II. OUTSOURCING AND LABOR MARKETS

A. Outsourcing and Vertical Disintegration

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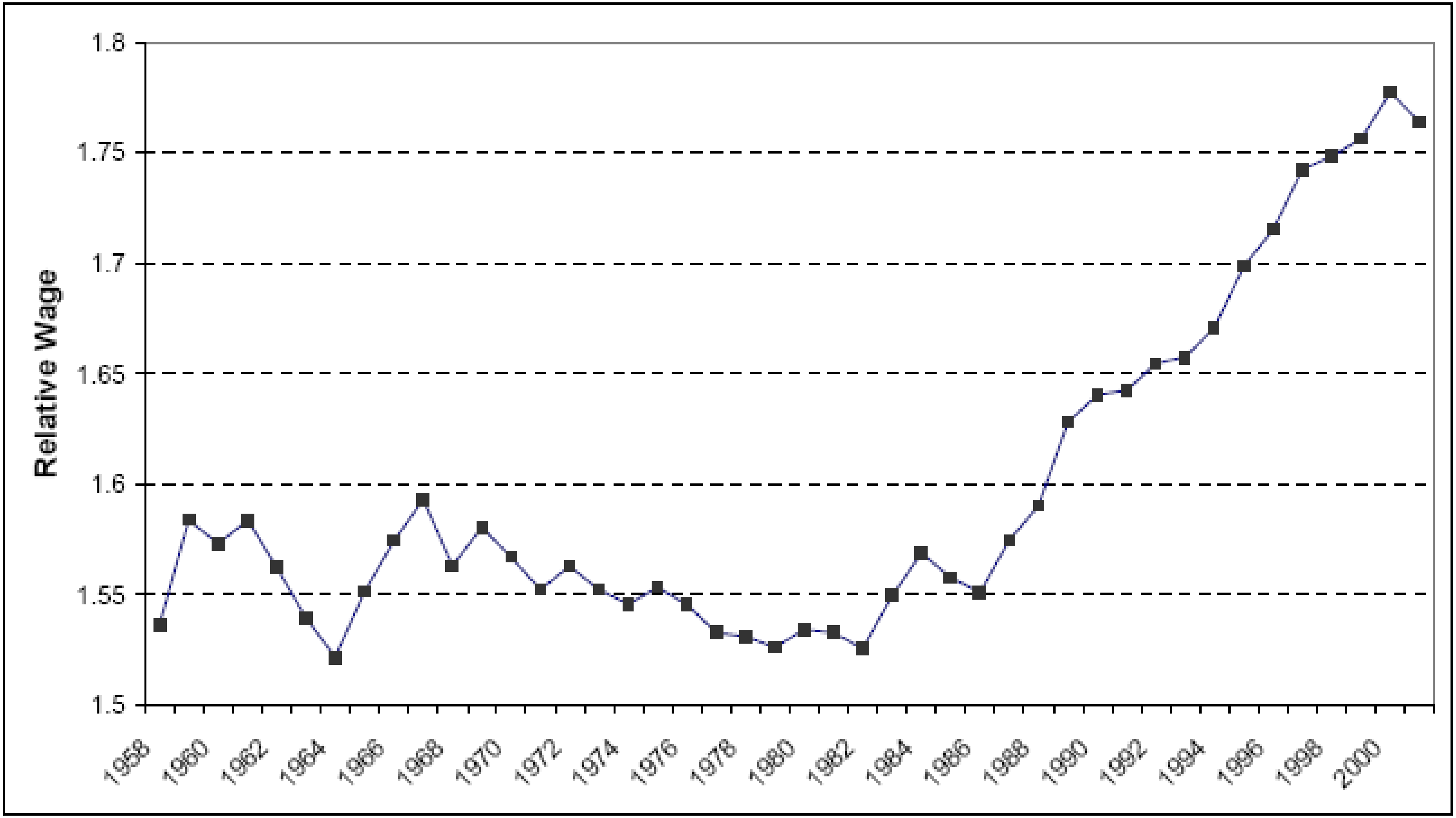
More and less skilled workers

- Switch from “outsourcing” to “offshoring”
- Let me begin with offshoring and its impact on wages in the United States.
- In our first two figures, I use data from the manufacturing sector to measure the wages of “nonproduction” relative to “production” workers. As their name suggests, nonproduction workers are involved in service activities, while production workers are involved in the manufacture and assembly of goods. These two categories can also be called “white collar” versus “blue collar.”
- Generally, nonproduction workers require more education, and so we will treat these workers as skilled, while production workers are less skilled.

Relative wages over four decades

- In the first figure, we see that the earnings of nonproduction relative to production workers moved erratically from the late 1950s to the late 1960s, and from that point until the early 1980s, relative wages were on a downward trend.
- It is generally accepted that the relative wage fell during this period because of an increase in the supply of college graduates, skilled workers who moved into nonproduction jobs.
- Starting in the early 1980s, however, this trend reversed itself and the relative wage of nonproduction workers increased steadily to 2000, with a slight dip in 2001. The same increase in the relative wages of skilled workers has been found for other industrial and developing countries.

