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Employment: Based on a WIOT Analysis
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Gains or Pains?-- Effects of US-China Trade on US Employment: Based on a WIOT Analysis from 1995 to 2011

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I. Introduction

With the rise of China, US-China trade has developed rapidly since the 1990s. In 2007, China overtook Mexico as the second largest trade partner of the US. But the trade imbalance, or more specifically, the US merchandise trade deficit with China has become the focus of both countries, especially after China’s entry into WTO in 2001. In 2013, the US-China trade deficit on goods was about 23 times more than that in 1991, up from 13.95 to 330.29 billion dollars, and elevated to 61% of US total trade deficit on goods (Figure 1). A large and persistent trade imbalance raises policy concerns because of its perceived links to domestic production and employment—specifically, the fear that more imports will mean less production and fewer jobs in the United States (Bown, 2005). From 1991 to 2013, the US manufacturing employment rate (percentage of population) decreased from 10.64% to 6.05%, leading to a widespread view that job losses in the US are “made in China”.

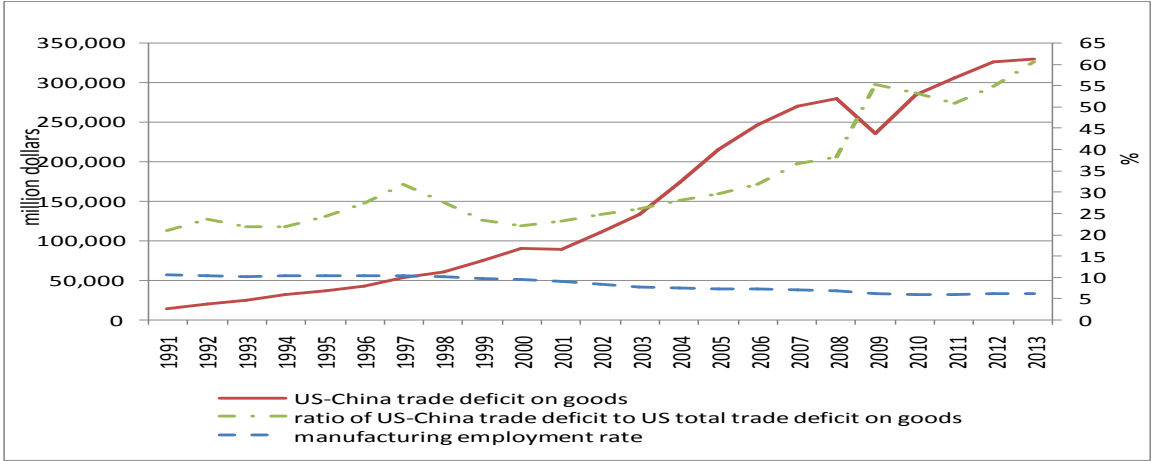


Figure 1 US-China Trade Deficit on Goods² (left scale) and US Manufacturing Employment Rate (right scale)

Source: UN COMTRADE, BLS and authors’ calculation.

¹ The authors thank Anthony Roberts for helpful comments.

²The trade data include re-exports from US to China.

The impact of trade with developing countries on employment in the US has been a controversial topic during the last two decades. The relevant literature is extensive and varied.

The Heckscher-Ohlin theory tells us when a country shifts from no trade to free trade, the export sectors will expand and the import-competing sectors will shrink. For developed countries, trade with developing countries tends to generate additional employment opportunities for skilled labor while reducing employment opportunities for unskilled labor. However, the early debate among Leamer (1993, 1994), Lawrence and Slaughter (1993), Krugman and Lawrence (1993), and Wood (1994, 1995) raised questions over the validity of the classic trade theory and the role of international trade in the local labor market effects in the US and other developed countries.

Sachs and Shatz (1994) conclude that since 1980, trade expansion has been one factor, albeit a small one, of the decline in employment in the US low-skill manufacturing sectors. Matusz (1996) argues that, in a model of monopolistic competition and efficiency wages, trade liberalization will increase employment. Berman, Bound and Machin (1998) find that skill-biased technological change rather than increased trade with developing countries is the principal reason for the decrease in demand for less skilled workers in the US. Baily and Lawrence (2004) have found the weakness of the US payroll employment since 2000 is primarily caused by inadequate growth of domestic demand in the presence of strong productivity growth. Partridge et al (2013) study the data over 1990-2010 and draw a similar conclusion--the impact of trade on employment are small relative to those generated by domestic demand. Bernard, Jensen, and Schott (2006) estimate that between 1977-1997, 14% of the total job loss in US manufacturing is due to import penetration from low-income countries. Dutt, Mitra and Ranjan (2007) study cross-country data and conclude that trade protection increases unemployment rates while trade openness decreases unemployment rates, both across countries and within countries over time. Carrere et al. (2014) also verify this finding with cross-national data and show trade liberalization causes higher unemployment in countries with comparative advantage in sectors with strong labor market frictions.

