Skill Biased Technical Change and Rising Inequality: What is the Evidence? What are the Alternatives?

David H. Autor
MIT and NBER

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4 Lecture IV: The Role of International Trade and Outsourcing

The volume of world trade flows relative to economic output grew during the 1980s.

1. In the U.S., for example, the value of trade (an average of imports and exports) was 6.1% of GDP in 1913, but only 4.1% in 1970, rising to 8.8% in 1980.

2. France, Germany, Italy, Sweden, Canada and the UK also show significant jumps in merchandise trade as a share of GDP in the 1980s (see Table 1 in Feenstra in *Journal of Economic Perspectives*, Fall 1998).

3. Though trade flows in the 1980s and 1990s were below those at the turn of the century in most cases, the timing of the recent increase is coincident with rise in earnings inequality in many countries.

These facts raise the logical question of whether international trade is responsible for the growth in the relative earnings of skilled workers during the 1980s. The intuition for this idea–and hence its plausibility–is immediately apparent. Most North-South trade, that is trade between the U.S./OECD and the less-developed countries (LDCs), is trade between relative skill-endowed economies and relatively unskilled-endowed economies. If you imagine that LDCs primarily export unskilled-intensive products and developed countries (DCs) primarily export skill-intensive products, than the opening of trade is analogous to a skill transfer between economies. The DCs import low skilled workers and export high skilled workers, and vice versa for the LDCs. This is nearly equivalent to a decline in the relative supply of skilled workers and an increase in the supply of unskilled workers in Developed economics (and vice versa in LDCs). Hence, all else equal, you would expect this type of trade opening to raise the relative earnings of skilled workers relative to unskilled workers in DCs.

To see this point more formally, consider the two good interpretation of the CES model above. Consumer utility is defined over $[Y_l^\rho + Y_h^\rho]^{1/\rho}$, with the production functions for two goods being $Y_h = A_h H$ and $Y_l = A_l L$. Both goods are assumed to be tradable. For simplicity, compare the U.S. labor market equilibrium without any trade to the equilibrium with full international trade without any trading costs.

Before trade, the U.S. relative price of skill intensive goods, p_h/p_l, is given by

$$p^{US} = \frac{p_h}{p_l} = \left[\frac{A_h H}{A_l L}\right]^{\rho-1}. \tag{59}$$

The skill premium is then simply equal to the ratio of the marginal value products of the two types of workers, that is,

$$\omega^{US} = p^{US} \frac{A_h}{A_l} \tag{60}$$

Next, suppose that the U.S. starts trading with a set of LDCs that have access to the same technology as given by A_h and A_l, but are relatively scarce in skills. Denote the total supplies of skilled and unskilled workers in the LDCs by $\widehat{H}$ and $\widehat{L}$ where $\widehat{H}/\widehat{L} < H/L$, which simply reiterates that the U.S. is more abundant in skilled workers than the LDCs.

After full trade opening, the product markets in the U.S. and the LDCs are joined, so there will be a unique world relative price. Since the supply of skill-intensive and labor-intensive goods are $A_h \left(H + \widehat{H}\right)$ and $A_l \left(L + \widehat{L}\right)$, the relative price of the skill intensive good will be

$$p^W = \left[\frac{A_h \left(H + \widehat{H}\right)}{A_l \left(L + \widehat{L}\right)} \right]^{\rho - 1} > p^{US}. \tag{61}$$

The fact that $p^W > p^{US}$ follows immediately from $\widehat{H}/\widehat{L} < H/L$. Intuitively, once the U.S. starts trading with skill-scarce LDCs, demand for skilled goods increases, pushing the prices of these goods up.

Labor demand in this economy is derived from product demands. The skill premium therefore follows the relative price of skill-intensive goods. After trade opening, the U.S. skill premium increases to

$$\omega^W = p^W \frac{A_h}{A_l} > \omega^{US} \tag{62}$$

where the fact that $\omega^W > \omega^{US}$ is an immediate consequence of $p^W > p^{US}$. Therefore, trade with less developed countries increases wage inequality in the U.S..

The skill premium in the LDCs will also be equal to ω^W after trade since the producers face the same relative price of skill-intensive goods, and have access to the same technologies. Before trade, however, the skill premium in the LDCs was $\widehat{\omega} = \widehat{p} A_h / A_l$, where $\widehat{p} = \left(A_h \widehat{H} / A_l \widehat{L}\right)^{\rho - 1}$ is the relative price of skill-intensive goods in the LDCs before trade. The same argument as above implies that $\widehat{p} > p^W$, i.e., trade with the skill-abundant U.S. reduces the relative price of skill-intensive goods in the LDCs. This implies that $\omega^W < \widehat{\omega}$; after trade wage inequality should fall in the LDCs that have started trading more with the U.S. or other OECD economies.

At face value, this theory has much appeal. However, many have noted (such as Krugman, 2000) that imports of manufactured goods from LDCs are still only 2 percent of combined GDP of the OECD. Can trade flows this small explain changes in earnings as large as were observed in the 1980s? Common sense says no, but trade theory says yes. In trade theory, it is prices rather than quantities that matter. And prices are set at the margin. So the answer is: yes, it can matter. (It is often said in trade theory that 'the tail wags the dog'). The relevance of North-South trade opening to the growth of earnings inequality must therefore be evaluated from a more sophisticated perspective than 'it's too small to matter.' To test the applicability of the trade-opening hypothesis requires some rudimentary trade theory–often unfamiliar, but certainly harmless. That's what we undertake here.

To start off, we need to define SBTC in trade terminology. Skill-biased technical is something trade economists would call a 'factor biased technical change,' that is a change that raises the relative quantity demanded of a specific factor (e.g., skilled labor) at given relative prices. This type of technical change should be distinguished from 'sector biased technical change,' that is a technical change that increases productivity in one sector (e.g., high-tech versus farming) of the economy relative to another. Although it could well be that the sector experiencing the productivity growth is the 'skilled' sector, the distinction between sector- and factor- biased technical change is nevertheless crucial.

4.1 Factor biased technical change in a one good economy

In a one-good economy, there is only one sector and hence only one type of technical change: factor-biased. Assume two factors: skilled and unskilled labor. For added simplicity, assume that there are an equal number (or supply) of each worker type. The wage ratio in this economy is the line tangent to intersection between the endowment line and the economy's unit production isoquant. (See hand drawing 1.)

Hicks neutral technical change in this economy is a change that moves the unit isoquant towards the origin (a decline in the resources needed to produce one unit of output) perpendicular to the original production isoquant. This movement raises real earnings but leaves relative skill prices unchanged.