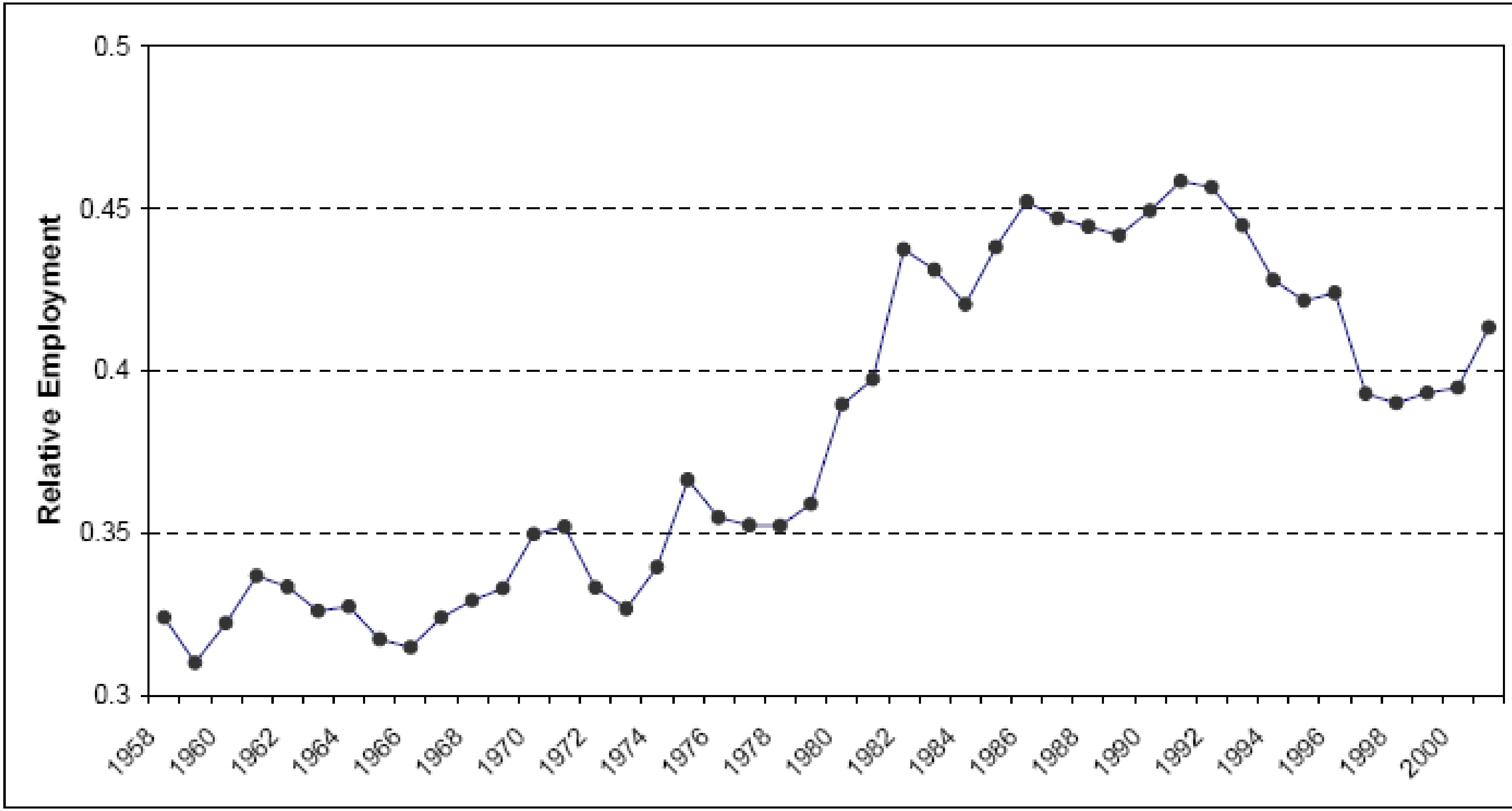
Relative wage of Nonproduction/Production Workers, U.S. Manufacturing



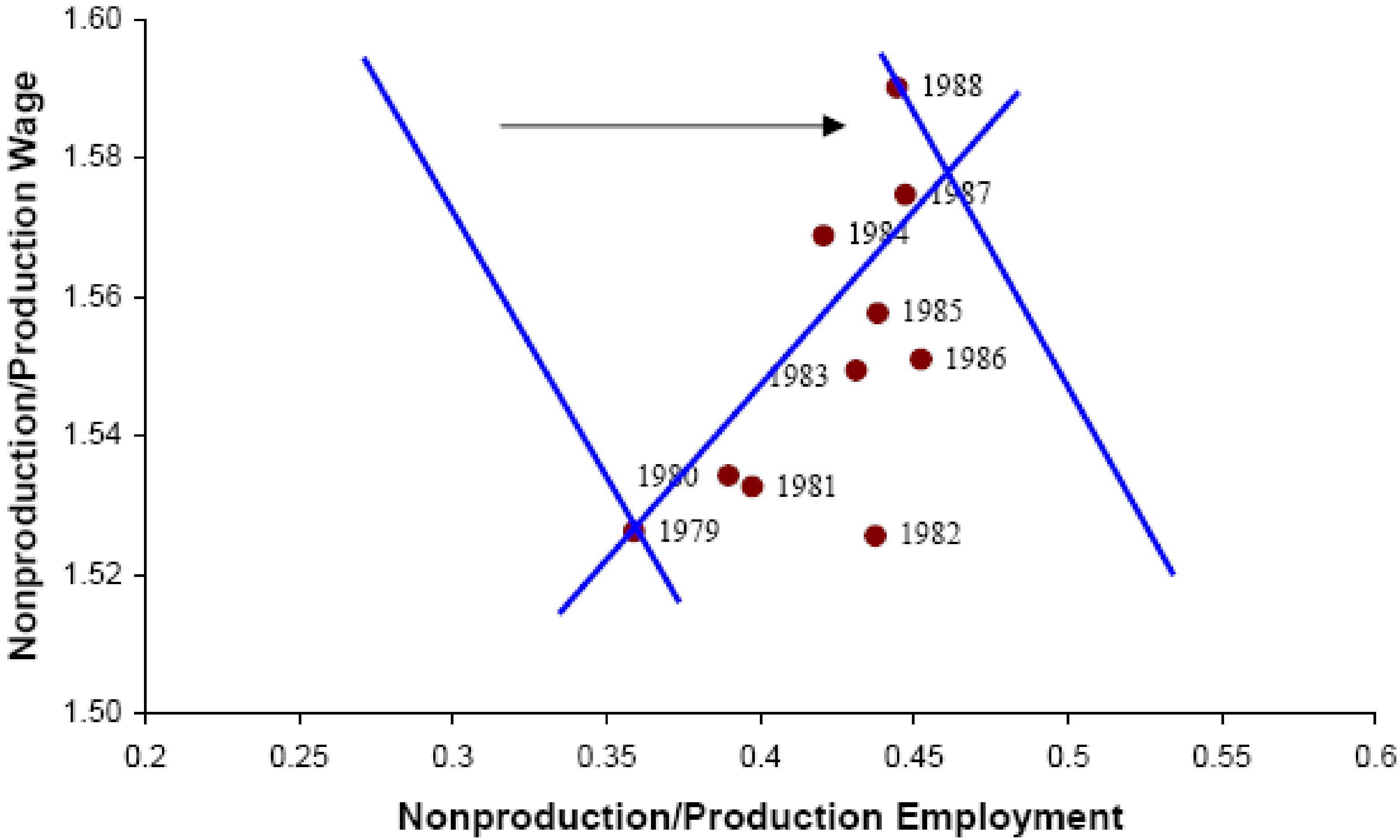
Evidence from U.S. Manufacturing

- Turning to the second figure, we see that there has been a steady increase in the ratio of nonproduction to production workers through the end of the 1980s, but then a fall in the 1990s.
- The increase in the relative supply of workers can account for the *reduction* in the relative wage of nonproduction workers through the 1970s, as shown in our first figure, but is at odds with the *increase* in the relative nonproduction wage during the 1980s.
- The rising relative wage should have led to a shift in employment *away* from skilled workers, along a demand curve, but it did not.
- Thus, the only explanation consistent with these facts is that there has been an *outward shift* in the demand for more-skilled workers during the 1980s, leading to an increase in their relative employment and wages, as shown in the next figure.

