The Stolper-Samuelson Theorem when the Labor Market Structure Matters

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Research question

Consider the conclusion of Stolper and Samuelson Theorem (SST):

a rise in the relative price of a good determines an increase in the reward of that factor which is most intensively used in the production of that good and a fall in the return of the other factor.

Should we expect the SST to hold when there are <u>frictions in the factor market</u> and factors have <u>different bargaining power</u>?

Related Literature (1)

Theory: Davidson, Martin and Matusz, JPE (1988) JIE (1999)

- SST works for unemployed workers, and for workers who are employed in the sector in which they are intensively used.
- Ambiguous results for workers who are employed in a sector in which they are not intensively used.

Evidence: Davis and Mishra (NBER Chp. 2006), Goldberg and Pavnick (JEL, 2007), Haskel et al. (JEP, 2012)

- SST does not work, in particular for developing countries (relatively skill scarce) it predicts a decrease in the skill premium.

Related Literature (2)

SST is about between-group inequality

Matched employer-employee datasets document the importance of within-group and residual inequality

Theory: Helpman, Itskhoki, Redding (2010)

Evidence

- Sweden: Akerman, Helpman, Itskhoki, Muendler, Redding (2013)
- Brazil: Helpman, Itskhoki, Muendler, Redding (2014)

In AHIMR (2013) and HIMR (2014), at least 40% of overall inequality is across sector-occupations (where occupations are defined based on skills)

Motivation (1/3)

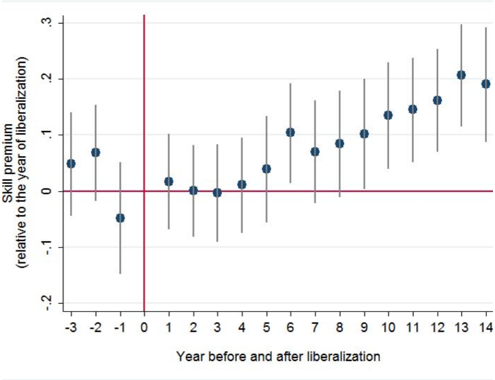

Figure : Plot of β_t from $log\left(w^s_{cit}/w^u_{cit}\right) = \sum_{t=-3}^{t=14} \beta_t I_{[t]} + controls + error$. Sample of 29 countries **c**, 15 industries **i** involved in a trade liberalization after 1983. Source: Own computations on ILO data, OWW database.

The skill premium rises following trade reforms.

Motivation (2/3)

Hall and Krueger (AEJ, 2012) survey a representative sample of US workers.

	Bargain?	Difference from base case
Knowledge worker	87%	+54%
	(4)	(7)
Blue collar	6%	-27%
	(2)	(6)
Observations	1,284	

Table : Responses to the survey, table 3 in Hall and Krueger (2012); bootstrap std. errors in parentheses.

The propensity to bargain increases with the skill of human service.

Motivation (3/3)

Hall and Krueger (AEJ, 2012), survey a representative sample of US workers.

	Bargain?	Difference from base case
Not HS graduate	29%	-3%
	(10)	(9)
Some college	43%	+11%
	(8)	(6)
College graduate	45%	+12%
	(8)	(6)
Profes. training	60%	+27%
	(9)	(7)
Observations	1,284	

Table : Responses to the survey, table 3 in Hall and Krueger (2012); bootstrap std. errors in parentheses.

The propensity to bargain increases with worker's education.

Contribution

With frictions and unemployment, factor prices are the outcome of:

1. Relative marginal product $\rightarrow$ pro SST
2. Rent sharing, with asymmetric shares $\rightarrow$ anti SST

In contrast to the previous literature, we argue that
the second channel works against Stolper-Samuelson when:

knowledge workers have higher bargaining power

- skilled factors extract relatively more of the surplus of a match, in the export sector as in the import sector.

Model - Outline of the Economy

- 2 countries: the domestic economy (small) and the RofW
- 2 factors: labor **L** and knowledge **K**
- 2 sectors: knowledge-int. goods **S** and labor-int. goods **N**

Market structures:

\- Output

- large number of identical competitive firms
- homothetic preferences, CES technology

\- Factor

- unemployed search for **their own** skill, in **either** sectors
- firms post **skill** and **sector** specific vacancies at a cost γ
- workers and firms match randomly

Model - Market for Factors of Production (1/2)

For each factor $f = \{L, K\}$ employed in each sector $y = \{N, S\}$

- CD matching technology, such that the matching probabilities are a function of the **factor market tightness**:

$$\theta_{fy} = \frac{v_{fy}}{u_{fy}} \tag{1}$$

- Continuous time Bellman equations for the value of employment **E**, unemployment **U**, job **J** and vacancy **V**.