Factor biased technical change is a technological change that moves the isoquant towards the origin *and* shifts its slope to increase the quantity of one factor used to produce one unit at the old wage ratio. However, the old price ratio will not be market clearing. The new equilibrium will remain on the endowment line but the slope will be tilted towards the factor that is now in greater demand, meaning that this factor's wage will rise. It is quite possible that the wages of the other factor will fall in real terms.

But note that a factor-biased technical change that does not raise total productivity will not typically be adopted. Because old technologies are presumably still available, a factor-biased technical change must also raise (or at least not lower) GDP to be adopted. If the point of tangency between the new isoquant and the wage ratio falls below the old point of tangency, then the new technology is dominated.

This one good economy suggests that a *(skilled) factor biased technical change* will raise relative earnings of skilled workers and potentially lower earnings of unskilled workers. This seems to fit the data well. But this example is too simple. Predictions flip when we add a second sector.

4.1.1 Trade opening in a two good economy

Now we will consider a two good economy with one good skill-intensive and the other good unskilled-intensive. The economy operates under the basic Hecksher-Ohlin assumptions:

1. Constant return to scale production technology, quasi-concave production functions.
2. Perfect competition.
3. Both goods are produced in equilibrium under trade (i.e., incomplete specialization).
4. Preferences are homothetic (i.e., no income effects on consumption basket).
5. World prices are parametric for any country, that is all countries are price takers under trade. They are assumed too small to affect world prices.

We will consider how SBTC and trade opening affects relative wages and factor intensities in this economy. The crucial things to attend to are:

- Relative wages
- Skill intensity in each sector
- How relative wages and skill intensity covary under different cases

The cases we will consider are:

1. Exogenous skill price increases caused by opening to trade.
2. Hicks neutral technical change in skill intensive sector
3. SBTC in both sectors (with parametric prices)
4. Pervasive SBTC in both sectors in the world economy (goods prices changed as well)

4.1.2 Exogenous skill price increases caused by opening to trade

Consider a small economy that is relatively intensive in skilled labor (relative to the world economy) under autarky (i.e., no trade). Opening to trade with the world economy immediately raises the relative wage of skilled labor to the world price (which is higher). The iso-value isoquant for the skill intensive good shifts towards the origin in relative terms (i.e., the price of this good has risen). Responding to the wage increase, both sectors substitute towards *less intensive* use of skilled labor. Hence, the observable implications:

1. The relative wage of skilled labor rises.
2. The use of skilled labor within each sector *falls*.
3. The skill-intensive sector expands.

4.1.3 Hicks neutral technical change in skill intensive sector

Now, consider a sector-biased technical change. This change will be Hicks neutral, meaning that at given prices, it would not alter the intensity of use of skilled versus unskilled labor in the skill-intensive sector (i.e., it is simply an inward movement of the isovalue isoquant towards the origin but perpendicular to the current wage ratio). The increase in productivity in this sector increases profit opportunities and relative skilled wages are bid up (note: relative wages would not rise if this sector used skilled and unskilled labor in proportions equal to the initial endowment, so it is important that it is skill-intensive). Again, both sectors become less skill intensive. Hence, the observable implications of this Hicks neutral *sector-biased* change are identical to above:

1. The relative wage of skilled labor rises.

2. The use of skilled labor within each sector *falls*.

3. The skill-intensive sector expands.

Note that these implications are identical to above.

4.1.4 Factor biased technical change in a small, open economy

Now consider a technical change that is biased towards the skilled *factor* rather than the skilled sector. For simplicity, imagine factors are saved in equal proportions in each sector so that value isoquants shift equally toward the origin and the original wage ratio is preserved. Both sectors now use skilled labor more intensively (so the relative size of the unskilled sector will have grown to clear the market).

Key point: Because world prices for goods are parametric and both sectors gained proportionally in productivity, there is no change in relative wages (though all workers are better off).

So, the observable implications are:

1. Production becomes *more skill intensive* in both sectors

2. Incomes rise

3. Unskilled intensive sector grows relatively larger (it must do this to accomodate the fact that both sectors have become more skill intensive–this is an adding up constraint).

4. *No change in inequality*: Because goods prices are unchanged (set by world market), relative wages of skilled labor *do not rise*.

So, strangely enough, *factor-biased* technical change does not seem to affect inequality. Yet, it is exactly factor-biased technical change (i.e., $\partial(A_h/A_l)/\partial_t$ in the CES model) that we have been using to study inequality. Have labor economists been thoroughly misguided as Edward Leamer asserted in his article "What is the use of factor contents?" What are we missing?

4.1.5 Pervasive factor-biased technical change

What is artificial about the small, economy example above is that the technical change is *unique* to a single country–the rest of the world lives in technical isolation. This seems quite unlikely, bordering on unreasonable. The relevant case for the last several decades is a technical change occurring in most advanced countries *simultaneously* (e.g., advances in information technologies). Berman, Bound and Machin label this a 'pervasive' factor-biased technical change.

In the case of a pervasive factor-biased technical change, the world market acts much like a single country in autarky experiencing a factor-biased technical change. Skilled factor biased technical releases unskilled labor in both sectors. The unskilled-intensive sector expands. With homothetic preferences, the price of the unskilled-intensive good declines. The isovalue curve for the unskilled intensive good shifts outward and so relative wages of unskilled labor falls. The net result is:

1. Production becomes more skill intensive in both sectors.
2. Relative price of the unskilled intensive good falls.
3. Inequality rises.

Hence, this case of *pervasive factor-biased technical change* is consistent with a simultaneous rise in the use and wage of skill intensive labor. This suggests that to distinguish the trade story from the technical change story, we need to focus on:

- Relative wages
- Skill intensity in each sector (i.e., *within* industries)
- The covariance of wage and skill intensity shifts.

4.1.6 Evidence on pervasive SBTC

Berman, Bound and Machin (1998) provide evidence on whether skilled factor-biased technical change appears pervasive among developed countries. The implications they test:

1. Substitution towards skilled labor in all sectors simultaneously as relative wages rise.

2. This substitutions is common among developed countries.

BBM Table II and III:

- 10 countries
- Almost all skill upgrading (production/non-production) occurs within industries
- In 7 out of 10 countries, industries substituted towards non-production labor despite rising wages.

BBM Table IV:

- Skill upgrading reasonably highly correlated across countries within industries (consistent with 'pervasive' notion–though how high is high?)

BBM Figure III:

- Movements in U.S. and UK are pretty strikingly similar (but this is not so surprising).