Relative employment of Nonproduction/Production Workers, U.S. Manufacturing



U.S. Manufacturing Nonproduction/Production Workers, 1980s



Skill-biased technological progress?

- What factors can lead to an outward shift in the relative demand for skilled labor?
- Such a shift can arise from the use of computers and other high-tech equipment, or *skill-biased technological change.*
- Researchers such as Berman, Bound and Griliches (1994) argued that such technological change was the dominant explanation for the rising relative wage of skilled labor in the United States, and other countries. Their reason for rejecting international trade as an explanation was the finding that the majority of the increase in the manufacturing wage and employment of non-production workers was caused by shifts *within* industries, and not by shifts *between* industries.
- That is, the outward shift in relative demand being illustrated in the last figure applied to many individual industries, as well as in the aggregate. In their view, that ruled out the Heckscher-Ohlin model as an explanation, since in that model they expected to see a shift between industries instead of within industries.

Evidence from other countries

- Their findings for the United States were reinforced by the work of and Berman, Bound and Machin (1998), who looked at cross-country data. They found that the same shift towards skilled workers in the U.S. also occurred abroad.
- That again appeared to rule out the Heckscher-Ohlin model as an explanation, because in that model we expect wages to move in opposite directions between countries when comparing autarky to free trade, as factor price equalization occurs.
- Instead, the evidence was that wages were moving in the same direction – with an increase in the relative wage of skilled workers.

From a “horizontal” to a “vertical” model of international trade

- Feenstra and Hanson (1996, 1997), present a model of an industry in which there are many “activities,” denoted by z, arranged along a “value chain.”
- For convenience they arrange these activities in increasing order of the ratio of skilled to unskilled labor used in each activity.
- The structure of this model is very similar to a Heckscher-Ohlin model with a continuum of goods, as in Dornbusch, Fischer and Samuelson (1980), except that we now think of all these activities as taking place within the same industry.

Technology in the vertical model

- Formally, we specify the unit-costs of each activity as:

  $$c(w, q, r, z) = B[wa_L(z) + qa_H(z)]^{\theta} r^{1-\theta},$$

  with the same technologies used in the foreign country, except that we allow the country-wide technology parameter B* to differ from B.
- The outputs x(z) from these activities are combined in a Cobb-Douglas fashion to produce a single, final output:

  $$Y = \int_0^1 \alpha(z) x(z) dz .$$

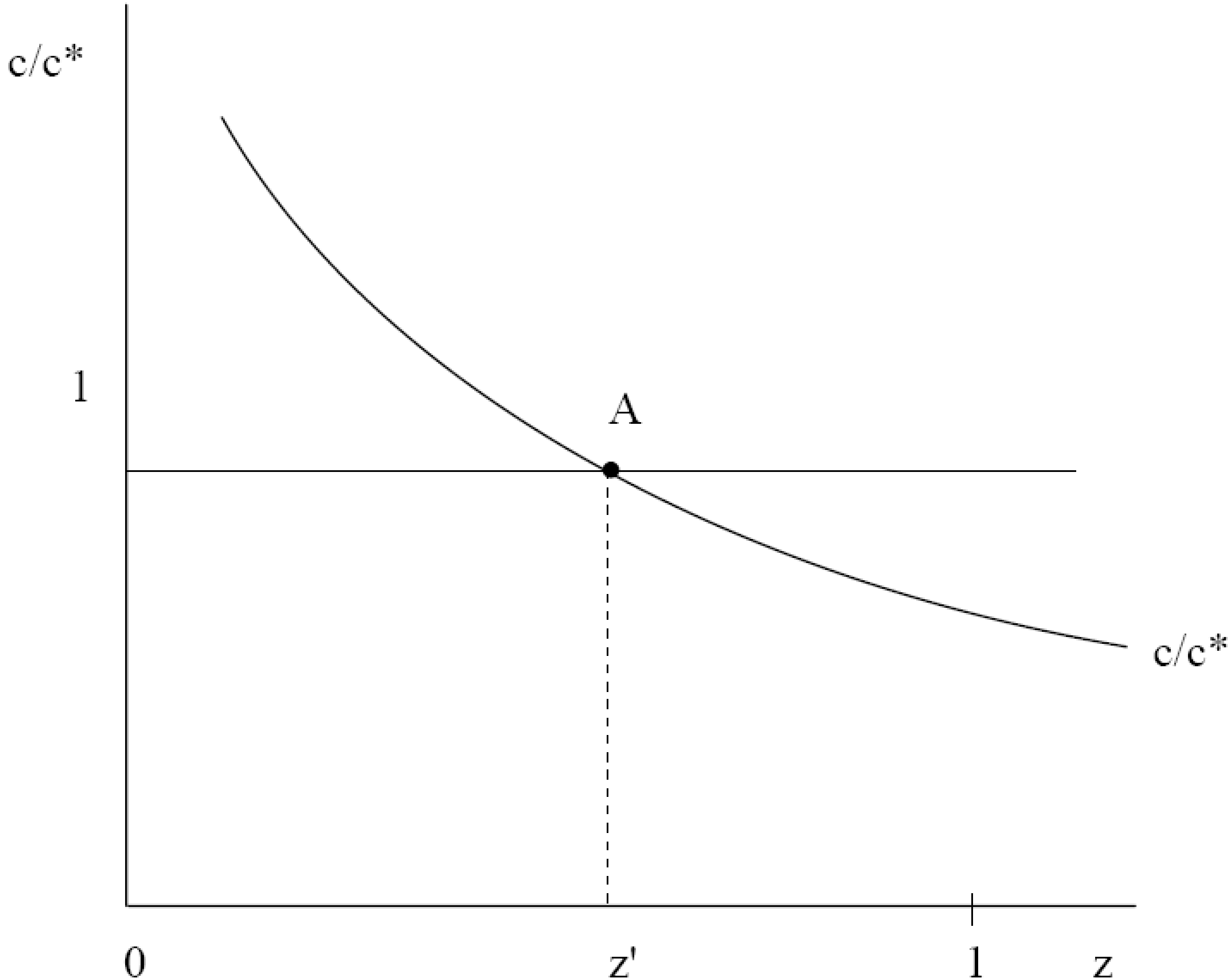
Different factor prices and complete specialization

- We suppose that relative wage of skilled labor is higher in the foreign country, and the rental on capital is also higher:

$$\frac{q}{w} < \frac{q^*}{w^*}, \quad \text{and} \quad r < r^*.$$

- Then just like the Heckscher-Ohlin model with a continuum of goods, in a trade equilibrium we will find that countries specialize in different portions of the skill continuum.
- Under our assumption that the relative wage of skilled labor is higher abroad, and that goods are arranged in increasing order of their skill intensity, then the ratio of the home to foreign unit costs is downward sloping, as shown by the schedule c/c^* in Figure 1.5.

