emp	Wage
Yelp Sample	9,908	6.01	16.9	13.94	29.02	15.40	31.14
By Quality:							
$	2,316	3.54	11.15	9.60	21.32	11.48	23.81
$$	6,089	6.38	17.28	14.94	30.19	16.01	31.80
$$$	1,503	9.49	23.72	19.40	36.97	21.53	40.24

- Share of high-skill workers is about 1.5-2.6 times higher in high quality firms than low quality firms.

Back

Quality and skilled workers

Nielsen sample: High-quality firms employ a larger share of high-skill workers.

Sample	#Firms	Skilled 1		Skilled 2		Skilled 3	
		Emp	Wage	Emp	Wage	Emp	Wage
Nielsen Sample	1,097	12.64	30.76	22.04	42.43	28.04	48.30
By Quality:							
Low	384	10.46	25.89	20.47	38.67	26.03	44.04
Middle	339	11.63	29.30	21.14	41.25	26.55	46.82
High	374	15.79	37.08	24.48	47.38	31.45	54.02

- Share of high-skill workers is about 1.5-2.6 times higher in high quality firms than low quality firms.

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Establishments' share of skilled workers

Sample	#Est.	Skilled 1		Skilled 2		Skilled 3	
		Emp	Wage	Emp	Wage	Emp	Wage
All Sectors	1,131,170	16.7	36.9	23.7	45.6	27.7	49.9
NAICS Sector:							
Management	13,997	50.3	53.6	63.5	59.5	61.0	63.0
Educational	39,385	33.6	25.4	38.0	38.2	40.9	48.0
Information	33,176	29.3	45.4	34.8	58.2	40.0	64.3
Utilities	6,217	29.8	30.3	35.9	31.1	55.9	31.6
Professional	106,407	28.9	29.1	34.3	38.1	37.6	48.6
Finance	56,599	23.6	53.8	30.1	59.6	31.9	64.9
Health Care	124,463	16.4	55.1	27.1	59.8	29.7	63.0
...							...
Manufacturing	107,826	13.9	43.1	20.9	49.4	29.8	59.6
Entertainment	26,549	12.0	38.9	20.0	53.2	19.7	55.5
Real Estate Rental	37,750	10.3	49.9	16.1	56.8	24.8	58.7
Retail	121,065	9.6	42.7	17.8	52.1	21.7	56.1
Accommodation	50,700	3.2	31.7	10.4	43.4	11.5	43.3

Back

Bils-Klenow Style Model

- Two goods: Homogenous and one quality.
- Same production function as previous model.
- For homogenous good, same CES with $\gamma = 0$

Back

Bils-Klenow Style Model

HH problem is given by

$$max_{C,q} \frac{C^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} + \frac{\nu \times q^{1-\frac{1}{\sigma_q}}}{1-\frac{1}{\sigma_q}}$$

subject to

$$P(q) \times 1 + C = HW_H + LW_L$$

where C is the "numeraire good".

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Bils-Klenow Style Model

Quality Good:

$$Y_q = A\left[\alpha\left(SH_q\right)^{\rho} + q^{-\gamma\rho}(1-\alpha)\left(L_q\right)^{\rho}\right]^{\frac{1}{\rho}}$$

Homogenous Good:

$$Y = A\left[\alpha\left(SH_{nq}\right)^{\rho} + (1-\alpha)\left(L_{nq}\right)^{\rho}\right]^{\frac{1}{\rho}}$$

Labor Market Clearing:

$$H = H_q + H_{nq};\ \ L = L_q + L_{nq}$$

Goods Market Clearing:

$$Y_q = 1;\ \ Y = C$$

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Bils-Klenow Style Model

- Feed Fernald (2014) HBTC values.
- Externally set parameters:
  - $\sigma = 1$ and $\frac{\sigma_q}{\sigma} = 0.76$ from Bils and Klenow.
  - $\rho = 0.41$ from Acemoglu and Autor.
- Parameters α , ν, γ calibrated to match moments:
  - Share of quaity good in expenditures over the sample 41%
  - $\frac{W_H H_q}{W_H H_q + W_L L_q} / \frac{W_H H_{nq}}{W_H H_{nq} + W_L L_{nq}} = 1.6713$
  - $BK = 0.038$ quality growth
  - Ratio of quality good price to numeraire of 2.0829

Implied SBTC required to match rise in SP: 1.42% Back