Conclusion: Pervasive SBTC story is an important response to arguments in trade literature that SBTC itself should not impact the relative wages of less skilled workers in a small open economy. Pervasive factor-biased SBTC in an open economy acts much like factor-biased SBTC in a closed economy.

4.1.7 Additional evidence on trade and inequality

As the comparison of equations (60) and (62) shows, the effect of international trade works through a *unique intervening mechanism*: free trade with the LDCs increases the relative price of skill-intensive goods, p, and affects the skill premium via this channel. Hence, another damaging piece of evidence for the trade hypothesis is that most studies suggest the relative price of skill-intensive goods did not increase over the period of increasing inequality. Lawrence and Slaughter found that during the 1980s the relative price of skill-intensive goods actually fell. Sachs and Shatz found no major change or a slight decline, while a more recent paper by Krueger found an increase in the relative price of skill-intensive goods, but only for the 1989-1995 period.

Second, as noted above, a direct implication of the trade view is that, while demand for skills and inequality should increase in Developed Countries, the converse should happen in the LDCs, i.e., those that have started trading with the more skill-abundant developed world. The evidence, however, suggests that more of the LDCs experienced rising inequality after opening to international trade (Figure IV of BBM). Notably, the *absence* of a relationship between a country's development and its change in inequality during the 1980s is particularly striking because most countries–even LDCs–saw an increase in the supply of skilled workers during the 1980s. (BBM Figure V.)

These facts are consistent with pervasive SBTC, and suggest that increased international trade with the LDCs is not the major cause of the changes in the wage structure by itself.

4.2 The role of outsourcing

Feenstra and Hanson (2001) make an impassioned case that the empirical implications of international outsourcing of low-skill-intensive intermediate production ('global production sharing') are roughly equivalent to pervasive SBTC and hence may explain rising inequality:

1. Skill upgrading within industries in developed economies despite a rising relative price of skill.

2. Not especially large changes in the total quantity of trade as a share of GDP.

3. No decline in the relative price of unskilled goods, but a rise in the price of domestic relative to imported intermediate inputs *within industries.*

Although the Feenstra-Hanson evidence does not seal the case that outsourcing is the *primary* source of increased relative demand for skilled workers in developed countries, it does keep this explanation on the table. I will not discuss the paper in detail but I recommend it.

If outsourcing was not an enormous force for inequality in the 1980s, it seems likely to become increasingly important with time. Consider for example the foreign outsourcing of many traditionally non-traded services such as telephone banks, bill processing, back office bank operations, and software development. These innovations are facilitated by advances in information technology, *but* these advances would not be particularly relevant to inequality were it not for the existence of a vast supply of relatively less skilled workers in LDCs. Underscoring the connection between increasing outsourcing and improving technology, Autor, Katz, Krueger Table VII shows that industries that outsourced heavily were also those that made the largest investment in computers during the 1980s and 1990s, a pattern also implied by the Feenstra and Hanson results.

Table 1

Ratios of Merchandise Trade to GDP *(percent)*

Country	*1890*	*1913*	*1960*	*1970*	*1980*	*1990*
Australia	15.7	21.0	13.0	11.5	13.6	13.4
Canada	12.8	17.0	14.5	18.0	24.1	22.0
Denmark	24.0	30.7	26.9	23.3	26.8	24.3
France	14.2	15.5	9.9	11.9	16.7	17.1
Germany	15.9	19.9	14.5	16.5	21.6	24.0
Italy	9.7	14.4	10.0	12.8	19.3	15.9
Japan[a]	5.1	12.5	8.8	8.3	11.8	8.4
Norway	21.8	25.5	24.9	27.6	30.8	28.8
Sweden	23.6	21.2	18.8	19.7	25.0	23.5
United Kingdom	27.3	29.8	15.3	16.5	20.3	20.6
United States[b]	5.6	6.1	3.4	4.1	8.8	8.0

Notes: Merchandise trade is measured as the average of imports and exports, except as noted below.

[a] Data for 1890–1950 uses three-year averages.

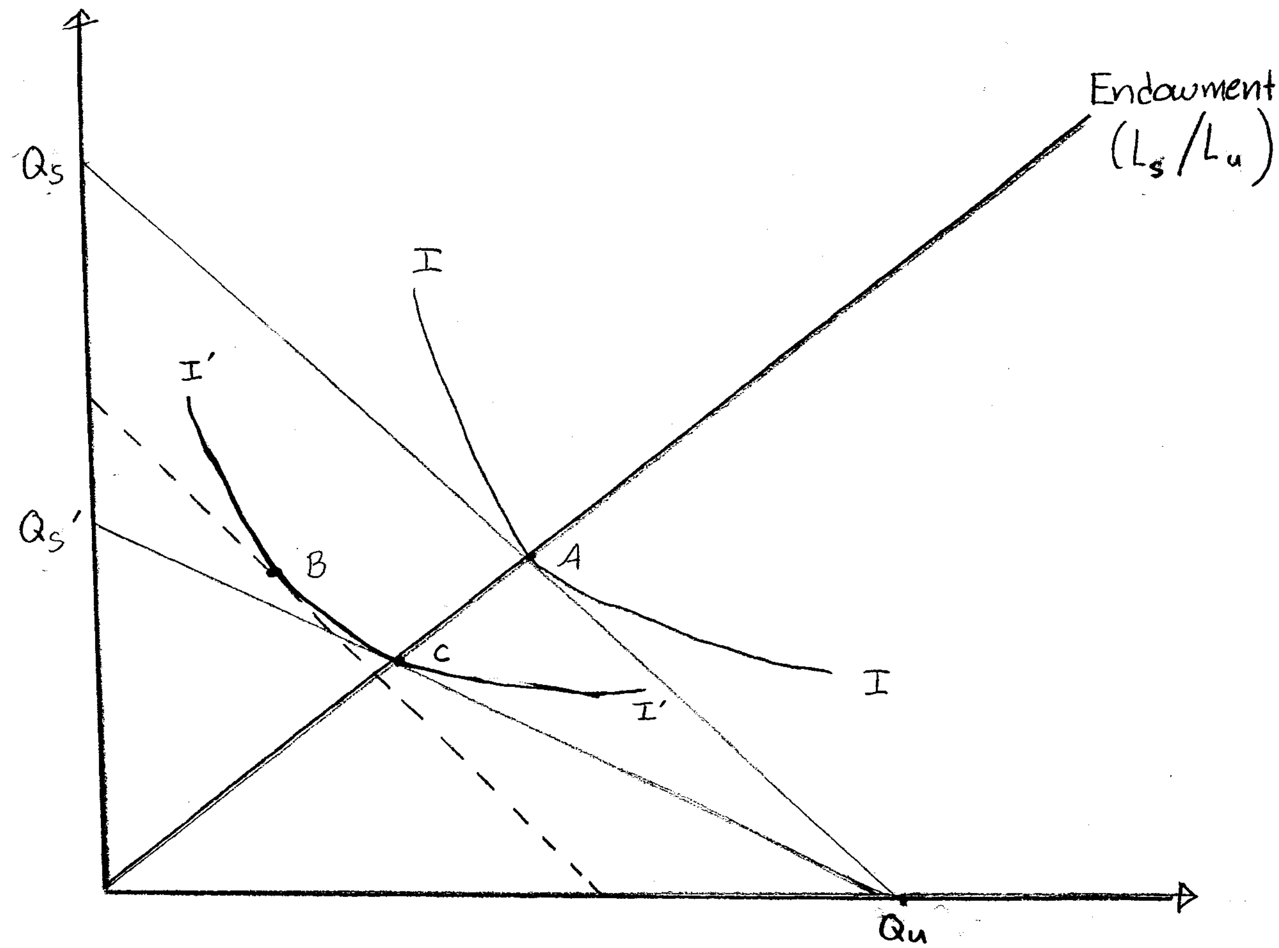
[b] Data recorded under 1890 is for 1889, and along with that in 1913, measures the ratio of merchandise exports to GNP.