Dividing the value chain of production



Determination of z'

- Foreign production – or offshoring – occurs where the relative costs at home are greater than unity, in the range [0,z'), whereas home production occurs where the relative costs at home are less than unity, in the range (z',1].
- The borderline activity z' is determined by equal unit costs in the two countries:

$$\frac{c(w,q,r,z')}{c(w^*,q^*,r^*,z')} = 1 \ .$$

Determination of the relative demand for labor

- Using this unique borderline activity z', we can then calculate the demand for labor in each country. At home, for example, the relative demand for skilled/unskilled labor is:

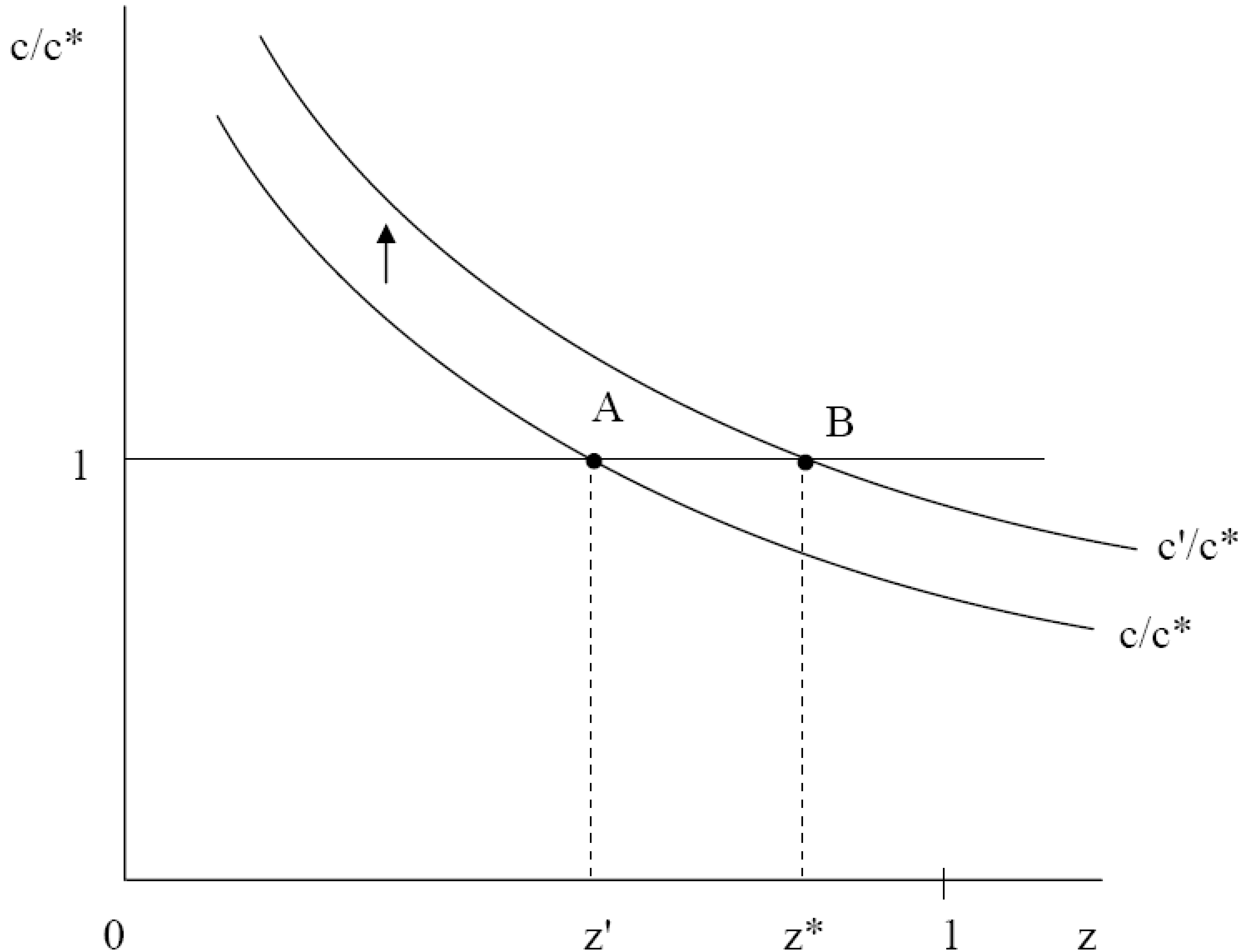
$$D(z') = \frac{\int_{z'}^{1} \frac{\partial c}{\partial q} x(z)dz}{\int_{z'}^{1} \frac{\partial c}{\partial w} x(z)dz} .$$

- It can be shown that this schedule is a downward sloping function of the relative wage. A downward sloping relative demand curve applies to the foreign country, too, where now we integrate over the activities in [0, z').
- In both countries, equilibrium factor prices are determined by the equality of relative demand and supply.

A change in the borderline activity

- Suppose now that the home firm wishes to offshore more activities. The reason for this could be a capital flow from the home to foreign country, reducing the rental abroad and increasing it at home; or alternatively, technological progress abroad, neutral across all the activities, but exceeding such progress at home.
- In both cases, the relative costs of production at home rise, which is an upward shift in the relative cost schedule. As a result, the borderline between the activities performed at home and abroad therefore shifts from the point z' to the point z*, with z* > z', as shown in the next figure.