Some evidence shows that competition from developed countries rather than from developing countries has a greater impact on the labor market. Greenaway, Hine and Wright (1999) find that increases in trade volumes reduce the derived labor demand in the UK, but imports from the EU and US have stronger negative effects on labor demand than from East Asia. Ojeda et al. (2000) estimate that the total potential job impact in the United States from 1990 to 1997 due to imports from Mexico is smaller than the impact due to imports from Canada.

More recently, with China playing a more important role on the stage of world trade, some literature focuses specifically on trade with China. Pierce and Schott (2014) point out that a substantial portion of the loss of US manufacturing employment since 2001 is related to China's WTO accession. Autor, Dorn and Hanson (2013a) study from the regional level and estimate that Chinese import competition explains 21% of the US manufacturing employment decline from 1990 to 2007. Balsvik, Jensen and Salvanes (2014) and Dauth, Findeisen, and Suedekum (2014) follow Autor's approach and study the impact of imports from China on the manufacturing employment share in Norwegian and German local labor markets. Balsvik, Jensen and Salvanes (2014) find there is a negative impact and further show that this negative impact is due to imports of intermediate products rather than for final consumption. But Dauth, Findeisen, and Suedekum (2014) find the labor market effects in Germany are mostly driven by the rise of Eastern Europe, instead of China; and in the aggregate, the job losses in regions specializing in import-competing industries can be offset by job gains in export-exposed regions. Acemoglu et al. (2014) expand Autor's analysis to include non-manufacturing sectors and suggest that in the period between 1999 to 2011, imports from China caused 2 to 2.4 million job losses in the US.

It is not difficult to conclude that the net impact of trade on employment is likely to be complex and ambiguous (Davidson, Martin and Matusz, 1999; Helpman and Itskhoki, 2010) and the evidence for clear labor market effects of trade shocks is limited (Krugman, 2008). Different models, different data, and different variables may lead to different results. We find most studies only analyze the impact of imports on manufacturing sectors which ignores the effects of exports and the impact of trade on non-manufacturing sectors. This analytical focus is probably because of sharp decline in overall employment in the US manufacturing (Sachs and Shatz, 1994) and, in terms of US-China trade, imports from China are much larger than exports to China (Autor, Dorn and Hanson, 2013a; Acemoglu et al, 2014).

However, increased U.S. exports to developing countries could provide offsetting aggregate gains (Partridge et al., 2013) and, the inter-industry links between manufacturing and non-manufacturing sectors may generate both positive and negative changes in US industrial employment (Pierce and Schott, 2014; Acemoglu et al., 2014). The narrow focus on declining jobs in manufacturing may overlook the increasing number of jobs in non-manufacturing sectors (Timmer et al, 2013). Therefore, excluding the export effects and focusing solely on manufacturing employment gives a biased picture of trade effects on employment.

In this paper, we try to clarify the role of trade with China in the US employment changes using new data and modeling technique which embrace exports to China and non-manufacturing sectors. Until 2011, US export of goods and services to China has risen to a noteworthy 29.81% of the total US-China trade value. A key feature of global trade in the new century is the rapid growth of offshoring (Feenstra and Hanson, 2001) and trade in intermediate goods (Hummels, Ishii, and Yi, 2001). Analyzing the imports as a whole is less informative, so we follow the recent research by Pierce and Schott (2014) and Autor, Dorn and Hanson (2013a), and separate the imports into final goods and intermediate inputs. Figure 2 shows that, from 1995 to 2011, the portion of intermediate imports from China has increased from 22% to 33% of the total US-China trade, and elevated to almost half of the total imports from China. The overall employment rate (percentage of population) experienced two declining periods from 1995 to 2011-- one from 2000 to 2003, when it dropped from 64.4% to 62.3%; the other period is from 2007 to 2011, when it dropped from 63% to 58.4%.