- Conditions hold for the economy to remain diversified, s.t. there are workers in both sectors.
  - mobility frictions (extension)

Model - Market for Factors of Production (2/2)

- The price of labor w_y and the return to knowledge r_y in every sector $y = \{N, S\}$ are the outcome of Nash bargaining

$$\begin{aligned} \mu_L \left[J\left(w_y\right) - V\right] &= \left(1 - \mu_L\right)\left[E\left(w_y\right) - U_L\right] \\ \mu_K \left[J\left(r_y\right) - V\right] &= \left(1 - \mu_K\right)\left[E\left(r_y\right) - U_K\right] \end{aligned} \tag{2}$$

- Free entry

$$V = 0 \tag{3}$$

- Knowledge workers have higher bargaining power: $\mu_K > \mu_L$

Equilibrium Conditions

micro

- firms make zero profit, *"zero profit condition"*
- the value of a job under free entry is equal to the expected cost of hiring, *"job creation"*
- factor prices satisfy the bargaining under free entry, *"wage equation"*

Macro

- Steady state employment flows and factor markets clear (relative output supply)
- Optimal consumption allocation (relative output demand)
- Output market clears

Price index $P = 1$ and define the relative price $p = \frac{p_S}{p_N}$.

Within-sector Skill Premium

The within-sector skill premium is an increasing and concave function of the relative market tightness of the skilled factor:

$$\frac{r_N}{w_N} = \left(\frac{\theta_{KN}}{\theta_{LN}}\right)^{\alpha} = \left(\frac{\mu_L}{\mu_K}\frac{1-\mu_K\left(1+x_N\right)}{1-\mu_L\left(1+x_N\right)}\right)^{\frac{\alpha}{1-\alpha}} \tag{4}$$

$$\frac{r_S}{w_S} = \left(\frac{\theta_{KS}}{\theta_{LS}}\right)^{\alpha} = \left(\frac{\mu_L}{\mu_K}\frac{1-\mu_K\left(1+x_S\right)}{1-\mu_L\left(1+x_S\right)}\right)^{\frac{\alpha}{1-\alpha}}$$

where $\alpha \in (0,1)$ is the unemployment share in matching tech.

The skill premium depends on the **share of hiring cost over production cost** in the sector: $x_N = \frac{\gamma}{c_N}\frac{v_N}{N}$ and $x_S = \frac{\gamma}{c_S}\frac{v_S}{S}$

Within-sector Skill Premium

Proposition 1. The difference in factor's bargaining power is a necessary condition for the existence of within-sector skill premium.

Proof. Consider (4). If $\mu_L = \mu_K$ then the skill premium is $\frac{r}{w} = 1$, regardless the sector.

Proposition 2. If the bargaining power of knowledge workers is higher $\mu_K > \mu_L$, then the within-sector skill premium is a decreasing function of the share of hiring cost over production cost in the sector x_y.

Proof. Consider (4). If $\mu_K > \mu_L$ then
$sign\left\{\frac{\partial(r_y/w_y)}{\partial x_y}\right\} = sign\left\{\mu_L - \mu_K\right\} < 0$ for every sector $y = \{N, S\}$.

Skill Premium

Proposition 3. If the relative price of knowledge-intensive goods in the international market is lower than in autarky, $\varphi < p$ then opening to trade leads to:

(3.1) change in the within-sector skill premium

- Knowledge-intensive sector $\downarrow$
- Labor-intensive sector $\uparrow$

(3.2) change in the employment size of the two sectors

- Knowledge-intensive sector: *contraction*
- Labor-intensive sector: *expansion*

The composition of the two channels determines an increase of the weighted average skill premium.

Mechanism (1/3)

The system of **job creation** and **wage equation** yields the factor market tightness

$$\theta_{fy} = \left(\frac{1 - \mu_f (1 + x_y)}{\mu_f x_y} \right)^{\frac{1}{1-\alpha}} \tag{5}$$

and factor prices,

$$\begin{aligned} w_y &= \frac{\gamma}{x_y} \left(\frac{1 - \mu_L (1 + x_y)}{\mu_L x_y} \right)^{\frac{\alpha}{1-\alpha}} = \frac{\gamma}{x_y} \theta_{Ly}^{\alpha} \\ r_y &= \frac{\gamma}{x_y} \left(\frac{1 - \mu_K (1 + x_y)}{\mu_K x_y} \right)^{\frac{\alpha}{1-\alpha}} = \frac{\gamma}{x_y} \theta_{Ky}^{\alpha} \end{aligned} \tag{6}$$

decreasing functions of the hiring cost share in the sector x_y.