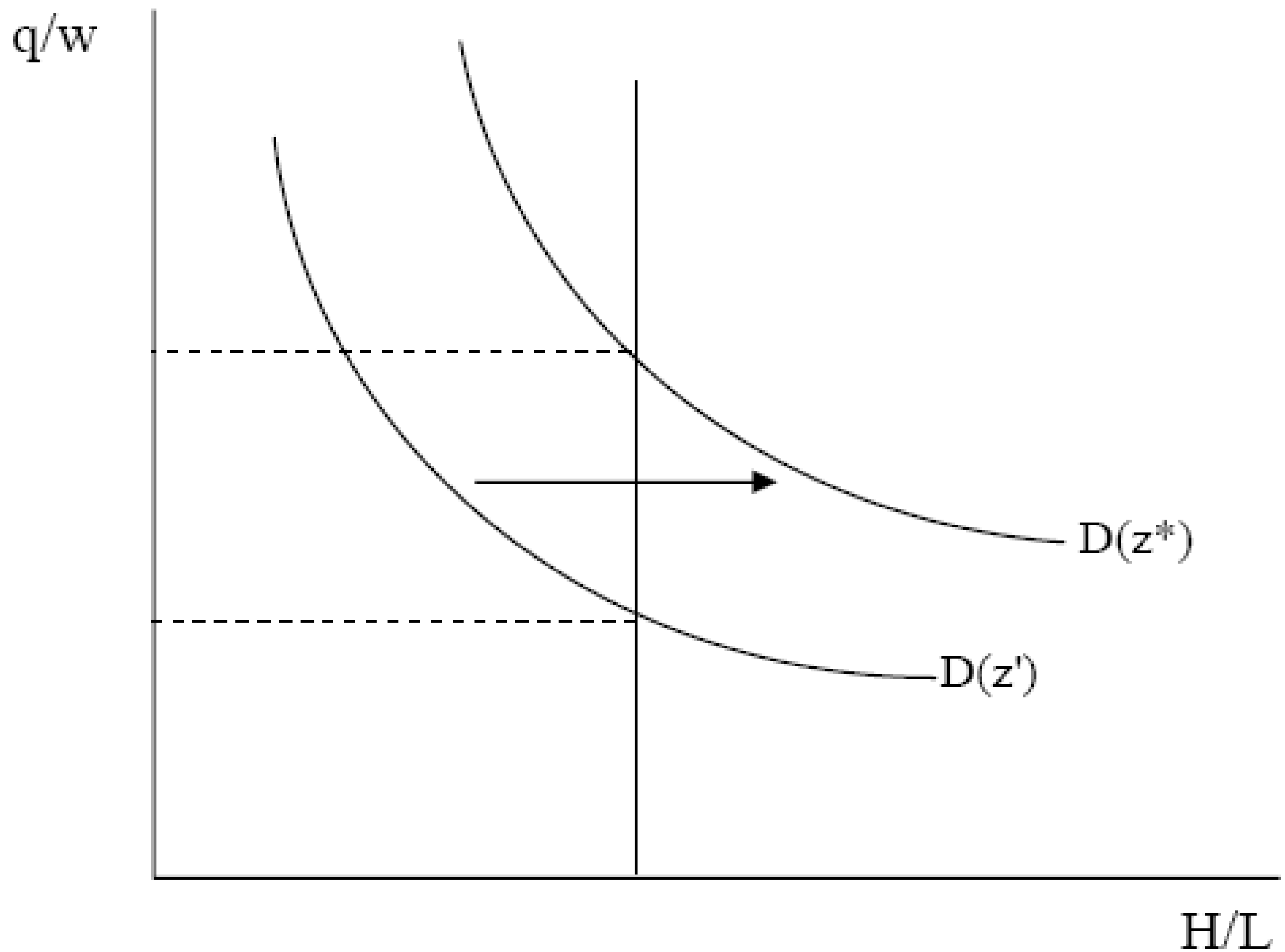
Increase in offshoring



Vertical disintegration and the relative demand for labor

- What is the impact of this increase in offshoring on the relative demand for skilled labor at home and abroad?
- Notice that the activities no longer performed at home (those in-between z' and z*) are *less* skill-intensive than the activities still done there (those to the right of z*).
- This means that the range of activities now done at home are more skilled-labor intensive, on average, than the set of activities formerly done at home.
- For this reason, the relative demand for skilled labor at home increases, as occurred in the United States during the 1980s.
- That increase in demand will also increase the relative wage for skilled labor, as shown in the next figure.

Increase in relative demand for skilled labor



Same results in skilled-labor abundant *and* unskilled-labor abundant countries

- What about in the foreign country?
- The activities that are newly sent offshore (those in between z' and z*) are *more* skill-intensive than the activities that were initially done in the foreign country (those to the left of z').
- That means that the range of activities now done abroad is also more skilled-labor intensive, on average, than the set of activities formerly done there.
- For this reason, the relative demand for skilled labor in foreign also increases. With this increase in the relative demand for skilled labor, the relative wage of skilled labor *also increases* in the foreign country.
- That outcome occurred in as Mexico, for example, during the 1980s, as well as in Hong Kong and other developing countries.

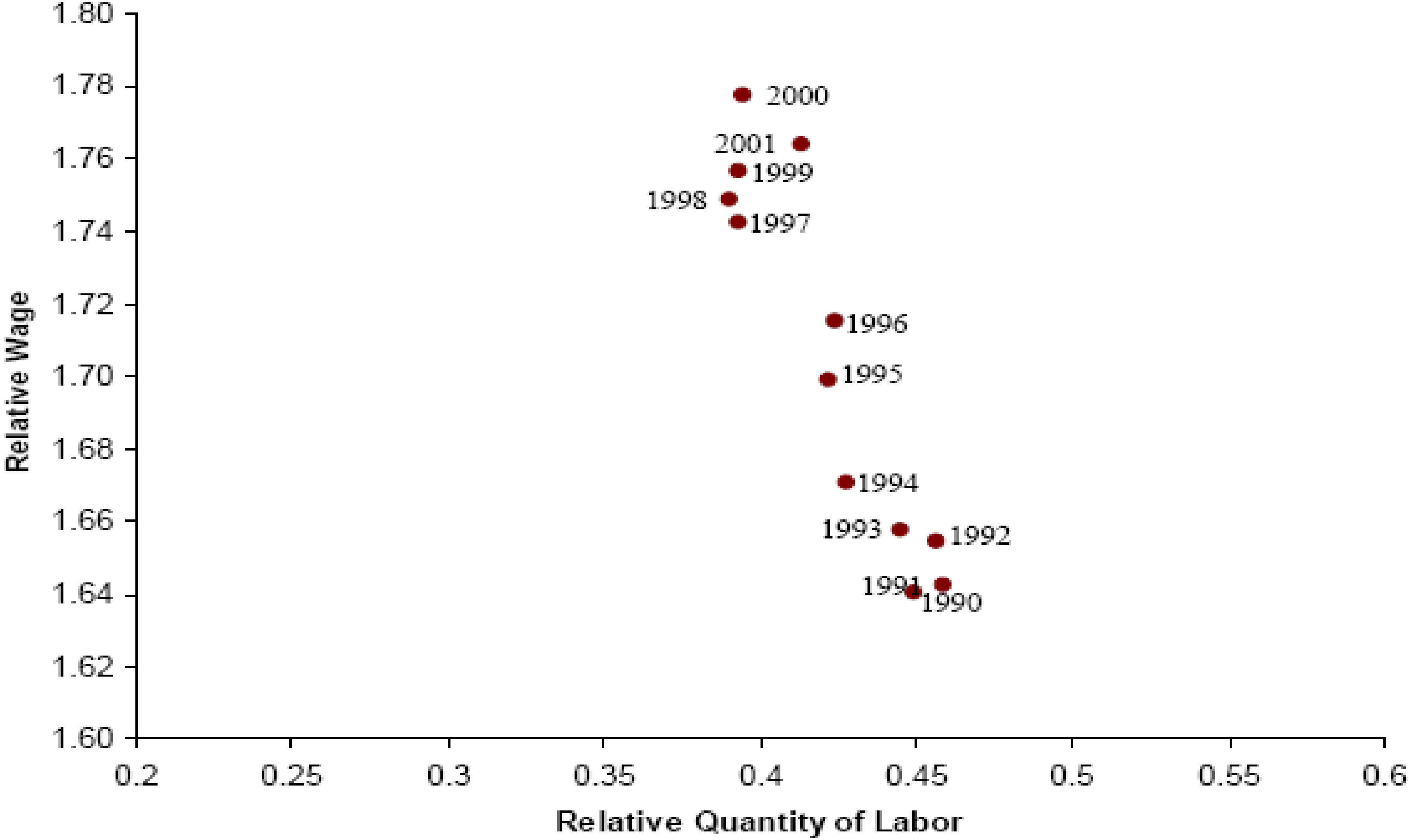
Which explanation is more important is an empirical question

