The Factor Content of U.S. Trade: An Explanation for the Widening Wage Gap?

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Presented at Western Agricultural Economics Association 1997 Annual Meeting
July 13-16, 1997
Reno/Sparks, Nevada

July 1997

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March 21, 1997

Abstract

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I. Introduction

Over the last two decades, unskilled workers in the U.S. have been experiencing a widening wage gap with skilled labor, and at times a declining real wage and higher unemployment rate. Some analysis suggest that trade has been a major cause of this earnings gap, while others suggest that technological change is a more important cause [Burtless (1995), Levy and Murnane (1992)]. How important changes in U.S. trade have been for the demand of low and high skilled labor is an empirical question we investigate in this paper.

Our analysis follows the tradition of input-output structural analysis [Wood (1994)], where the factor content of trade is examined. A factor content analysis of U.S. trade will show how much skilled and unskilled labor is used in producing the country's exports, and how much would have been used to produce its imports. Based on input-output techniques, the factor content of trade includes both direct and indirect employment. Intermediate goods and the jobs associated with their production account for approximately 50 percent of total U.S. production. Consequently, it is important to account for these "indirect" jobs when looking at the skill content of U.S. trade.

II. Data

For the purpose of this analysis, we have assembled a time series of input-output accounts and employment data to investigate the link between U.S. trade and the demand for low and high

skilled labor. The data used in our analysis cover the period 1972-1993. Input output accounts for 1972, 1977, 1982, 1987, are used, as well as an inhouse updated 1987 table for 1993. Industries and commodities are aggregated to 80 sectors for the analysis. BLS commodity price indicies are used to convert current dollar input-output accounts to 1987 base year prices.

Employment by industry is disaggregated into two labor occupations, high-skilled and low-skilled. The Occupation data are taken from the Bureau of Census, Public Use Micro Data Sample, 1990. Occupational shares of industry employment by industry are created from the source data. The same shares are used for each year in the analysis, consequently our analysis does not account for technological change in the use of laobr by occupation.

III. Methodology

Factor content of trade calculations used by Wood (1994, pp. 67-69) are:

$$Z_x = C_A\, Sx,$$

where, Z_x = a vector of factor quantities per dollar of exports (simply factor input coefficients weighted by the share of each industry in total exports).

C_A= the matrix of coefficients showing the quantity of each of the q skill levels needed to produce a dollar of output in each of the r industries,

S_x= a vector whose elements represent the share of exports produced by each of the r-th industries. Likewise, factor content of imports is:

$$Z_m = C_A\, Sm$$

The impact of trade on factor demands in U.S. can be estimated as:

$Z_A = X_A(Z_x - Z_m)$.

The I/O method used here differs from Wood's method for two reasons. First, whereas C_A in Wood's case is direct factor use, I/O method calculates the direct and indirect use in the economy. Secondly, Wood estimates factor-content in trade using labor-input coefficients for developing countries rather than those for developed countries. We use published U.S. labor coefficients for our computation. The computational procedures is as follows:

$Z_x = F[\ I\text{-}A\ ]^{-1} * X$ and $Z_m = F[I - A\ ]^{-1} * M$

where F is 2 by 80 matrix of factor coefficients; skilled and unskilled labor. Within the H-O framework of international trade, factor abundance can be inferred by comparing the factor content in net exports with the factor contentment in consumption.

$Z_{nx} = F[I - A\ ]^{-1} * Nx$ *and* $Zd = F[I - A\ ]^{-1} * D$

where Z_{nx} is a 2 by 80 matrix whose elements in the rows are the amount of each factor (skilled and unskilled labor) contained in net exports (Nx), Zd is a 2 by 80 matrix whose elements in the rows are the amount of each factor contained in domestic production of nontraded goods (D).

The factor-content-of-trade calculations estimates the amount of skilled and unskilled labor that is embodied in a nation's exports, and estimates the amount of skilled and unskilled labor that would be needed to produce domestically the goods that are imported. The skilled and unskilled labor embodied in exports represents an addition to the domestic demand for those occupations, while the labor embodied in imports represents a subtraction from domestic labor demand. The influence of trade on relative wages of skilled and unskilled labor is related to the net demand for skilled and unskilled labor that results from imports and exports. The factor content of U.S. economy can be calculated by adding the factor contents of net trade and domestic production of

nontraded goods.

IV. Empirical Analysis

We summarize the results of our analysis in five tables. For these tables, we selectively present the results for four aggregate sectors agriculture, processed foods, nondurable manufacturing, durable manufacturing, and the total economy. The analysis underlying the reported results are done at 80 sector detail, in an attempt to capture sectoral differences in the use of skilled and unskilled labor. Similarly, labor occupations are aggregated into high-skilled and low-skilled categories.

