Intraindustry Trade and the Wage Premium: Theory and Evidence

by

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INTRODUCTION

An extensive and influential body of literature has documented the change in the demand for high-skilled labor and the skill premium during the 1980s and 1990s.

In contrast to the general consensus on the increase in the skill premium in developed countries, the evidence for developing countries is mixed

A small but growing literature has proposed several novel mechanisms linking economic openness to skill-biased technological change and the skill premium.

Feenstra and Hanson (1996, 1999) proposed international outsourcing.

Dinopoulos and Segerstrom (1999) proposed the Schumpeterian mechanism.

Neary (2002) advanced a mechanism that links trade to wages through strategic interactions among competing oligopolists.

This paper proposes an alternative mechanism of income distribution that operates in markets characterized by Chamberlinian (1933) monopolistic competition.

The Chamberlinian mechanism derives its strength from two distinguishing features.

> **First, preferences are quasi-homothetic in the quantities consumed.**
>
> **Second, production exhibits non-homothetic internal scale economies.**

The theoretical model generates several interesting predictions.

> **A move from autarky to free international trade increases the output per variety and the level of total factor productivity.**
>
> **The effect of intraindustry trade on the skill premium depends on the output elasticity of substitution.**
>
> > **If the output elasticity of substitution is negative then a move from autarky to free trade reduces the skill premium in both countries.**
>
> **If countries differ in skill abundance intraindustry trade does not equalize the skill premium internationally.**

The empirical analysis is based on Mexican plant level data for 1993-2003 and provides strong support for the Chamberlinean mechanism.

First, we find a strong and significant positive correlation between trade liberalization and output of a typical Mexican plant.

We also find that, if plant output is not controlled for, trade liberalization (measured by the standard index of intraindusty trade) does not have a significant impact on the Mexican skill premium.

However, once we control for plant output, intraindustry trade leads to a reduction in the Mexican skill premium.

THE MODEL

The world we consider consists of two countries, Home and Foreign, which may differ in factor endowments.

In each economy there is a single sector producing similar products under increasing returns to scale

It is thus sufficient to describe only Home's economy.

2.1 A Translated Additive Utility Function

Every individual i has taste for variety, as indicated by the additive utility function

$$U^i = \sum_{j=1}^{m} u(x_j^i), \qquad (1)$$

The sub-utility function $u(x_j^i)$ is assumed to take the form

$$u(x_j^i) = (x_j^i + \theta)^{\rho} \quad for\ x_j^i > 0 \qquad (2)$$

Noting that $\varepsilon = 1/(1-\rho) > 1$, it is possible to derive the following expression for the price elasticity of demand x_j for a typical variety j:

$$\eta_j \equiv -\frac{p_j}{x_j}\frac{\partial x_j}{\partial p_j} = \varepsilon\left(1 + \frac{\theta N}{x_j}\right) > 1 \qquad j = 1, 2, \ldots, m; \qquad (3)$$

2.2 The Output Elasticity of Substitution

The technology for each produced variety is non-homothetic, exhibits increasing returns to scale, and does not differ across varieties.

In our framework, all firms are symmetric and thus in equilibrium each firm supplies the same quantity of each variety.

Output is produced by the following augmented CES production function

$$x = \left[(\Phi_H Z_H)^{\frac{\sigma-1}{\sigma}} + (\Phi_L Z_L)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \qquad \textbf{(4)}$$

where Z_H **and** Z_L **are the amounts of high- and low-skilled labor employed by the firm.**

$\sigma \in (0,\infty)$ **is the constant (wage) elasticity of substitution**

Φ_H**,** Φ_L **are two distinct functions capturing the efficiency of high-skilled and low-skilled labor, respectively.**

The efficiency of labor is a function of market size measured by the representative firm's output.

$$\Phi_H(x) = x^{\gamma_H}; \qquad \Phi_L(x) = x^{\gamma_L}. \qquad \textbf{(5)}$$

Parameters $\gamma_H \in (0,1)$ **and** $\gamma_L \in (0,1)$ **respectively capture the (constant) output elasticities of high-skilled and low-skilled labor efficiency.**

Let us now explore the analytical properties of the proposed technology through the corresponding unit-cost function it implies.

The total cost function is given by $C(w_H, w_L, x) \equiv c(w_H, w_L, x)x$**, where**

$$c(w_H, w_L, x) = \left[\left(\frac{w_H}{\Phi_H} \right)^{1-\sigma} + \left(\frac{w_L}{\Phi_L} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} = \left[\left(x^{-\gamma_H} w_H \right)^{1-\sigma} + \left(x^{-\gamma_L} w_L \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \qquad \textbf{(6)}$$

is the corresponding unit-cost function.