Mechanism (2/3)

The system of **zero profit condition** and equilibrium factor prices (6) yields the "*price equation*":

$$\frac{x_y}{1+x_y}p_y \quad = \quad \gamma\left[\lambda_y^{\tau}\theta_{Ly}^{\alpha(1-\tau)}+\kappa_y^{\tau}\theta_{Ky}^{\alpha(1-\tau)}\right]^{\frac{1}{1-\tau}} \tag{7}$$

as a function of the hiring cost share x_y,

- l.h.s. of (7) is an increasing and concave function that spreads out from the origin and it tilts up the higher is the output price p_y.
- r.h.s. of (7) goes to infinity for $x_y \to 0$ and it goes to zero for $x_y \to \frac{1-\mu_K}{\mu_K}$.

Mechanism (3/3)

$p \downarrow$ the price of labor-intensive goods $p_N = \left(\frac{1}{1+p^{1-\sigma}}\right)^{\frac{1}{1-\sigma}} \uparrow$

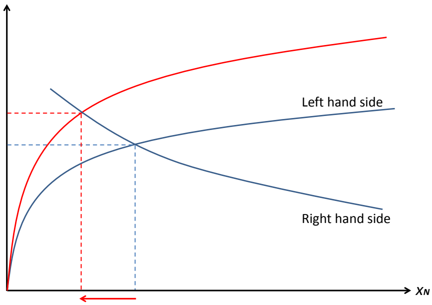

Figure : Price equation (7) in the labor-intensive sector.

Prop. 2 $\Longrightarrow$ skill premium in the labor-intensive sector $\uparrow$

Mechanism (3/3)

$p\downarrow$ the price of knowledge-intensive goods $p_S = \left(\frac{p^{1-\sigma}}{1+p^{1-\sigma}}\right)^{\frac{1}{1-\sigma}} \downarrow$.

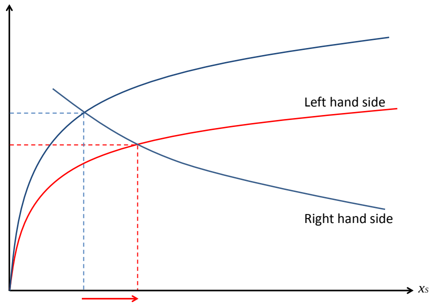

Figure : Price equation (7) in the knowledge-intensive sector.

Prop. 2 $\implies$ skill premium in the knowledge-intensive sector $\downarrow$

Implications

- Workers in the labor-intensive sector gain from trade, both in real and in nominal terms; workers who remain employed in the knowledge-intensive sector lose.

- The ex-ante expected reward in the knowledge-intensive sector falls, whereas it rises in the labor-intensive sector.
  $\Longrightarrow$ reallocation of workers from the knowledge-intensive sector to the labor-intensive sector (as predicted by the classical theory).

- After the trade liberalization, more workers are allocated to the sector in which the skill premium rises.
  $\Longrightarrow$ rise of the average skill premium across employed workforce (the opposite of what the classical theory predicts).

Conclusions

1. Evidence in favor of an increase of the skill premium after trade liberalization.
2. Simple theory of trade and factor market frictions based on one channel that differs from the previous literature: knowledge workers have higher bargaining power.
3. Under these circumstances, in an economy that exports labor-intensive goods the market tightness for knowledge workers can increase, leading to a rise of the skill premium.

Further work has to be done

- investigate the properties of the model as factor market frictions vanish
- provide a quantitative analysis of the model based on the documented trade liberalization episodes

Appendix

Model - Market for Factors of Production (1/3)

For each factor $f = \{L, K\}$ employed in each sector $y = \{N, S\}$,

- CD matching technology with unemployment share $\alpha \in (0, 1)$

$$\theta_{fy} = \frac{v_{fy}}{u_{fy}} \ , \ m = \min\left\{\theta_{fy}^{\alpha}, 1\right\} \ , \ h = \min\left\{\theta_{fy}^{\alpha-1}, 1\right\}$$

- Every worker has been employed at least once and employed workers who separate search for a job in either one of the two sectors.
- Unemployed workers of type f previously employed in sector y who search for a job in a different sector $\not{y}$ lose a share $\psi_f \in [0, 1)$ of the value of searching in the new sector.

Model - Market for Factors of Production (2/3)

Given the factor price $z_y = \{w_y, r_y\}$ and the marginal revenue associated to factor f in sector y, MR_{fy},

- Value of **E**mployment and **U**nemployment

$$\begin{aligned} \varrho E_{fy}(z_y) &= z_y + \delta \left[max\left\{ U_{fy}, (1-\psi_f) U_{fy} \right\} - E_{fy}(z_y) \right] \\ \varrho U_{fy} &= m(\theta_{fy}) \left[E_{fy}(z_y) - U_{fy} \right] \end{aligned} \tag{8}$$

- Value of a **J**ob and value of a **V**acancy

$$\begin{aligned} \varrho J_{fy}(z_y) &= MR_{fy} - z_y + \delta \left[V - J_{fy}(z_y) \right] \\ \varrho V &= -\gamma + h(\theta) \left[J_{fy}(z_y) - V \right] \end{aligned} \tag{9}$$