Sources:

1960–1990: Data for the United States are taken from *Economic Report of the President, 1997,* Tables B-10 and B-101; data for other countries are calculated from *World Tables of Economic and Social Indicators, 1950–1992,* The World Bank, 1993.

1890–1913: Data for the United States from Irwin (1996, Table 1); data for Japan from Bairoch and Kozul-Wright (1996); data for other countries from Williamson (1996, Table 1).

Figure I : Factor-Biased Techical Change in a One-Good Economy



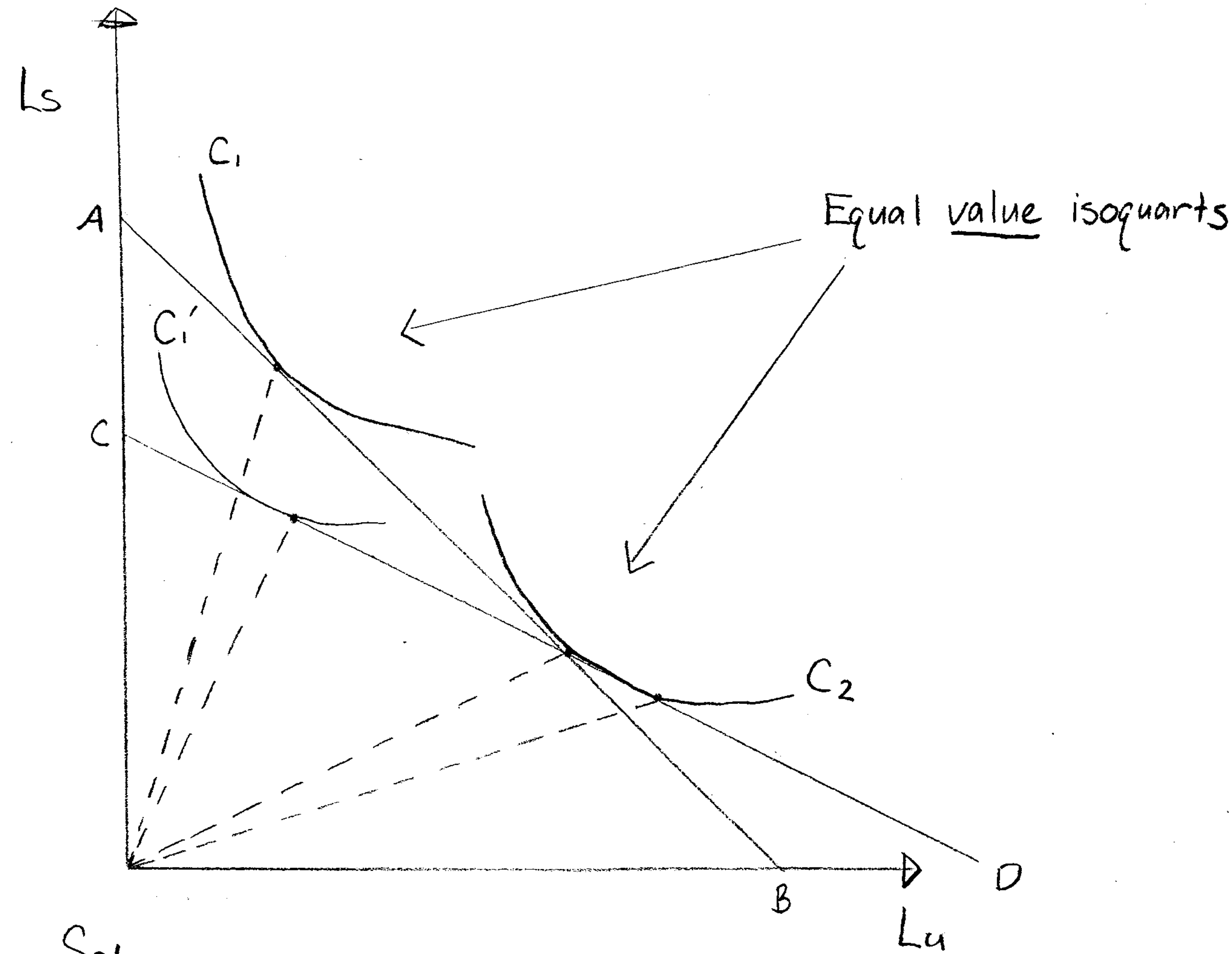
Period 1:

- I · Unit Isoquart
- Relative Earnings $\frac{W_s}{W_u} = \frac{Q_u}{Q_s}$

Period 2:

- Unit isoquart moves to I'
- At previous prices, demand for (L_s, L_u) is B. But this gives excess demand for L_s
- New equilibrium: $\frac{W_s'}{W_u'} = \frac{Q_u'}{Q_s'} > \frac{Q_u}{Q_s}$