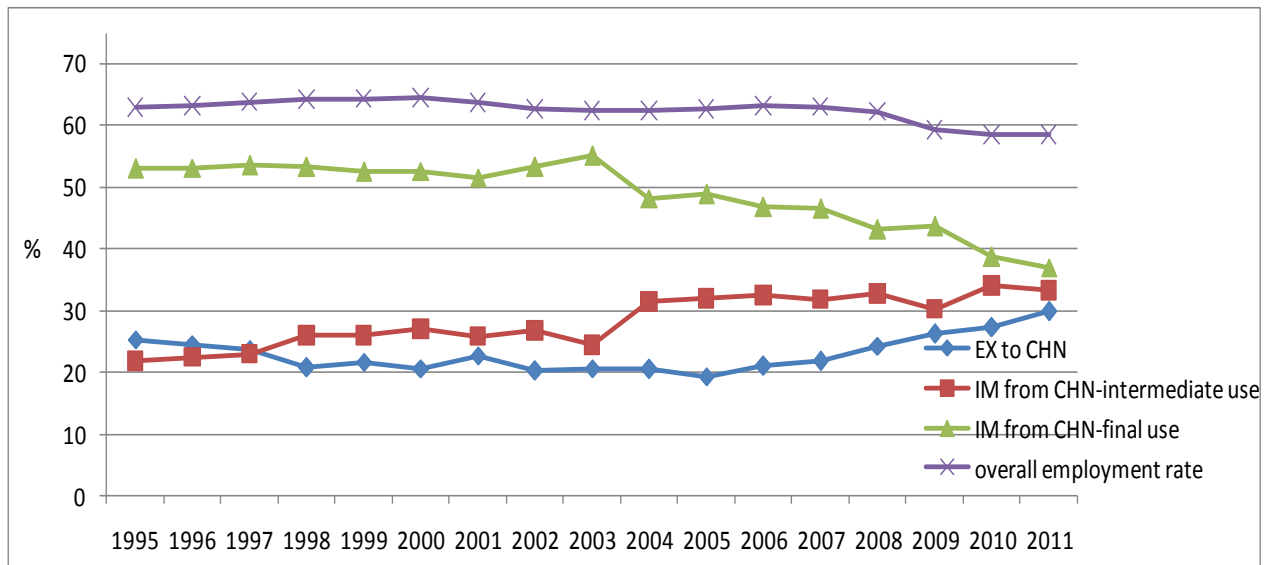


Figure 2 Portions of US-China Trade in Goods and Services and US Total Employment rate

Source: WIOD, BLS and authors' calculation.

Adopting the new public world input-output database (WIOD), which more accurately captures the inter-industry links in US-China trade, and using the method of Structural Decomposition Analysis (SDA) based on a world input-output table (WIOT) framework, we attempt to decompose the two periods of employment decline. We find that the job losses are

mainly caused by labor productivity changes, while imports from China, including intermediate and final imports, only account for 3.11% during 2000-2003 and 3.58% during 2007-2011, of the job losses in the US. Further analyzing the marginal effect of imports or exports on employment, we find that the negative impact is due to imports of intermediate products rather than for final consumption; but over those two periods, no matter whether we examine exports or imports, the marginal effects of US-China trade on US employment are weakening, and the effects of final imports weaken most. Comparing these two periods, we find the effects of US-China trade on US employment have switched from manufacturing towards services sectors, and the negative factor has shifted from final imports towards intermediate imports. In the sector of “renting of M&Eq. and business services”, jobs increase as well as decrease. Looking specifically at different skill levels, the data indicates that the increase in US-China trade is affecting high-skilled jobs more than low-skilled jobs. Moreover, for high-skilled and mid-skilled labors, most job gains and losses happen in the “Renting of M&Eq & Other Business Services” and “Electrical and Optical Equipment” sectors; while for low-skilled labors, most job gains are in the “Agriculture & Food” sector, while most job losses are in the “Textiles & related” and “Leather & related” sectors.