- To summarize, this model of Feenstra and Hanson, which borrows the structure of the Heckscher-Ohlin model with a continuum of goods, gives an explanation for the increase in the relative demand for skilled labor that was observed across countries during the 1980s.
- Of course,this explanation does not *prove* that offshoring was the source of the wage changes, since skill-biased technological change is equally well an explanation.
- So determining which of these explanations accounts for the changes observed during the 1980s is an empirical question.

A different picture for the 1990s

- Let me turn now to consider the evidence in the United States for the 1990s. The picture for the 1980s is well-known and launched dozens of research studies, but it is surprising that the picture for the 1990s – shown in the next figure – is not yet familiar.
- We see that from 1990-2000, there continued to be an increase in the relative wage of nonproduction/production labor in U.S. manufacturing, but in addition, there was a *decrease* in the relative employment of these workers.

U.S. Manufacturing Nonproduction/Production Workers, 1990s



Two possible explanations again

- There are two possible explanations for this shift suggested by the literature.
- First, some labor economists have argued that the 1990s witnessed a changing pattern of labor demand, benefitting those in the highest and lowest-skilled occupations, at the expense of others in moderately skilled occupations. Autor, Katz and Kearney (2008, p. 301) attribute this once again to technological change: "…we find that these patterns may in part be explained by a richer version of the skill-biased technical change hypothesis in which information technology complements highly educated workers engaged in abstract tasks, substitutes for moderately educated workers performing routine tasks, and has less impact on low-skilled workers performing manual tasks."

Offshoring in the 1990s and services

- A second possibility is that this figure is a “smoking gun” for service offshoring from U.S. manufacturing.

- To the extent that the back-office jobs being offshored from manufacturing use the lower-paid nonproduction workers, then the offshoring of those jobs could very well raise the *average* wage among nonproduction workers, while lowering their employment.

- Some evidence for the impact of service offshoring on employment of high versus low skilled workers is found by Crinò (2007), to whose work we now turn.

Data coverage and proxy for service offshoring

- Crinò has U.S. data for employment in 144 manufacturing and service industries during the period 1997-2002.
- His proxy for service offshoring is the share of imported services in total non-energy inputs purchases (*SOSS*).
- The underlying idea is that offshoring entails foreign relocation of service activities, whose output has to be imported back to the U.S., where it will enter the production process together with other intermediate inputs. The more intense the use of offshoring, the higher the share of total inputs accounted for by imported services.

- Industry-level data on service imports are not available for the U.S. , so they must be estimated for each of the 144 industries.
- Crinò attributes to each industry a share in the economy-wide level of service imports. The U.S. Bureau of Economic Analysis (BEA) provides time-series data on affiliated and unaffiliated imports for 14 categories of private services, which are listed in the following table.

Categories of private services used to compute the proxy for service offshoring

Financial Services	Management, Consulting and Public Relation Services
Insurance Services	Industrial Engineering
Computer and Information Services	Installation, Maintenance and Repair of Equipment
Research, Development and Testing Services	Legal Services
Business, Professional and Technical Services	Operational Leasing
Advertising	Accounting, Auditing and Bookkeeping
Telecommunication	Other Business, Professional and Technical Services

Note: Affiliated and unaffiliated data on payments to foreign residents for these services are available from BEA ("U.S. International Services: Table 1 - Trade in Private Services, 1992-2004")