Figure II: Opening of Small, Skill-Intensive Economy to World Trade

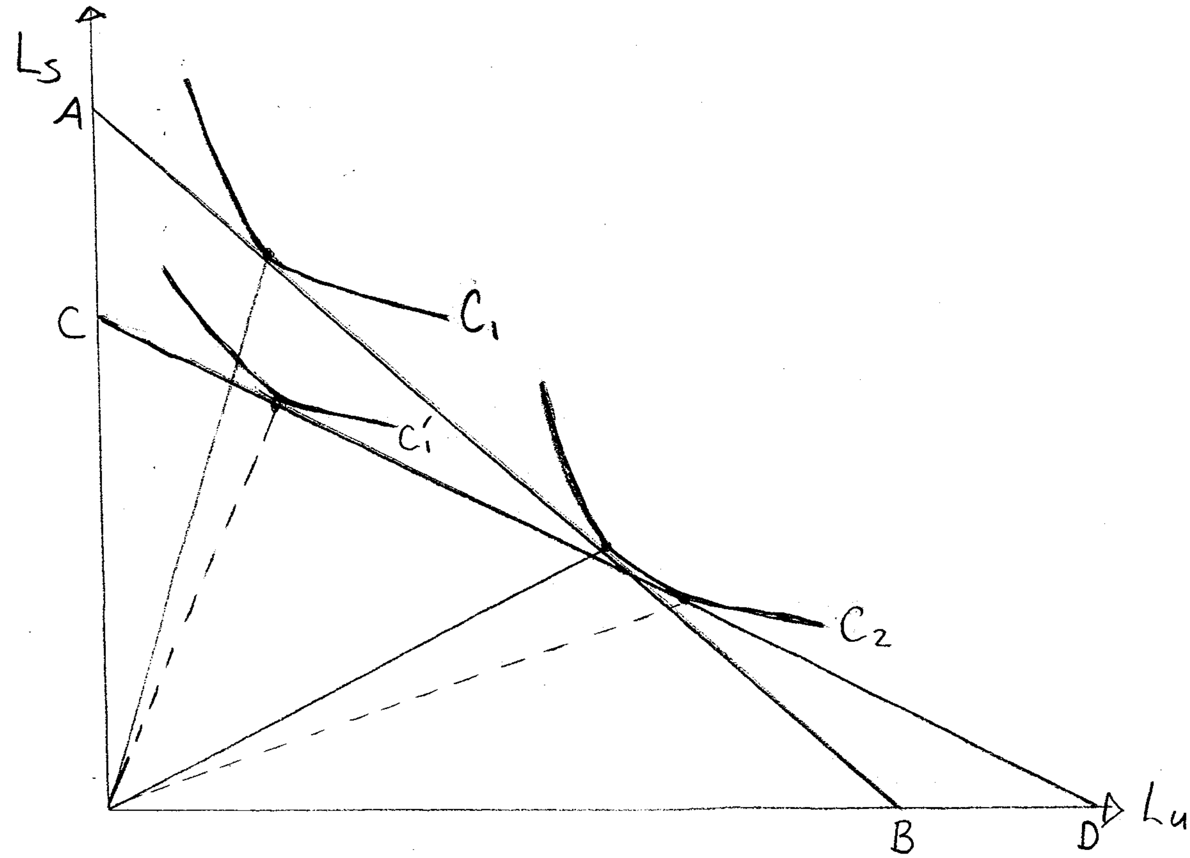


Setup:
- Small economy under autocracy
- Relatively skill intensive by world standards
- C_1, C_2 are equal value isoquarts
- $\frac{W_s}{W_u} = \frac{B}{A}$

Opening to trade:
- Price of skilled good rises
- $C_1 \rightarrow C_1'$ shifts towards origin (note; Value fixed)
- $\frac{W_s'}{W_u} = \frac{D}{C} > \frac{B}{A}$

Key point: Both sectors less skill intensive

Figure III: Hicks Neutral Technical Change in Skill Intensive Sector

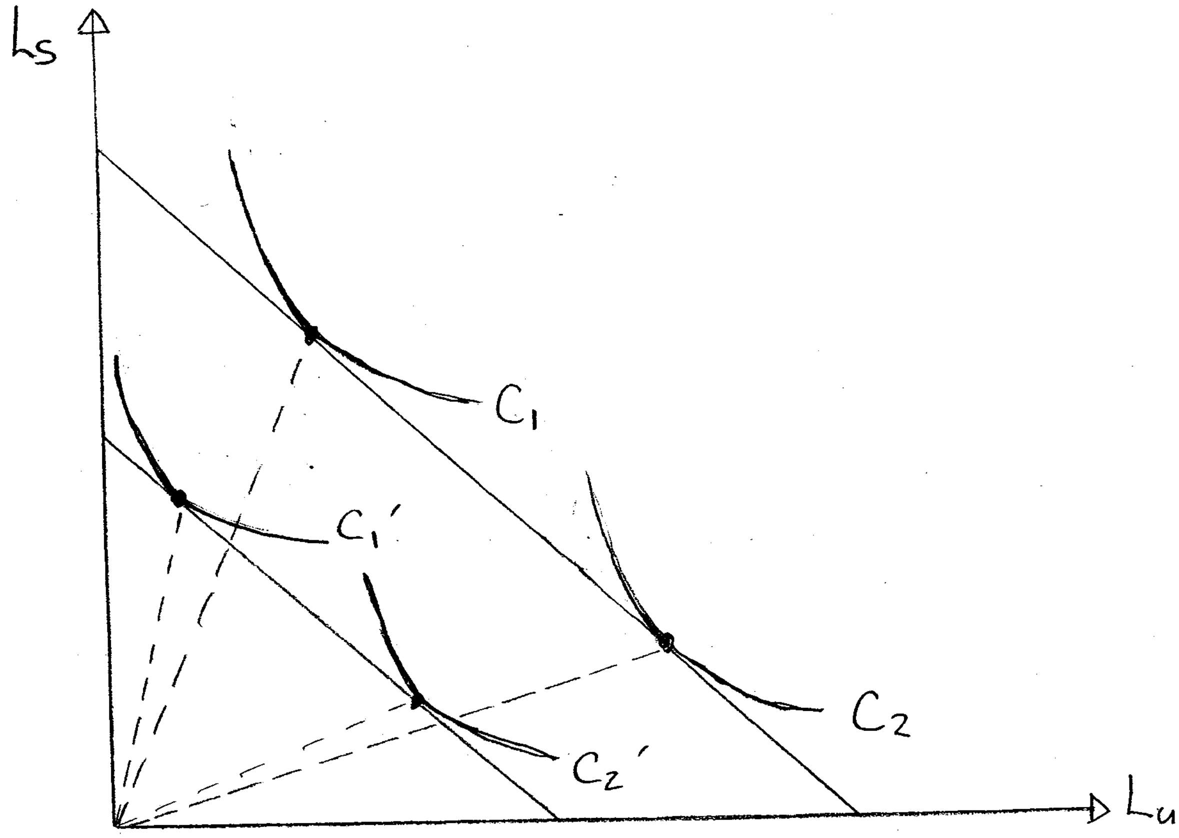


A. Hicks neutral technical change in skill intensive sector → moves equal value isoquant inward, reduces demand <u>in this sector</u> proportionally for L_S, L_H at given factor prices.