II. Technical Framework

We use the method of Structural Decomposition Analysis (SDA) to decompose the different determining factors in the changes of the US employment. It is rooted in the Input-Output framework introduced by Leontief (1936) and is a major tool for disentangling the growth in some variable over time, separating the changes in the variable's constituent parts (Dietzenbacher and Los, 1998). And the use of the input-output table made it possible to estimate both the direct and indirect effects of trade on employment opportunities (Aho and Orr, 1981). The direct effect refers to the employment changes in an industry when the final demand changes due to the changes in imports or exports of the industry. The indirect effect includes the employment changes in industries which supply inputs to industries whose products are directly affected by trade.

Assume that an open economy can be categorized into n sectors. We define Y_i as the total output (production) of sector i , F_i as the total final demand for sector i 's product, either domestic or foreign demand, Z_{ij} as sector j 's total demand for inputs from sector i , either domestic or imported inputs. The product market clearing condition can be written as

$$Y_i = \sum_{j=1}^n Z_{ij} + F_i \quad (i=1,2,\dots,n) \quad (1)$$

Denote Z_{ij}/Y_i by a_{ij} , which is intermediate input coefficient, and the matrix of a_{ij} by A .

Let

$$Y = \begin{bmatrix} Y_1 \\ \vdots \\ Y_n \end{bmatrix} \quad A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix} \quad F = \begin{bmatrix} F_1 \\ \vdots \\ F_n \end{bmatrix}$$

Then the equation can be rewritten as:

$$Y = AY + F \quad (2)$$

Final demand comprises final domestic demand and final foreign demand (exports and imports):

$$F = F^C + F^I + Ex - M \quad (3)$$

Where, F^C denotes the final domestic consumption demand, both by households and the government, F^I denotes the final domestic investment demand, Ex and M denote final foreign demand—exports and imports.

We further decompose imports into imports for intermediate use and final use:

$$M = A^m Y + F^m \quad (4)$$

A^m represents the matrix of imported intermediate input coefficient, which is $[Z^{m,ij}/Z_{ij}]$, F^m denotes the final demand for imports. If we define f^m as the final import demand coefficient, recognizing that imports will not be exported directly then,

$$f^m = F_j^m / (F_j^C + F_j^I) \quad (5)$$

$$F^m = f^m (F^C + F^I) \quad (6)$$

$$Y = AY + F^C + F^I + Ex - [A^m Y + f^m (F^C + F^I)] \quad (7)$$

$$Y = [I - (A - A^m)]^{-1} [(I - f^m)(F^C + F^I) + Ex] \quad (8)$$

Define $B = [I - (A - A^m)]^{-1}$, which is famously known as the Leontief inverse (Leontief, 1936).

$$G = [(I - f^m)(F^C + F^I) + Ex] \quad (9)$$

Then we can get

$$Y = BG \quad (10)$$

Define l as the direct labor input coefficients, which is the direct labor input per unit of gross output. Then the total employment can be written as

$$L = lY = lBG \quad (11)$$

If we look at the change of employment from time 0 to time 1, ΔL , it can be described as

$$\Delta L = L_1 - L_0 = l_1 B_1 G_1 - l_0 B_0 G_0 \quad (12)$$

Using the above equations, we can make a structural decomposition of the change of employment:

$$\begin{aligned} \Delta L = & l_1 B_1 (I - f_1^m) (F_1^C - F_0^C) \\ & + l_1 B_1 (I - f_1^m) (F_1^I - F_0^I) \\ & + l_1 B_1 (Ex_1 - Ex_0) \\ & + l_1 B_1 (I - A_1^m) (A_1 - A_0) Y_0 \\ & + l_1 B_1 (A_0^m - A_1^m) A_0 Y_0 \\ & + l_1 B_1 (f_0^m - f_1^m) (F_0^C + F_0^I) \\ & + (l_1 - l_0) X_0 \end{aligned} \quad (13)$$

Where, $l_1 B_1 (I - f_1^m) (F_1^C - F_0^C)$ reflects the effects of final consumption changes on employment;

$l_1 B_1 (I - f_1^m) (F_1^I - F_0^I)$ reflects the effects of final investment changes on employment;

$l_1 B_1 (Ex_1 - Ex_0)$ reflects the effects of export changes on employment;

$l_1 B_1 (I - A_1^m) (A_1 - A_0) Y_0$ reflects the effects of production technology changes on employment;

$l_1 B_1 (A_0^m - A_1^m) A_0 Y_0$ reflects the effects of structural changes in intermediate-imports on employment;

$l_1 B_1 (f_0^m - f_1^m) (F_0^C + F_0^I)$ reflects the effects of structural changes in final-imports on employment;

$(l_1 - l_0) X_0$ reflects the effects of labor productivity changes on employment.