Constant dollar values (billion $ 1987) for total output, exports, imports, and domestic final demand are presented in the top part of table 1. Throughout the period of study, we find that exports and imports each only make up 11 and 12 percent of total economic activity. Most economic activity in the U.S. economy involves of domestic use of domestically produced goods and services. Any labor market impact that trade has through employment gains from exports and losses from imports, will be diluted by the small share of total economic activity from trade.

For further discussion of table 1, we focus on the growth ratio for exports and imports from 1972 to 1987 and from 1987 to 1993 (lower part of the table). It is interesting to note that for U.S. exports, the growth ratio from 1972 to 1987 are essentially equal to the ratio from 1987 to 1993, but in one-third the time (6 years relative to 15 years). For imports the growth ratio was considerably lower during the latter period for the economy as a whole and for durable and nondurable manufacturing. Agriculture was the only sector where the growth ratio was larger in the latter period, while for processed food the growth rate was only slightly lower.

The slower growth of imports between 1987 and 1993 corresponds with a long term trend with the exchange rate. A multilateral trade weighted exchange rate (foreign currency per U.S. dollar) peaked around 1984 through 1986, and fell about 35 percent through 1993. It appears that imports responded more than exports to this large devaluation. As for imports of agriculture and processed food, their growth ratio during the latter period is consistent with the rest of the economy, but during the earlier period the level of imports is small and the growth ratio is low relative to the economywide growth ratio.

Turning to table 2, we report aggregate industry employment, in thousands and as growth ratios for 1972 to 1987 and for 1987 to 1993. Over both time periods and across aggregate sectors, employment growth ratios follows the patterns that occur for exports and imports. One difference is that they are consistently lower for all but one case. The lower employment growth ratios can be accounted for by gains in labor productivity, that is, the use of labor per unit of real, constant dollar value, of production has fallen over time.

The one exception to the influence of labor productivity gains on the relation between employment growth ratios and output growth ratios, is with domestic production for domestic use in the total aggregate economy during the period of 1972 to 1987. For this case there is a 1.5 growth ratio for both employment and output. Labor productivity growth for the nonfood, and nonmanufacturing sectors of the economy, primarily service sectors, does not lower the growth ratio of employment relative to the growth ratios of output.

Next, use tables 3 and 4 to determine whether there has been any shifts in demand for low and high -skilled labor, relative to the change in total employment. For both periods for which growth ratios are calculated, 1972 to 1987 and 1987 to 1993, most ratios are the same for both

high and low-skilled labor, and hence total employment. Some differences occur for durable manufacturing (DM) during the early period, where low-skilled employment growth was lower than for high-skilled employment for both exports and imports. During the period of 1972 to 1987, the growth of both low and high -skilled jobs was greater for imports than for exports. From 1987 to 1993 this relative impact of exports and imports on jobs switched, with export job growth greater than import job growth. The growth of jobs for imports of durable goods manufacturing relative to the growth of jobs for exports, does suggest an adverse impact of our net trade on jobs during the period of 1972 to 1987.

Finally, use table 5 to compare low and high-skilled labor content of agriculture and processsed food. For the five years examined, agricultural exports were greater than imports resulting in more employment in both high and low skilled labor. However, labor used per billion dollar of output indicates that, other than 1972, agricultural imports used more of both high and low skilled labor than exports. In 1972, 6,489 and 15,954 high and low skilled labor were used per billion dollar of exports, while imports used 6,170 and 15,000 high and low skilled labor. For the years 1977-1993, agricultural exports used less high and low skilled labor per billion dollar of export than imports.

For processed foods, the constant dollar value of imports are greater than exports during the period 1972-1993, except for 1993. The high and low skilled labor copntent per billion dollar of imports were higher than for exports during the period 1972-1987. In 1993, a positive net trade resulted in more use of high skilled labor for exports than for imports, but imports show more low skilled labor used than exports. An interesting observation is that for processed foods, more high and low skilled labor was used per billion dollar of imports than of exports, except for

1987. Thus, for both agriculture and processed foods, U.S. imports are more labor intensive than exports, and they low-skilled intensive products as well.