B. Profit opportunities in skill intensive sector bid up relative wages of skilled workers.

C. Both sectors become <u>less</u> skill intensive.

Figure IV: Factor Biased Technical Change for a Small Open Economy



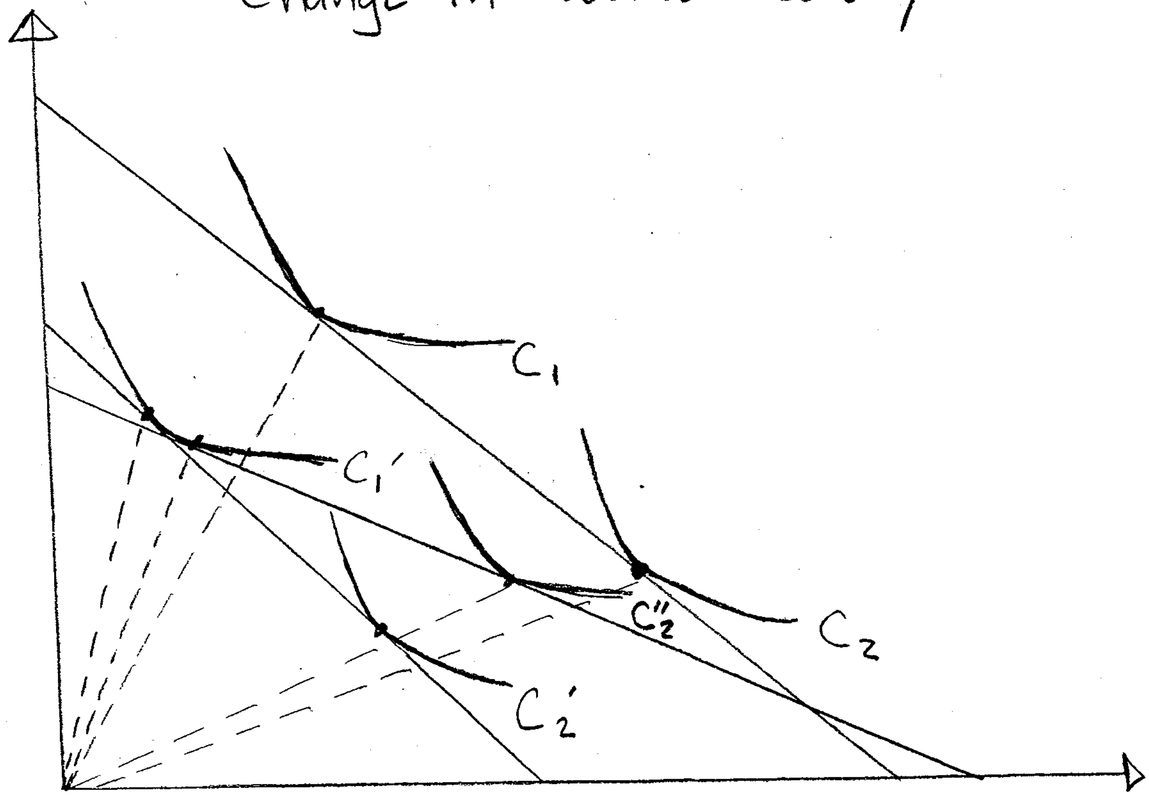
A. Factor-biased technical change benefits both sectors. In this example, factors are saved in the same proportions in both sectors.

B. Shifts are skill biased:
New equilibrium has increase in skill intensity in <u>both sectors</u>.

C. Skilled sector must relatively contract to clear labor market

D. Wage rates at W_s/W_u <u>unchanged</u> because prices for each good are parametric (at world prices) and so L_s, L_v benefits equally.

Figure V: Pervasive Factor-Biased Technical Change in World Economy



A. Factor biased technical change initially raises supply of unsullied goods as in previous example.

B. Prices are no longer parametric since this is a world-wide change ⇒ Price of unskill-intensive good <u>falls</u>.

C. Fall reflected in outward movement of $C_2' \rightarrow C_2''$ (recall: Iso-value not isoquant)

D. In net:
- Both sectors use skilled labor more intensively
- Inequality rises

TABLE II
PROPORTION OF INCREASED USE OF SKILLS "WITHIN" INDUSTRIES

	1970–1980			1980–1990			
Country	Change in % non-production (annualized)	% within	Change in wage ratio (%)	Change in % nonproduction (annualized)	% within	Change in wage ratio (%)	Note
U. S.	0.20	81	−2	0.30	73	7	
Norway	0.34	81	−3	—	—	—	1970,80,n/a
Luxembourg	0.57	90	6	0.30	144	12	
Sweden	0.26	70	3	0.12	60	−3	
Australia	0.40	89	−17	0.36	92	2	1970,80,87
Japan	—	—	—	0.06	123	3	n/a*,81,90
Denmark	0.44	86	−11	0.41	87	7	1973,80,89
Finland	0.42	83	−11	0.64	79	−2	
W. Germany	0.48	93	5	—	—	—	1970,79,n/a
Austria	0.46	89	7	0.16	68	7	1970,81,90
U. K.	0.41	91	−3	0.29	93	14	
Belgium	0.45	74	6	0.16	96	−5	1973,80,85
Average	0.40	84.3	−1.8	0.28	91.5	4.2	

a. The change in aggregate proportion of nonproduction workers can be decomposed into a component due to reallocation of employment *between* industries with different proportions of skilled workers and another due to changes in the proportion of skilled workers *within* industries. The percentage within is calculated by dividing the second term of equation (2) in the text by the sum of both terms.

b. *Source:* United Nations General Industrial Statistics Database.

c. There are 28 industries in this classification for all countries except Belgium (20), W. Germany (22), Japan (27), Luxembourg (9 in 1970–1980, 6 in 1980–1990), and Norway (26). For these countries aggregate changes and "within" calculations are based upon the reduced set of industries. Appendix 2 includes an industry list. See the Data Appendix for details.

* The sampling frame changed for Japanese data between 1970 and 1981.