We can also analyze a specific trade partner using the bilateral trade data. It should be noted that the decomposition methodology outlined above is basically an ex-post accounting framework rather than a general equilibrium analysis. We use annual IO-tables indicating that cost shares in production change overtime. Therefore our analysis does not rely on Leontief or Cobb- Douglas types of production functions where cost shares are fixed (Timmer, et al., 2013), thus it reflects the technological changes.

III. Data Sources

Autor, Dorn and Hanson (2013a) combine U.S. trade data with the 1992 U.S. input-output table to calculate industry imported inputs from China. They assume that industry patterns of input usage are the same for imports as for U.S. domestic goods. This is actually the so-called “proportionality” assumption and can be rather misleading as import shares differ significantly across use category and by country of origin (Feenstra and Jensen, 2012; Winkler and Milberg, 2012; Timmer, et al., 2013).

In order to accurately capture the inter-industry links in US-China trade, we use the new public database, World Input-Output Database (WIOD), which provides a time-series of World Input-Output Tables (WIOT) that are benchmarked on national account series of industry-level output and value added. It was recently created in a joint effort by a consortium of 11 research institutions led by the University of Groningen and funded by the European Commission, and is constructed from underlying Supply-Use tables and presents data on sales and purchases of 35 sectors across 40 countries and the rest of the world between 1995 and 2011. Unlike the proportionality assumption, WIOD allows for different import shares for different end-uses and country origins. It also provides additional socio-economic accounts, which include industry-level data on employment, labor and capital compensation, price levels, compensation and hours worked by skill type (high, medium and low), etc.

In terms of US-China trade, the processing trade plays a notable role, however, in the US IO tables, re-exports and re-imports are excluded. Parts of imports for processing are excluded both in intermediate inputs and imports in the Chinese IO tables as well. In order to reflect the underlying technology of the processing industry, WIOT adds back re-exports and re-imports based on the UN COMTRADE database (Timmer (ed.), 2012).

Since some of the data in WIOD is only updated to the year 2009, we made some estimates using other sources to fill in current data. The data for US-China trade on goods from 1991-2013 comes from UN COMTRADE, the data for manufacturing employment rates from 1991-2013 comes from the Bureau of Labor Statistics (BLS). The data on price levels in 2010 and 2011 are collected from the Bureau of Economic Analysis (BEA). Hours worked by different skill types in 2010 and 2011 are estimated using the changes over the previous three years.

IV. Structural Decomposition Analysis of Total Employment

We focus on the two periods when total employment in the US dropped notably: 2000-2003 and 2007-2011. During the first period, China entered the WTO in 2001 and employment dropped from 147.72 to 145.19 million. During the second period, the global financial crises occurred and employment dropped from 152.57 to 145.55 million. We use the WIOT and the above mentioned technique to decompose the employment changes into the effects of final consumption changes, final investment changes, export changes, production technology changes, structural changes of intermediate-imports, structural changes of final-imports and labor productivity changes. Specifically, we separate the US-China import and export effects on employment. We find that some factors are driving, while others are depressing total employment in the US. We add all the positive effects and all the negative effects separately, and then calculate the ratio of each effect to the total positive or negative effects.

Table 1 shows that from 2000 to 2003, final consumption and investment are the major forces driving changes in total employment. While the effect of total exports is negative, exports to China shows a positive effect, creating 120,830 jobs. It may reflect that after China entered the WTO in 2001, US exports to China increased and focused on more labor intensive goods than exports to other markets. Among all the factors reducing total employment, labor productivity changes play the most important role. During this period, labor productivity changes, accounted for an 83.59% decrease in total employment, while structural changes of final-imports from China only reduced total employment by 2.18% to and structural changes of intermediate-imports from China only reduced total employment by 0.93%.

Table 1. Decomposition of Total Employment Changes (2000- 2003)

Factors	Changes in employment (thousand)	Employment increased or reduced (%)
Change in Total Employment	-2527.64	
Final Consumption	16275.90	+97.07
Final Investment	491.69	+2.93
Total Exports	-375.88	-1.95
--Exports to China	(120.83)	(+0.72)
Production Technology	-1719.56	-8.91
Structural Changes in Total Intermediate Imports	-342.87	-1.78
--Structural Changes in Intermediate Imports from China	(-180.67)	(-0.93)

Structural Changes in Total Final Imports	-727.78	-3.77
--Structural Changes to Total Final Imports from China	(-420.55)	(-2.18)
Labor Productivity Changes	-16130.52	-83.59

Note: In this table, employment refers to number of persons engaged.