Differentiating (6) with respect to each wage rate yields the unit-output requirements for high- and low-skilled labor

$$\alpha_H(\omega, x) \equiv \frac{\partial c(w_H, w_L, x)}{\partial w_H} = \left[\left(x^{-\gamma_H} \omega \right)^{1-\sigma} + \left(x^{-\gamma_L} \right)^{1-\sigma} \right]^{\frac{\sigma}{1-\sigma}} \omega^{-\sigma} x^{(\sigma-1)\gamma_H} \qquad \textbf{(7)}$$

$$\alpha_L(\omega, x) \equiv \frac{\partial c(w_H, w_L, x)}{\partial w_L} = \left[\left(x^{-\gamma_H} \omega \right)^{1-\sigma} + \left(x^{-\gamma_L} \right)^{1-\sigma} \right]^{\frac{\sigma}{1-\sigma}} x^{(\sigma-1)\gamma_L} \qquad \textbf{(8)}$$

where $\omega \equiv w_H / w_L$ **is the relative wage of high-skilled labor and is identified with the skill premium.**

Dividing (7) by (8) yields the following expression for the representative firm's relative demand for high-skilled labor (the skill-intensity of production):

$$\frac{\alpha_H(\omega, x)}{\alpha_L(\omega, x)} = \omega^{-\sigma} x^{(\sigma-1)(\gamma_H - \gamma_L)}. \qquad \textbf{(9)}$$

Taking logs and differentiating (9) yields the standard *wage* elasticity of substitution

$$\sigma \equiv -\partial \ln(\alpha_H / \alpha_L) / \partial \ln \omega .$$

In addition, (9) generates the non-standard *output* elasticity of substitution

$$\lambda \equiv \partial \ln(\alpha_H / \alpha_L) / \partial \ln x = (\sigma - 1)(\gamma_H - \gamma_L).$$

Definition 1: ***The output elasticity of substitution is defined as the percentage change in the ratio of high-skilled to low-skilled labor demanded brought about by an one percent change in output. The production function exhibits output-skill complementarity, output-skill substitutability, or output-skill neutrality if and only if the output elasticity of substitution λ is positive, negative or zero, respectively.***

In the case of constant marginal costs, the output-elasticity of substitution would be negative (positive) if fixed costs were high-skilled (low-skilled) labor intensive.

CLOSED ECONOMY EQUILIBRIUM

The typical firm will maximize its profit by choosing the level of output so that its marginal revenue is equal to its marginal cost

$$p\left[1-\frac{1}{\eta(x,N)}\right]=c(w_H,w_L,x)+xc_x(w_H,w_L,x), \tag{10}$$

Free entry and exit will drive economic profits down to zero

$$p=c(w_H,w_L,x). \tag{11}$$

The following full-employment conditions ensure factor market clearing and thus close the model:

$$\alpha_H(\omega,x)xm=H \tag{12}$$

$$\alpha_L(\omega,x)xm=L. \tag{13}$$

Substituting the zero-profit condition (11) into the optimality condition (10) and simplifying yields

$$\eta(x,N)=s(x,\omega), \qquad \textbf{(\textit{Pricing Condition})} \tag{14}$$

where

$$s(x,\omega) \equiv -\frac{c(w_H, w_L, x)}{x c_x(w_H, w_L, x)} = \frac{1 + x^{\lambda}\omega^{(1-\sigma)}}{\gamma_L + \gamma_H x^{\lambda}\omega^{(1-\sigma)}} > 1 \qquad \textbf{(15)}$$

is the inverse of the output elasticity of the unit cost function, and $\gamma_H < 1$ **and** $\gamma_L < 1$**.**

The second general-equilibrium condition is obtained by dividing (12) by (13) and substituting (9) to obtain

$$\frac{\alpha_H(\omega, x)}{\alpha_L(\omega, x)} = \omega^{-\sigma} x^{\lambda} = \frac{H}{L}. \quad \textbf{(\textit{Market-Clearing Condition})} \qquad \textbf{(16)}$$