TABLE III
PROPORTION OF INCREASED WAGE BILL SHARE OF SKILL "WITHIN" INDUSTRIES

Country	1970–1980 Change in % nonproduction (annualized)	1970–1980 % within	1970–1980 Change in wage ratio (%)	1980–1990 Change in % nonproduction (annualized)	1980–1990 % within	1980–1990 Change in wage ratio (%)	Note
U. S.	0.19	86	−2	0.51	76	7	
Norway	0.33	76	−3	—	—	—	1970,80,n/a
Luxembourg	0.90	95	6	0.73	123	12	
Sweden	0.38	81	3	0.07	25	−3	
Australia	0.07	51	−17	0.42	92	2	1970,80,87
Japan	—	—	—	0.14	84	3	n/a*,81,90
Denmark	0.12	42	−11	0.64	89	7	1973,80,89
Finland	0.27	82	−11	0.70	83	−2	
W. Germany	0.67	95	5	—	—	—	1970,79,n/a
Austria	0.69	93	7	0.36	76	7	1970,81,90
U. K.	0.39	91	−3	0.62	92	14	
Belgium	0.77	86	6	−0.06	92	−5	1973,80,85
Average	0.43	79.8	−1.8	0.41	83.2	4.2	

a. The change in aggregate wage bill share of nonproduction workers can be decomposed into a component due to reallocation of wage bill *between* industries with different shares of skilled workers and another due to changes in the shares of skilled workers *within* industries. The percentage within is calculated by dividing the second term of the following decomposition by the sum,

$$\Delta S_n^w = \sum_i \Delta W_i^w \overline{S_{n_i}^w} + \sum_i \Delta S_{ni}^w \overline{W_i^w},$$

where

$$S_n^w \equiv \frac{w_S S}{w_S S + w_U U}, \qquad W_i^w \equiv \frac{WB_i}{\Sigma_i WB_i},$$

and an overstrike indicates a simple average over time.

b. *Source:* United Nations General Industrial Statistics Database.

c. There are 28 industries in this classification for all countries except Belgium (20), W. Germany (22), Japan (27), Luxembourg (9 in 1970–1980, 6 in 1980–1990), and Norway (26). For these countries aggregate changes and "within" calculations are based upon the reduced set of industries. Appendix 2 includes an industry list. See the Data Appendix for details.

* The sampling frame changed for Japanese data between 1970 and 1981.

TABLE IV
CROSS-COUNTRY CORRELATIONS OF WITHIN-INDUSTRY CHANGES IN PROPORTION NONPRODUCTION: 1980–1990

	U. S.	Sweden	Australia	Japan	Denmark	Finland	Austria	U. K.
Sweden	.55*							
	(.00)							
Australia	.25	.18						
	(.20)	(.35)						
Japan	.25	.19	−.09					
	(.21)	(.35)	(.65)					
Denmark	.43*	.17	.19	.25				
	(.02)	(.40)	(.33)	(.21)				
Finland	.45*	.41*	.11	.42*	.31			
	(.02)	(.03)	(.57)	(.03)	(.11)			
Austria	.09	−.21	.33	−.08	.24	.40*		
	(.65)	(.27)	(.09)	(.70)	(.23)	(.04)		
U. K.	.48*	.09	.20	.14	.31	.41*	.64*	
	(.01)	(.65)	(.30)	(.48)	(.11)	(.03)	(.00)	
Belgium	.48*	.58*	.14	.29	.16	.42	.13	.03
	(.03)	(.01)	(.57)	(.23)	(.50)	(.06)	(.60)	(.91)

a. These are cross-country correlations of ΔSn_{ci} and $\Delta Sn_{c'i}$ for countries c and c'. Observations are weighted by industry employment shares averaged over time and across all countries.

b. The number in brackets is the significance level of a two-tailed test that the correlation is zero. An asterisk denotes a significant correlation at the 5 percent level.

c. The sample was restricted to countries with GNP/capita of over $8000 US in 1985 and twenty or more consistently defined industries observed in 1980–1990.

d. The 28 industries in this classification are listed fully in Appendix 2.

e. All correlation coefficients are calculated using a full set of 28 industries, except those involving Japan (27), Belgium (20), and Japan and Belgium (19).

f. *Source*: United Nations General Industrial Statistics Database.

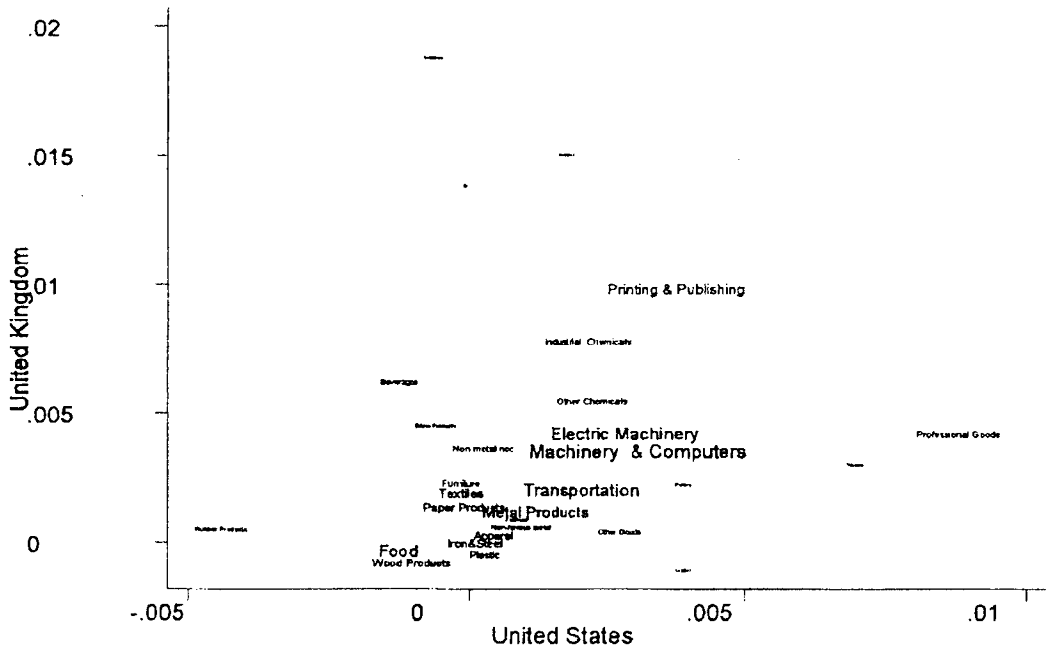


FIGURE III

Changes in Nonproduction Employment Shares: United States and United Kingdom

Note: Each observation is a pair of "within"-industry increases in the proportion of nonproduction workers between 1980 and 1990. Text size is proportional to the industry share in manufacturing employment.