Given the changes in trade value and employment, we can derive the marginal effect of import or export on employment. The result shows that from the year 2000-2003, a thousand dollar increase in exports to China increases total employment by 0.0103 persons while a thousand dollar increase in intermediate imports from China reduces total employment by 0.0154 persons; and a thousand dollar increase in final imports from China reduces total employment by 0.0123 persons in the US.

In addition to examining the 2000-2003 period, we also observe the effects of trade, investment, consumption, technological change, and labor productivity on total employment during the period from 2007 to 2011. The results are shown in Table 2. During the global recession, final consumption remains the major factor for job gains while labor productivity remains the major factor for job losses. Exports to China account for a 4.78% increase in total employment by creating 669,070 jobs. However, imports from China, including intermediate and final imports, account for a 3.58% decrease in total employment by eliminating 751,090 jobs.

Table 2. Decomposition of Total Employment Changes (2007- 2011)

Factors	Changes in employment (thousand)	Employment increased or reduced (%)
Change in Total Employment	-7018.66	
Final Consumption	12243.12	+87.54
Final Investment	-2051.81	-9.77
Total Exports	1744.95	+12.48
--Exports to China	(669.07)	(+4.78)
Production Technology	-1079.85	-5.14
Structural Changes in Total Intermediate Imports	-1354.80	-6.45
--Structural Changes in Intermediate Imports from China	(-541.66)	(-2.58)
Structural Changes in Total Final Imports	-134.89	-0.64
--Structural Changes to Total Final Imports from China	(-209.43)	(-1.00)
Labor Productivity Changes	-16378.58	-77.99

Note: In this table, employment refers to number of persons engaged.

The result also indicates the marginal effect of imports and exports on total employment from the year 2007-2011. A thousand dollar increase in total exports to China will increase total employment by 0.0073 persons. A thousand dollar increase in intermediate imports from China reduces total employment by 0.0074 persons while a thousand dollars increase in final imports from China reduces total employment by 0.0053 persons in the US. Comparing this data with the period from 2000-2003, we find the effects of US-China trade on US employment are weakening. Moreover, we find the effects of final imports are declining the most, at a rate of 56.91%. This can be explained by the fact that improvements in labor productivity in the US export and import competing sectors brings less labor intensity to their products. We therefore calculate the real labor productivity which is equal to the ratio between real gross value added and total employment³. As illustrated in Figure 3, we observe the five sectors with the most imports from China and find that the real labor productivity in three of them is higher and growing faster than the average labor productivity of total industries. Even though the “Leather and related products” sector has a lower labor productivity, its growth is higher than average.