V. Summary

We find input-output is able to analyze the impact of change in the structure of final demand, particularly exports and imports, on the demand for low and high- skilled labor. There is some evidence that net trade during the period of 1972 to 1987 had an adverse impact on both low and high -skilled labor, particularly in durable goods manufacturing. If trade has had an impact on the widening wage gap we would expect to see a differential impact of changes in trade patterns on employment of low and high- skilled labor. Such a pattern is not evident. Something more than trade seems to be at the root of the widening wage gap.

tab1

Table 1--Direct and indirect output, $ billion 1987

	TOTAL	EXPORTS	IMPORT	DOMESTIC
AGR .1972	135.3	13.1	-9.4	131.5
AGR .1977	137.5	19.8	-9.4	127.1
AGR .1982	155.2	24.9	-9.7	140.0
AGR .1987	166.4	23.6	-15.4	158.2
AGR .1993	232.1	45.9	-25.5	211.6
PF .1972	272.2	9.7	-16.6	279.1
PF .1977	281.9	14.6	-18.5	285.7
PF .1982	304.0	17.5	-19.4	305.8
PF .1987	329.7	17.5	-26.2	338.3
PF .1993	478.7	37.6	-34.3	475.3
NDM .1972	352.7	33.7	-40.7	359.8
NDM .1977	429.4	53.5	-62.6	438.5
NDM .1982	405.7	59.3	-57.8	404.2
NDM .1987	511.0	66.4	-91.6	536.3
NDM .1993	748.4	134.3	-125.3	739.4
DM .1972	1098.7	122.5	-153.5	1129.7
DM .1977	1218.6	191.4	-208.4	1235.7
DM .1982	1067.4	201.4	-232.0	1098.0
DM .1987	1402.2	248.6	-453.7	1607.3
DM .1993	1687.5	520.7	-696.5	1863.4
TOTAL.1972	5501.1	337.6	-368.5	5532.0
TOTAL.1977	6365.1	559.9	-588.6	6393.8
TOTAL.1982	6760.2	703.1	-657.7	6714.8
TOTAL.1987	8177.5	664.8	-988.6	8501.3
TOTAL.1993	12479.5	1417.7	-1515.0	12576.8

ratio from 1972 to 1987 and from 1987 to 1993

AGR .1987	1.2	1.8	1.6	1.2
AGR .1993	1.4	1.9	1.7	1.3
PF .1987	1.2	1.8	1.6	1.2
PF .1993	1.5	2.2	1.3	1.4
NDM .1987	1.4	2.0	2.3	1.5
NDM .1993	1.5	2.0	1.4	1.4
DM .1987	1.3	2.0	3.0	1.4
DM .1993	1.2	2.1	1.5	1.2
TOTAL.1987	1.5	2.0	2.7	1.5
TOTAL.1993	1.5	2.1	1.5	1.5

AGR agriculture
PF processed food
NDM nondurable goods manufacturing
MD durable goods manufacturing
TOTAL total economy, including services which are not reported separately.

tab2Table 2--Direct and indirect total employment, thousands

	TOTAL	EXPORTS	IMPORT	DOMESTIC
AGR .1972	3068	295	-199	2973
AGR .1977	3233	386	-224	3070
AGR .1982	2972	426	-204	2750
AGR .1987	2379	282	-244	2341
AGR .1993	2067	351	-253	1969
PF .1972	1620	59	-126	1687
PF .1977	1574	87	-140	1627
PF .1982	1494	95	-119	1518
PF .1987	1437	84	-121	1474
PF .1993	1417	124	-123	1416
NDM .1972	2856	284	-319	2890
NDM .1977	3025	336	-330	3020
NDM .1982	3184	400	-356	3140
NDM .1987	3326	361	-467	3432
NDM .1993	3407	550	-466	3324
DM .1972	10799	1224	-1407	10982
DM .1977	12860	2003	-2046	12903
DM .1982	12280	2327	-2439	12392
DM .1987	12380	2225	-3688	13843
DM .1993	10737	3378	-4286	11644
TOTAL.1972	76999	4745	-3594	75848
TOTAL.1977	93618	8334	-5464	90749
TOTAL.1982	101719	11198	-7428	97949
TOTAL.1987	114344	7707	-8173	114810
TOTAL.1993	119091	11500	-9742	117334

ratio from 1987 to 1972 and from 1993 to 1987

AGR .1987	0.8	1.0	1.2	0.8
AGR .1993	0.9	1.2	1.0	0.8
PF .1987	0.9	1.4	1.0	0.9
PF .1993	1.0	1.5	1.0	1.0
NDM .1987	1.2	1.3	1.5	1.2
NDM .1993	1.0	1.5	1.0	1.0
DM .1987	1.1	1.8	2.6	1.3
DM .1993	0.9	1.5	1.2	0.8
TOTAL.1987	1.5	1.6	2.3	1.5
TOTAL.1993	1.0	1.5	1.2	1.0