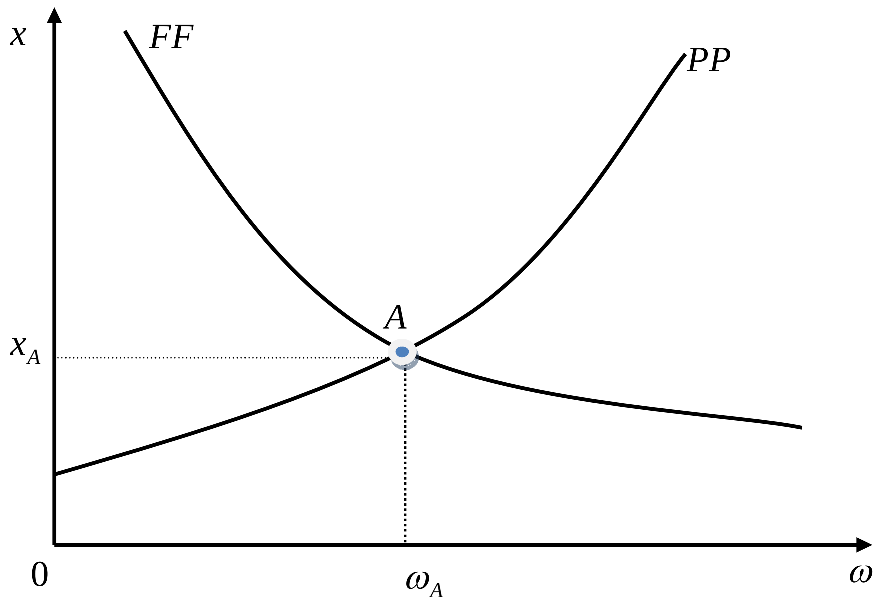

Fig.1: Closed-Economy Equilibrium ($\lambda < 0$)

EFFECTS OF INTRAINDUSTRY TRADE

Let us consider the case of output-skill substitutability ($\lambda < 0$).

The following Figure illustrates the impact of trade on the skill premium and the size of the representative firm in each country.

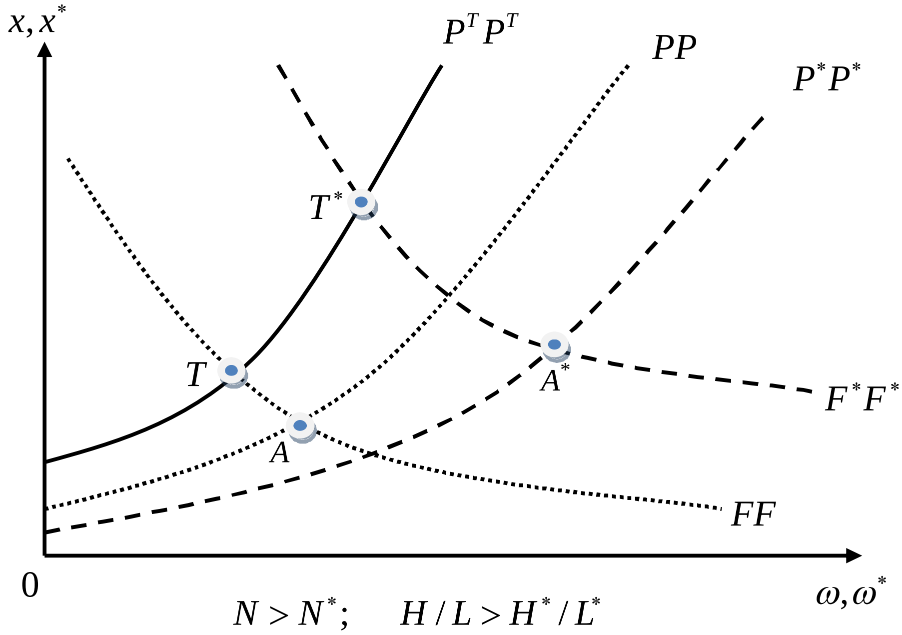

Fig. 2: Effects of Intraindustry Trade ($\lambda < 0$)

The *PP* curve lies to the left of the $P^* P^*$ curve because Home is assumed to be larger than Foreign.

The *FF* schedule is to the right of $F^* F^*$ because Home is skill-abundant.

The coordinates of points A and A^* determine the closed-economy equilibrium values of the skill premium and firm size at Home and Foreign, respectively.

We summarize these findings in two propositions:

Proposition 1: ***Suppose consumers in both countries consume positive quantities of all available varieties under free trade. Then, a move from autarky to free trade will***

(a) reduce the skill premium ω if the output elasticity of substitution λ is negative;

(b) increase the skill premium ω if the output elasticity of substitution λ is positive;

(c) induce the representative firm to expand its output x; and

(d) raise the total factor productivity.

The above changes are observed in both countries.