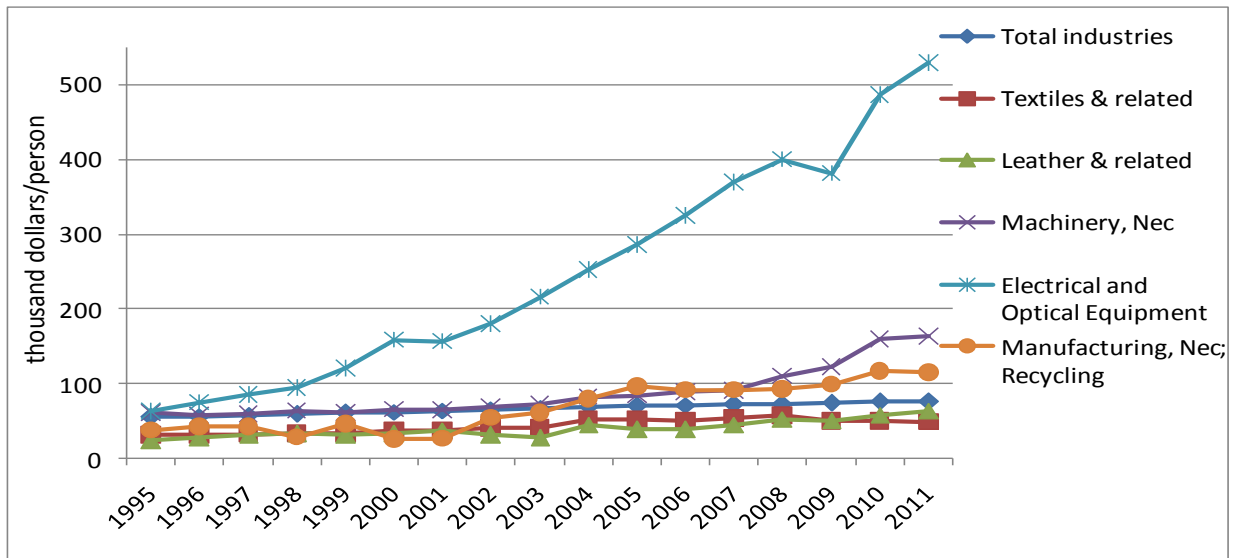


Figure 3 Real labor Productivity by Sectors

Source: WIOD, BEA and authors' calculation.

In terms of the marginal effects of imports from China on US employment, our findings are similar to Balsvik, Jensen and Salvanes' (2014) study on the Norwegian labor market in that the

³OECD Publications. Measuring productivity – OECD Manual: measurement of aggregate and industry-level productivity growth. 2001.

negative impact is due to imports of intermediate products rather than for final consumption. This can be explained in two ways. First, US industries are producing intermediate goods used by other industries and are exposed to increasing import competition from China, as China and the US have become both the biggest buyers and suppliers of intermediates (Baldwin and Lopez, 2013; WTO, 2013). Second, imported intermediate inputs may raise the labor productivity at a rate that exceeds the increase of the output, thus decreasing demand for labor.⁴

If we take a closer look at the employment changes over these two periods by sector, we find that from 2000 to 2003, the most obvious positive effects and negative effects on employment are dominated by three sectors-- “renting of Machine & Equipment (M&Eq.) and other business services”, “electrical & optical equipment manufacturing”, and “agriculture & food”, both in terms of export to China and final import from China (Figure 4). Exports to China create about 20,737 jobs in “renting of M&Eq. and other business services” while final-imports and intermediate-imports from China cause a decrease of 60,322 and 41,893 jobs in “electrical & optical equipment” and “renting of M&Eq. and other business services”, respectively.

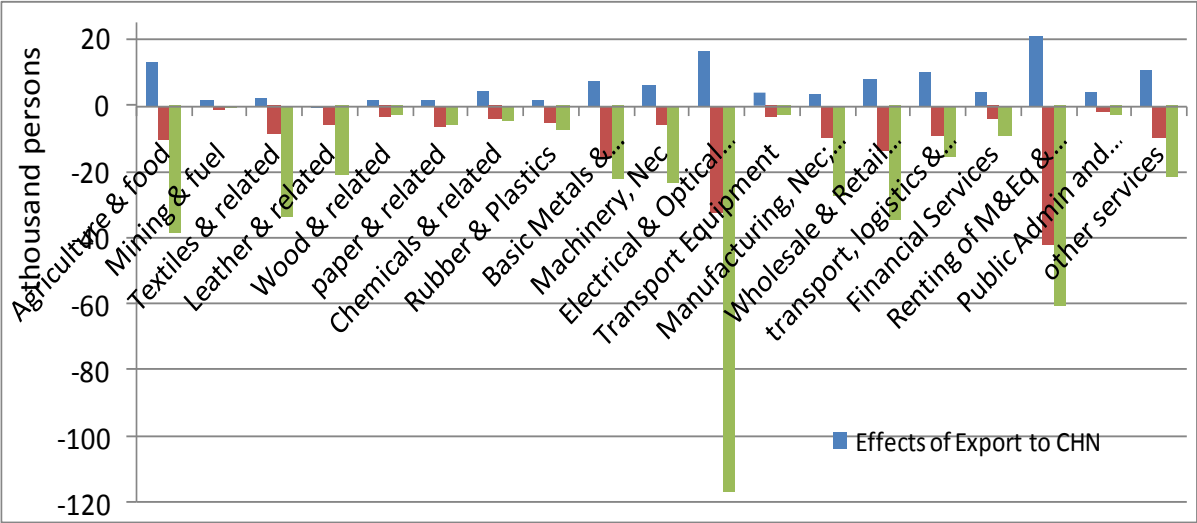


Figure 4 Effects of US-China Trade on US Employment by Sectors (2000-2003)
 Source: WIOD and authors’ calculation.