Source: United Nations General Industrial Statistics Database.

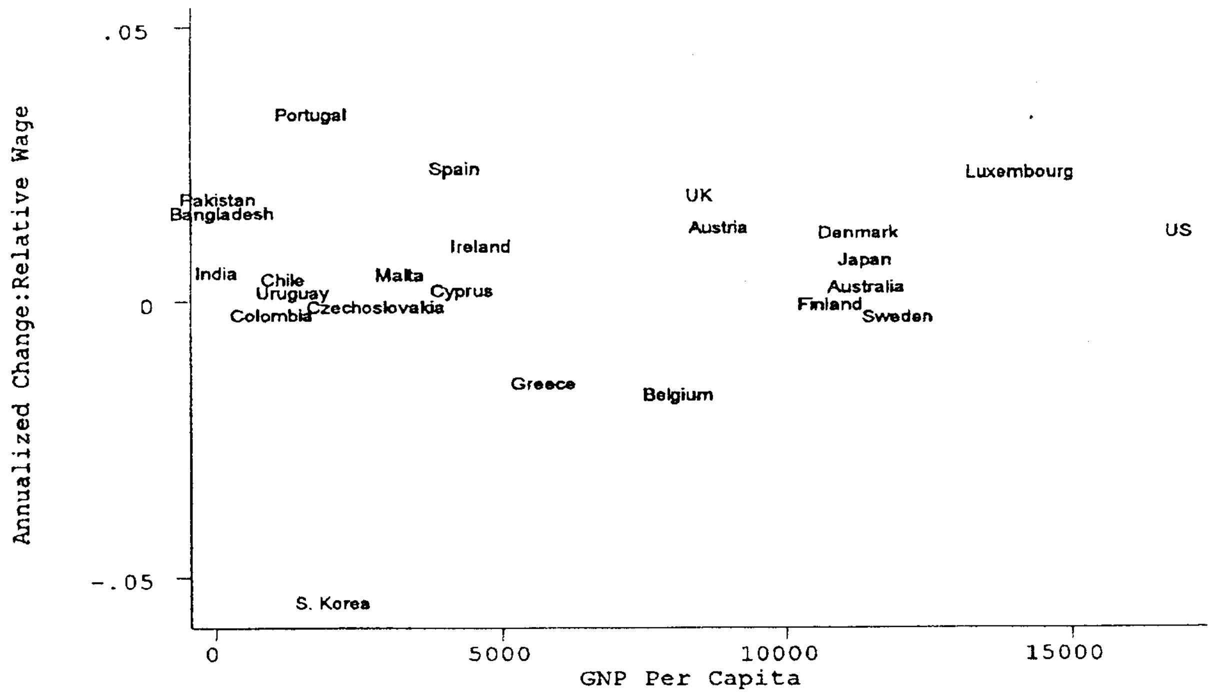


FIGURE IV

Change in Relative Wages in 1980s by GNP

The figure reports relative wages information for 24 countries judged to have reliable information over the 1980s. The annualized change in wage ratio of nonproduction to production workers is recorded between 1980 and 1990 where possible. Other endpoints are used when necessary.

Source: United Nations General Industrial Statistics Database.

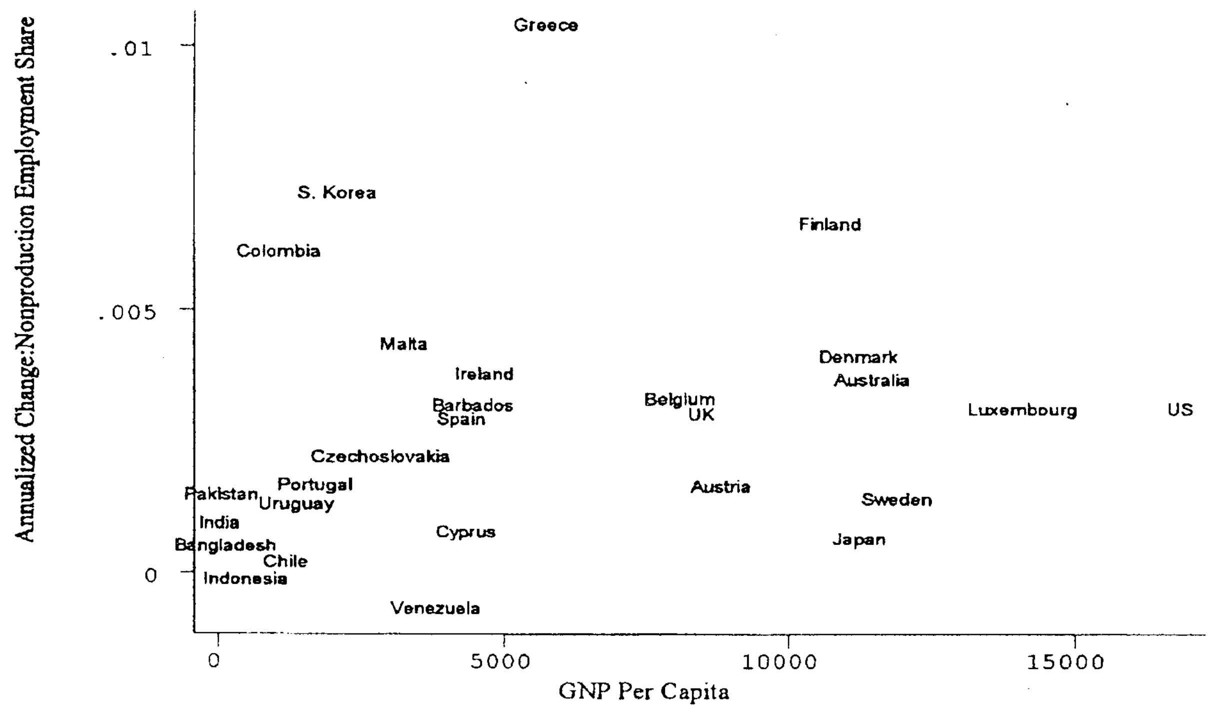


FIGURE V

Skill Accumulation in the 1980s by GNP

The figure reports changes in the proportion of nonproduction workers in manufacturing employment for 27 countries judged to have reliable information over the 1980s. The annualized change in the proportion of nonproduction workers is recorded between 1980 and 1990 where possible. Other endpoints are used when necessary.

Source: United Nations General Industrial Statistics Database.