Proposition 2: ***Consider a free-trade equilibrium in which consumers throughout the world consume positive quantities of all available varieties. Then, in the presence of output-skill***

(a) ***substitutability ($\lambda < 0$), the skill premium ω and per variety output x are larger (smaller) in the high-skilled- (low-skilled-) labor-abundant country;***

(b) ***complementarity ($\lambda > 0$), the skill premium ω is lower (higher) and the per variety output x is larger (smaller) in the high-skilled- (low-skilled-) labor-abundant country.***

EVIDENCE FROM MEXICO

Equation (9) translates into the following econometric specification

$$\ln \alpha_{it} = \beta_0 + \beta_1 \ln \omega_{it} + \beta_2 \ln x_{it} + \varepsilon_{it}, \qquad \textbf{(17)}$$

where, for each plant i and period t, $\alpha_{it} \equiv \alpha_{H,it} / \alpha_{L,it}$ is the skill intensity of production.

Both of the covariates in (17) are potentially endogenous. To address this issue, we estimate the econometric model in first-differences:

$$\Delta \ln \alpha_{it} = \beta_0 + \beta_1 \Delta \ln \omega_{it} + \beta_2 \Delta \ln x_{it} + \varphi_j + \psi_t + \varepsilon_{ijt}, \qquad \textbf{(18)}$$

where we introduce a set of sector-specific fixed effects φ_j and a set of year dummies ψ_t to capture any sector- and time-specific economy-wide shocks.

Comparing equations (9) and (18) reveals that the wage and output elasticities of substitution are given by $\sigma = -\beta_1$ and $\lambda = \beta_2$ and $\gamma_H - \gamma_L = -\beta_2 / (\beta_1 + 1)$.

The following Table shows the estimates obtained.

Table 1: Wage, Output and Efficiency Elasticities

SECTOR	OLS				IV				
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	σ	λ	$Y_H - Y_L$	N	σ	λ	$Y_H - Y_L$	N	OVRID
Mnfctrng	.288**	-.073**	.102**	51581	.265**	-.074**	.101**	49532	0.371
	(.011)	(.006)	(.008)		(.032)	(.003)	(.006)		
Food	.310**	-.052**	.076**	9608	.310**	-.053**	.078**	9332	0.823
	(.025)	(.017)	(.024)		(.074)	(.008)	(.014)		
Textiles	.308**	-.069**	.100**	8209	.222**	-.068**	.087**	7897	0.332
	(.022)	(.012)	(.018)		(.067)	(.008)	(.013)		
Wood	.35**	-.094**	.144**	1933	.169	-.101**	.121**	1821	0.577
	(.038)	(.023)	(.037)		(.161)	(.017)	(.028)		
Paper	.331**	-.047**	.070**	3890	.533**	-.031**	.066**	3768	0.376
	(.053)	(.019)	(.029)		(.122)	(.015)	(.032)		
Chemicals	.238**	-.067**	.087**	10545	.191**	-.075**	.093**	10133	0.068
	(.020)	(.014)	(.018)		(.068)	(.008)	(.012)		
Minerals	.239**	-.105**	.138**	3766	.252*	-.099**	.133**	3608	0.89
	(.038)	(.022)	(.029)		(.107)	(.013)	(.025)		
Metals	.222**	-.085**	.109**	1279	.840**	-.066**	.413	1177	0.504
	(.076)	(.025)	(.036)		(.321)	(.025)	(.763)		
Machinery	.298**	-.070**	.100**	11774	.228**	-.072**	.093**	11225	0.162
	(.024)	(.010)	(.015)		(.076)	(.006)	(.010)		
Other	.240**	-.133**	.176**	577	.296	-.131**	.186**	568	0.863
	(.081)	(.045)	(.062)		(.278)	(.030)	(.067)		

Standard errors in parentheses. + p<0.10, * p<.05, ** p<.01. All estimates are of equation (18). Columns (2)-(5) report OLS results. Columns (6)-(9) report IV estimates. Column (10) reports p-values from Sargan tests of overidentification. Standard errors in columns (4) and (8) are obtained with the Delta method.

TRADE AND THE SKILL PREMIUM

We use the following econometric specification to investigate the effects of intraindustry trade on the skill premium in Mexican manufacturing:

$$\Delta \ln \omega_{it} = \beta_0 + \beta_1 \Delta T_{jt} + \beta_2 \Delta \ln \alpha_{it} + \beta_3 \Delta \ln x_{it} + \varphi_j + \psi_t + \varepsilon_{ijt}. \quad \textbf{(19)}$$

We introduce a new variable, T_{jt}, which captures sector-specific effects of trade.

Our most preferred measure of T_{jt} is the standard Grubel and Lloyd (1975) index of intraindustry trade (IIT).

We control for unobserved industry and time characteristics by including sector-specific dummies, φ_j, and time fixed effects, ψ_t.