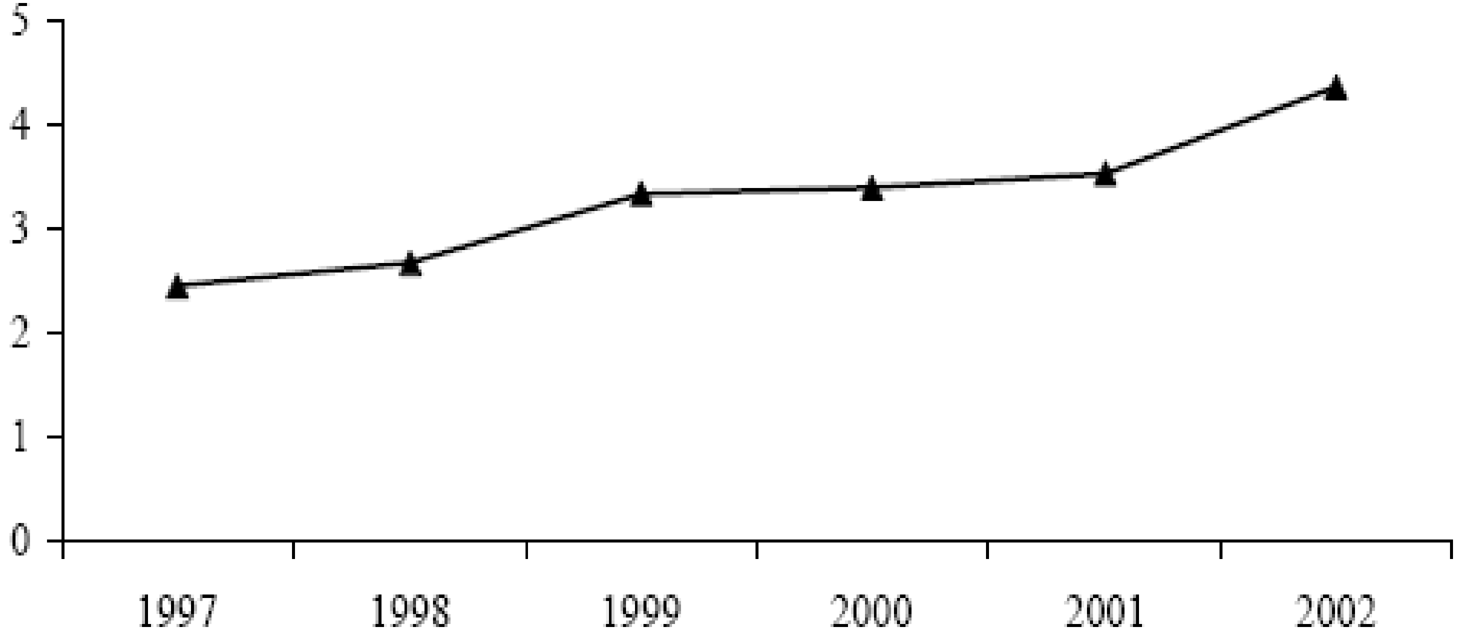
Construction of *SOSS*

- Crinò uses the 1997 BEA Import Matrix to estimate the share of each industry in the 1997 economy-wide level of imports of each of these services.
- For a generic industry *j* (*j* = 1; … ; *J* = 144) and service category *h* (*h* = 1; … ; *H* = 14), denote this share by ϑ_{jh}^{97}.
- Crinò maintains the assumption that ϑ_{jh}^{97} stayed constant between 1997 and 2002. Under this assumption, he applies ϑ_{jh}^{97} to the time-series of imports of service *h* (M_{ht}); this gives a time-varying estimate of the level of imports of that service in industry *j*.
- Crinò then sums these estimates across all services and normalizes the resulting quantity by the value of non-energy inputs purchased by industry *j* (NE_j). Formally:
- $$SOSS_{jt} = NE_{jt}^{-1} \sum_{h=1}^{14} \vartheta_{jh}^{97} M_{ht} \quad .$$

Time trend for *SOSS*

- Between 1997 and 2002, service offshoring has sharply increased in the U.S. On average, *SOSS* was equal to 2.5% in 1997; by the end of 2002, this figure increased to 5.4%.
- Interestingly, service offshoring has been always higher - and has risen faster - in the manufacturing sector: in 1997, *SOSS* was equal to 2.6% in manufacturing and to 2.3% in the service sector; by the end of 2002, these figures rose, respectively, to 5.6% and 3.1%.

Average share of imported services in total non-energy inputs purchases (*SOSS)*



Occupational employment

- The Occupational Employment Statistics (OES) of the Bureau of Labor Statistics (BLS) contain detailed information on employment and wages at the occupation-industry level for the period 1997-2005. An industry-year panel can however be constructed only for the shorter time horizon between 1997 and 2002, because data from 2003 on are available on a six-month basis and thus not fully comparable with those for earlier years.

- Only for 9 service industries can the OES data be matched with information on other relevant variables like output, capital stock, consumption of intermediate inputs and service offshoring.

- Within the service sector, however, these industries face the most significant effects of service offshoring. Workers in the remaining private service industries, in fact, generally provide non-tradeable services (think of sectors like transportation, education, art and entertainment), whereas the public sector is likely to be shielded from offshoring for political reasons.

8 white-collar occupation groups; 58 white-collar occupations

- Crinò disaggregates employment into 112 minor occupations that can be attributed to 13 major groups of workers performing homogeneous tasks.
- Out of the 13 major groups, 8 are white-collar, accounting for 58 minor occupations.
- As the next table shows, employment in the 8 white-collar groups represents a large fraction of the national total: with the only exception of "Life, Physical and Social Sciences Occupations," Crinò's data account for 55-86% of the 2002 level of national employment.

Share of white-collar national employment accounted for by the sample

Major Occupational Group	%, 2002
White-Collars	
Management Occupations	55.8
Business and Financial Operations	54.6
Computer and Mathematical Occupations	59.3
Architecture and Engineering Occupations	76.8
Life, Physical, and Social Science Occupations	14.9
Legal Occupations	75.8
Sales and Related Occupations	85.8
Office and Administrative Support Occupations	54.8

Defining high, medium, and low skill white-collar occupations

- The OES data do not contain any measures of education at the level of the minor occupations. Crinò therefore uses individual-level data from the 5% 2004 Public Use Microdata Sample (PUMS) to estimate the average level of schooling required to perform each occupation.

- PUMS classifies individuals into 16 different schooling categories, ranging from 0 (no schooling) to 16 (Ph.D.). His proxy is obtained by averaging out the individual-level figures over all workers aged 15 to 65 who share the same occupation.

- Crinò then defines high-skilled white-collar occupations as those whose average worker has at least a bachelor's degree, medium-skilled white-collar occupations as those whose average worker has an associate degree in college and low-skilled white-collar occupations as those whose average worker has lower levels of education.

Defining "tradeable" white-collar occupations

- Following previous studies, Crinò identifies as "tradeable" those occupations that show the following features jointly:

  1) involvement in routine tasks that are repeated almost mechanically; 2) provision of impersonal services that do not require face-to-face contact; 3) production of services that can be easily transmitted from remote destinations with low degradation of quality.

- To this purpose, he uses the description provided by the BLS of the main activity performed by each of the 58 white-collar occupations.

- The resulting classification may be arbitrary, but is only meant to distinguish the set of occupations that are in principle most at risk of service offshoring. The actual effects of service offshoring will be revealed by the econometric analysis.

Observed changes in U.S. white-collar employment

- Between 1997 and 2002, almost 1.5 million white-collar jobs were lost in the U.S.
- The overall decline in white-collar employment was extremely widespread across occupations. Nevertheless, two interesting pieces of evidence emerge.
- First, high-skilled white-collar employment increased, whereas medium- and low-skilled employment declined. However, the increase in high-skilled employment was been driven by only five occupations: 1) lawyers; 2) advertising, marketing, promotions, public relations and sales managers; 3) management analysts; 4) aerospace engineers; 5) civil engineers.
- Second, with a limited number of exceptions, the tradeable occupations experienced employment declines.

A simple, atheoretic analysis

- A simple analysis of the contribution of service offshoring to these changes in U.S. white-collar employment can be conducted by estimating a log-linear (conditional) demand function for each of the 58 white-collar occupations, measuring the effects of *SOSS* while controlling for a large set of covariates.
- The demand function takes the form:

$$\ln e_{jt}^{n} = b_0 + b_1 \cdot \ln w_{jt}^{n} + b_2 \cdot SOSS_{jt} + b_3 \cdot \ln y_{jt} + \mathbf{d}'\boldsymbol{\Omega}_{jt} + \varrho_{jt}$$

where *n* indexes occupations, *j* industries and *t* time, *e* is the number of employees, *w* is the wage, *y* is output, Ω is a vector of control variables and *ρ* is an idiosyncratic disturbance.