Definition of Equilibrium

- quantities of output consumption $\{S_c, N_c\}$, output production $\{S_p, N_p\}$ and prices $\{p_S, p_N\}$
- factor prices $\{w_y, r_y\}$, vacancies $\{v_{Ly}, v_{Ky}\}$, factor market tightness $\{\theta_{Ly}, \theta_{Ky}\}$

such that:

- the representative consumer is rational

$$N_c = \frac{I}{P}\left(\frac{p_N}{P}\right)^{-\sigma} \quad , \quad S_c = \frac{I}{P}\left(\frac{p_S}{P}\right)^{-\sigma} \tag{10}$$

- the representative firms in both sectors are rational

$$c_y = \left[\lambda_y^{\tau} w_y^{1-\tau} + \kappa_y^{\tau} r_y^{1-\tau}\right]^{\frac{1}{1-\tau}} \tag{11}$$

factor marginal revenues in the two sectors $y = \{N, S\}$ are: $MR_{Ly} = p_y\left(w_y/c_y\right)$ and $MR_{Ky} = p_y\left(r_y/c_y\right)$

Intermediate steps

- Prices

$$p_N = \left(\frac{1}{1+p^{1-\sigma}}\right)^{\frac{1}{1-\sigma}} P \quad , \quad p_S = \left(\frac{p^{1-\sigma}}{1+p^{1-\sigma}}\right)^{\frac{1}{1-\sigma}} P \quad , \quad P = 1$$

- Beveridge curve

$$\begin{aligned} m(\theta_{LN})\, u_{LN} &= \delta L_N \quad , \quad m(\theta_{KN})\, u_{KN} = \delta K_N \\ m(\theta_{LS})\, u_{LS} &= \delta L_S \quad , \quad m(\theta_{KS})\, u_{KS} = \delta K_S \end{aligned}$$

- Loading factors

$$\ell_{fy} = \left(\frac{\lambda_y c_y}{z_y}\right)^{\tau} \quad , \quad e_{fy} = \frac{m(\theta_{fy}) + \delta}{m(\theta_{fy})}$$

- *Frontier of production possibilities*:

$$\begin{aligned} e_{LN}\ell_{LN}\ N_p + e_{LS}\ell_{LS}\ S_p &= L \\ e_{KN}\ell_{KN}\ N_p + e_{KS}\ell_{KS}\ S_p &= K \end{aligned}$$

Mechanism

Multiplying both sides of the zero profit condition (**??**) by the factor marginal productivities $\frac{w_y}{c_y}$ and $\frac{r_y}{c_y}$ yields the revenue associated to the marginal unit of labor and knowledge in the two sectors:

$$\begin{aligned} MR_{LN} &= (1+x_N)\,w_N \quad , \quad MR_{KN} = (1+x_N)\,r_N \\ MR_{LS} &= (1+x_S)\,w_S \quad , \quad MR_{KS} = (1+x_S)\,r_S \end{aligned}$$

Arbitrage condition

In the long run, $m\left(\theta_{fS}\right)\left[E_{fS} - U_{fS}\right] = \left(1 - \psi_f\right) m\left(\theta_{fN}\right)\left[E_{fN} - U_{fN}\right]$:

$$\begin{aligned} \frac{w_N}{w_S} &= a_L \, \frac{\varrho + \delta + \epsilon \theta_{LN}^{1-\alpha}}{\varrho + \delta + \epsilon \theta_{LS}^{1-\alpha}} \left(\frac{\theta_{LS}}{\theta_{LN}}\right)^{1-\alpha} \\ \frac{r_N}{r_S} &= a_K \, \frac{\varrho + \delta + \epsilon \theta_{KN}^{1-\alpha}}{\varrho + \delta + \epsilon \theta_{KS}^{1-\alpha}} \left(\frac{\theta_{KS}}{\theta_{KN}}\right)^{1-\alpha} \end{aligned} \tag{12}$$

where $a_f = \frac{1}{1-\psi_f} \geq 1$ is the distortion in factor prices across sectors induced by the attachment of unemployed workers of type $f = \{L, K\}$ to the sector of their previous employment.

Mobility

Proposition 4. A fall in the relative price of the skill intensive good determines an increase of the skill premium in both sectors if:

(i) factors are complements $\tau \in (0, 1)$ and knowledge workers are less willing to switch sector than labor workers;

(ii) factors are substitutes $\tau > 1$ and knowledge workers are more willing to switch sector than labor workers;

such that:

$$\left(\frac{a_K}{a_L}\right)^{\frac{\alpha(1-\tau)}{\tau}} > \frac{\lambda_N/\kappa_N}{\lambda_S/\kappa_S} > 1 \tag{13}$$