tab3Table 4--Direct and indirect high-skilled employment, thousands

	TOTAL	EXPORTS	IMPORT	DOMESTIC
AGR .1972	896	85	-58	869
AGR .1977	948	113	-65	901
AGR .1982	872	124	-60	808
AGR .1987	696	82	-71	686
AGR .1993	605	102	-74	577
PF .1972	462	17	-35	479
PF .1977	450	25	-39	464
PF .1982	429	28	-34	436
PF .1987	410	24	-35	421
PF .1993	404	36	-34	403
NDM .1972	1238	122	-133	1249
NDM .1977	1321	147	-140	1313
NDM .1982	1401	178	-154	1377
NDM .1987	1461	159	-202	1504
NDM .1993	1500	243	-201	1458
DM .1972	3605	430	-449	3625
DM .1977	4432	718	-681	4395
DM .1982	4413	865	-832	4381
DM .1987	4437	860	-1305	4882
DM .1993	3709	1271	-1574	4011
TOTAL.1972	32718	2083	-1281	31916
TOTAL.1977	40778	3824	-2070	39024
TOTAL.1982	44987	5344	-3102	42745
TOTAL.1987	50990	3302	-2921	50609
TOTAL.1993	53424	4437	-3576	52563

ratio from 1987 to 1972 and from 1993 to 1987

AGR .1987	0.8	1.0	1.2	0.8
AGR .1993	0.9	1.2	1.0	0.8
PF .1987	0.9	1.4	1.0	0.9
PF .1993	1.0	1.5	1.0	1.0
NDM .1987	1.2	1.3	1.5	1.2
NDM .1993	1.0	1.5	1.0	1.0
DM .1987	1.2	2.0	2.9	1.3
DM .1993	0.8	1.5	1.2	0.8
TOTAL.1987	1.6	1.6	2.3	1.6
TOTAL.1993	1.0	1.3	1.2	1.0

tab4Table 3--Direct and indirect low-skilled employment, thousands

	TOTAL	EXPORTS	IMPORT	DOMESTIC
AGR .1972	2172	209	-141	2104
AGR .1977	2285	274	-158	2169
AGR .1982	2100	302	-144	1942
AGR .1987	1682	199	-173	1656
AGR .1993	1462	249	-179	1392
PF .1972	1159	42	-91	1208
PF .1977	1124	62	-101	1164
PF .1982	1064	68	-85	1082
PF .1987	1027	60	-86	1052
PF .1993	1013	88	-89	1013
NDM .1972	1618	162	-186	1641
NDM .1977	1704	189	-191	1707
NDM .1982	1783	222	-202	1763
NDM .1987	1865	202	-265	1928
NDM .1993	1907	307	-265	1865
DM .1972	7193	794	-957	7357
DM .1977	8428	1285	-1365	8508
DM .1982	7867	1462	-1606	8011
DM .1987	7943	1366	-2383	8961
DM .1993	7028	2107	-2712	7633
TOTAL.1972	44281	2662	-2313	43932
TOTAL.1977	52841	4510	-3394	51725
TOTAL.1982	56731	5854	-4326	55204
TOTAL.1987	63354	4405	-5251	64200
TOTAL.1993	65667	7063	-6166	64771

ratio from 1972 to 1987 and from 1987 to 1993

AGR .1987	0.8	1.0	1.2	0.8
AGR .1993	0.9	1.2	1.0	0.8
PF .1987	0.9	1.5	0.9	0.9
PF .1993	1.0	1.5	1.0	1.0
NDM .1987	1.2	1.2	1.4	1.2
NDM .1993	1.0	1.5	1.0	1.0
DM .1987	1.1	1.7	2.5	1.2
DM .1993	0.9	1.5	1.1	0.9
TOTAL.1987	1.4	1.7	2.3	1.5
TOTAL.1993	1.0	1.6	1.2	1.0

Table 5-- Low and high-skilled employment per billion dollar of export and import

	Agriculture				Processed foods			
	High skilled		Low skilled		High skilled		Low skilled	
	Export	import	export	import	Export	import	export	import
1972	6,489	6,170	15,954	15,000	1,752	2,108	4,330	5,481
1977	5,707	6,915	13,838	16,808	1,712	2,108	4,247	5,460
1982	4,980	6,186	12,128	14,234	1,600	1,753	3,886	4,381
1987	3,475	4,610	8,432	11,234	1,371	1,336	3,429	3,282
1993	2,222	2,902	5,424	7,020	958	991	1,808	2,594

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