Table 2: Intraindustry Trade and the Skill Premium

Covariate	No Output		Skill Intensity & Output				
	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	IIT	SKILL	IIT	L2.IIT	ALLTRADE	L2.IMP/EXP	NAFTA
Trade	0.036 (0.027)	0.002 (0.023)	-0.130** (0.052)	-0.132** (0.065)	-0.136*** (0.029)		-0.191*** (0.071)
Skill Intensity		-0.313*** (0.039)	-0.279*** (0.044)	-0.243*** (0.041)	-0.251*** (0.043)	-0.243*** (0.041)	-0.178** (0.064)
Output			0.273*** (0.097)	0.303*** (0.108)	0.262*** (0.096)	0.302*** (0.108)	0.286*** (0.105)
ΔIMP						0.157* (0.048)	
ΔEXP						-0.320** (0.099)	
First-Stage: Trade			0.491*** (0.032)	0.531*** (0.043)	0.291*** (0.016)		0.642*** (0.037)
ΔIMP						-0.321*** (0.044)	
ΔEXP						0.853*** (0.055)	
OVRID		0.49	0.33	0.03	0.04	0.04	0.59
R^2	0.001	0.07	0.07	0.07	0.07	0.07	0.07
N	51956	49829	49537	49537	49537	24210	30656

Standard errors in parentheses. * p < 0.10, ** p < .05, *** p < .01. The estimating equation is (19). The dependent variable is always the log of skill premium. Time and industry fixed effects estimates and most first-stage estimates from the IV regressions are omitted for brevity. The reported first-stage estimates capture the effects of trade on plant-level output. Row "OverId" reports p-values from Sargan tests of overidentification.

The empirical findings about the effects of trade on output and the skill premium of the typical manufacturing plant follow closely the theoretical predictions.

Intraindustry trade operates through changes in the output of a typical plant. These changes translate into changes in the skill premium via the Chamberlinian mechanism of income distribution.

The production technology of a typical Mexican manufacturing plant exhibits output-skill substitutability captured by a negative output elasticity of substitution. In this case, an increase in output reduces the skill premium and ameliorates wage-income inequality.

Our model of monopolistic competition and intraindustry trade strengthens the role of trade as an explanation of changes in the global demand for high-skilled labor independently of differences in skill abundance.

It also contributes to the literature that studies the link between international trade and the wage premium both in North (advanced countries) and South (developing countries).

CONCLUSIONS

We modified the traditional model of intraindustry trade based on monopolistic competition by introducing quasi-homothetic preferences and non-homothetic technology in the production of each variety.

These two modifications delivered the Chamberlinian mechanism of income distribution which operates in markets with internal economies of scale, product differentiation, and free entry and exit.

In the model, intraindustry trade flattens the inverse demand curve for each variety and intensifies competition pressures.

Trade induces each active firm to expand its output and generates total factor productivity improvements.

The output increase alters the relative demand for skilled labor and causes the skill premium to adjust.

More specifically, an increase in per firm output reduces the relative demand for high-skilled labor and lowers the skill premium if non-homotheticity in production takes the form of output-skill substitutability.

If technology exhibits output-skill complementarity, the increase in output boosts the relative demand for high-skilled labor, thereby raising the skill premium.

Since the Chamberlinian mechanism operates through changes in each firm's output, the above-mentioned changes occur in both trading countries.

To test the principal predictions of the model, we used Mexican plant-level data for the period 1993-2003.

The estimates of the wage elasticity of substitution (0.29), the output elasticity of substitution (-0. 073), and the difference in the output elasticity of labor efficiency between high- and low-skilled workers (about 10 percent) were all highly significant. As a result, they provide empirical support for the hypothesis of output-skill substitutability.

The effects of intraindustry trade on the skill premium are also consistent with our theoretical predictions: there is a strong and significant positive correlation between intraindustry trade and output of the typical Mexican plant.

The traditional view on intraindustry trade assumes that this type of trade is regional and occurs only among advanced countries. Contrary to this view, other recent empirical studies on "extensive margins" (variety exports) have documented the global character of intraindustry trade.

To ascertain the importance of the Chambelinian mechanism of income distribution, our analysis retained only those features of the model that appear essential.

Thus, several possible extensions could be considered. One possibility is to modify the representative firm's cost function so that it includes a fixed-cost component.

Another possibility is to generalize the supply side of the model so that skill abundance is an increasing function of the skill premium. Intraindustry trade may raise the skill premium and may generate industry-specific, firm-level skill upgrading.

Lastly, it is possible to further extend the analysis to introduce firm heterogeneity and trade costs along the lines or Melitz. This is a non-trivial theoretical and empirical extension that could shed further light on the structure of rewards among heterogeneous firms within an industry.