Control variables

- The vector Ω includes:
- Time dummies, that capture the effects of year-specific macroeconomic and political factors that are constant across industries
- A proxy for technological progress, that accounts for the effects of the introduction of new technologies. The proxy is the share of high-tech capital in total capital stock. High-tech capital includes computer and peripheral equipment, software, communications, photocopy and related equipment, and office and accounting equipment.
- A proxy for materials offshoring, that controls for the fact that some white-collar jobs may be relocated abroad as a result of offshoring of intermediate inputs. As an example, think of occupations like transportation and storage managers. These jobs may be moved abroad when firms decide to relocate the production of intermediate inputs. Without controlling for this possibility, these effects may be captured by *SOSS*, and thus confounded with those of service offshoring.

- Finally, all variables enter in deviation from industry-specific means, to control for industry-specific effects.

Results by skill group

- The estimated (conditional) labor demand elasticities with respect to service offshoring are reported in the following tables, together with heteroskedasticity-robust standard errors.
- I start commenting upon the elasticities along the first dimension of analysis, that is by looking at the effects of service offshoring across skill categories. Interestingly, the vast majority (11 out of 15) of occupations in the high-skilled group are characterized by positive elasticities to service offshoring; 5 of these elasticities are also significant at conventional levels, whereas only 1 of the negative elasticities is significantly different from zero (accountants and auditors).
- At the same time, there is some evidence of a concentration of negative elasticities in the medium- and low-skilled groups: out of 43 occupations, 26 are characterized by negative elasticities; out of these, 13 are significantly different from zero.

Results by tradeability

- Within each skill group, however, there is high heterogeneity in the response of specific occupations.
- Some of this heterogeneity seems to depend on the differences in tradeable features across occupations. In particular, the elasticities are always negative for the tradeable occupations, and are usually also significantly different from zero.
- As suggested by previous studies, this shows that tradeable occupations face negative employment effects from service offshoring, independent of their level of education. At the same time, service offshoring seems to stimulate employment in very complex and highly specialized non tradeable occupations. These latter effects have generally been neglected in the previous literature.

Estimated Labor Demand Elasticities with respect to service offshoring, high-skilled occupations

Occupation	Elasticity	Std. Err.
High Skilled		
Lawyers	0.0231	0.0104**
Life Scientists	0.0679	0.0785
Physical Scientists	0.0092	0.0089
Engineering managers	0.0126	0.0064*
Advertising, Marketing, Promotions, Public Relations and Sales Managers	0.0076	0.0032**
Petroleum engineers	-0.0080	0.0756
Computer hardware engineers	0.0248	0.0111**
Management analysts	0.0150	0.0071**
Aerospace engineers	0.0095	0.0064
Market and Survey Researchers	-0.0009	0.0062
Sales engineers	0.0057	0.0141
Mechanical engineers	0.0043	0.0111
Civil engineers	0.0034	0.0056
Accountants and auditors	-0.0039	0.0022*
Life, Physical, and Social Science Technicians	-0.0241	0.0081

Estimated Labor Demand Elasticities with respect to service offshoring, medium-skilled occupations

Medium Skilled		
Chief executives	0.0070	0.0032**
Medical and health services managers	-0.0796	0.1175
Financial managers	0.0059	0.0023***
Human Resources Managers	0.0016	0.0018
Purchasing managers	0.0017	0.0029
Administrative services managers	0.0101	0.0023***
Marine engineers and naval architects	-0.0817	0.2481
Computer systems analysts	-0.0143	0.0025***
Computer programmers	-0.0252	0.0046***
Mining and geological engineers, including mining safety engineers	-0.2672	0.3383
Industrial Engineers, Including Health and Safety	-0.0071	0.0108
Materials engineers	-0.0012	0.0098
Database administrators	-0.0143	0.0031***
Agricultural engineers	-0.0030	0.0017*
Budget analysts	0.0164	0.0045***
Compliance officers, except agriculture, construction, health and safety, and transportation	-0.0079	0.0067
Advertising sales agents	0.0338	0.0110***
Human Resources, Training and Labor Relations Specialists	0.0088	0.0032***
Computer support specialists	-0.0150	0.0031***

Estimated Labor Demand Elasticities with respect to service offshoring, low-skilled occupations

Low Skilled		
Construction managers	0.0006	0.0035
Industrial production managers	0.0023	0.0064
Transportation, storage, and distribution managers	0.0014	0.0063
Sales Representatives, Wholesale and Manufacturing	0.0162	0.0051***
Cost estimators	-0.0163	0.0039***
Buyers and Purchasing Agents	-0.0042	0.0072
Property, real estate, and community association managers	-0.0869	0.0632
First-line supervisors/managers of office and administrative support workers	0.0058	0.0028**
Engineering Technicians, Except Drafters	0.0029	0.0120
Drafters	0.0098	0.0109
Statistical assistants	-0.0265	0.0075***
Demonstrators and product promoters	-0.0125	0.0049***
Financial Clerks	-0.0113	0.0054**
Parts salespersons	-0.0028	0.0033
Information and Record Clerks	-0.0133	0.0062**
Other Office and Administrative Support Workers	-0.0121	0.0055**
Order, receptionist and information clerks	0.0059	0.0043
Switchboard operators, including answering service	-0.0063	0.0034*
Material Recording, Scheduling, Dispatching, and Distributing Workers	-0.0114	0.0056**
Retail salespersons	-0.0210	0.0110*
Executive secretaries and administrative assistants	0.0114	0.0027***
Weighers, measurers, checkers, and samplers, recordkeeping	-0.0102	0.0062
Telemarketers	-0.0153	0.0106
Cashiers, except gaming	-0.0031	0.0063

Conclusions

- These results have three main implications:

- First, they seem at odds with the widespread concern that service offshoring will lower incentives to invest in education and eventually slow down the process of human capital accumulation in developed countries. Although the white-collars represent the most skilled fraction of the workforce, the negative employment effects of service offshoring are concentrated on occupations with low levels of education, whereas high-skilled occupations benefit.
- Second, the results suggest that service offshoring may progressively shift the educational demand towards programs that prepare workers to perform highly complex non tradeable jobs.
- Finally, the results suggest that standard trade theories should combine the usual distinction of labor into skilled and unskilled workers with a parallel distinction that emphasizes the tradeable / nontradeable nature of specific occupations. There are two grad students at MIT who are working on a paper with a continuum of intermediates varying in terms of skill intensity and offshorability/tradeability, but they don't have a polished draft yet.