From 2007 to 2011, the “renting of M&Eq. and business services” sector experiences the most job gains but also suffers the most job losses. It gets 157.694 thousand jobs created from exports to China, but 197.617 thousand jobs lost from intermediate imports from China. “Public admin &

⁴ Eldridge et al(2010) find that over the 1998-2006 period, growth in imported intermediate inputs contributed 23 percent to the average annual growth in labor productivity in the manufacturing sector in the US.

defense services” and “other services” jump to the second and third job winners from exports to China with 81.020 thousand and 77.741 thousand jobs gained (Figure 5).

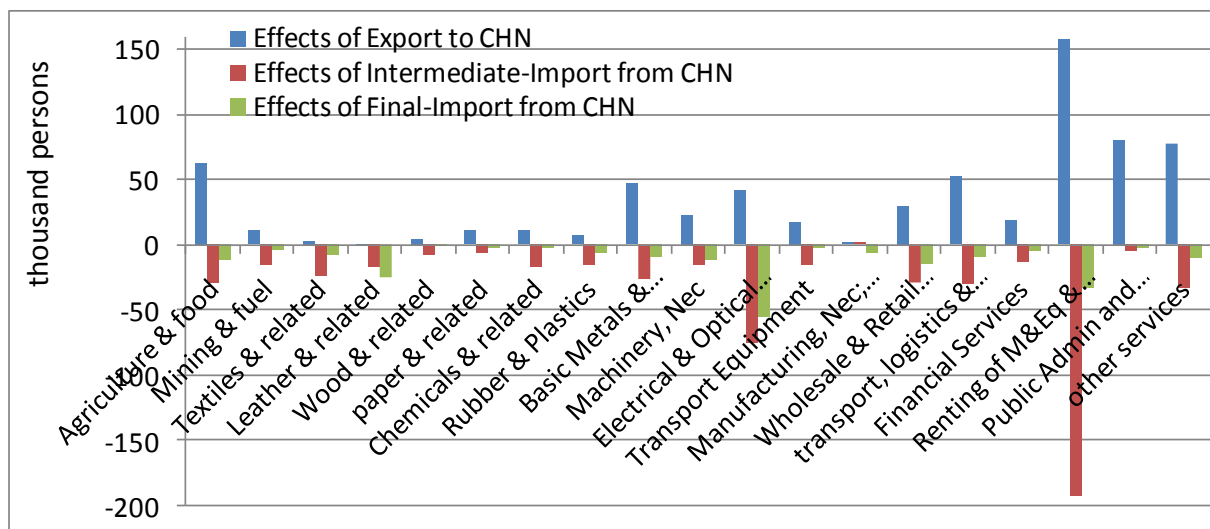


Figure 5 Effects of US-China Trade on US Employment by Sectors (2007-2011)

Source: WIOD and authors’ calculation.

Comparing Figures 4 and 5, we find it is noteworthy that from 2000 to 2011 the effects of US-China trade on US employment have shifted from manufacturing towards services sectors and job loss is more affected by intermediate imports than final imports. The findings reflect the fact that US-China trade in services and intermediate inputs are growing and their impact is increasing. The “renting of M&Eq. and other business services” sector is the most impacted sector over these two periods. This may reflect the rapid growth of outsourcing in business services (Yuskavage, Strassner, and Medeiros, 2006, 2008).

IV. Structural Decomposition Analysis of Employment by Skills

When digging deeper into the changes of employment by skills, we need to link the detailed data of skills to the WIOTs. We used the WIOD Socio-economic Accounts (SEAs) because the SEAs provide the employment data in different skill types, which can be used in conjunction with the WIOTs. Labor skill type is defined on the basis of the level of educational attainment of the workers as defined in the International Standard Classification of Education (ISCED)(table 3).

Table 3. Definition of Labor Skills

Skill type	Educational level description
Low	Primary education or lower secondary or first or second stage of basic education

Medium	(Upper) secondary or post-secondary non-tertiary education
High	First or second stage of tertiary education

Source: Timmer, M.P. (ed., 2012)

Figure 6 shows that from 1995 to 2011, the share of total hours worked by high-skilled workers increased from 40.70% to 51.08% while the shares of total hours worked by mid-skilled and low-skilled persons decreased from 52.81% to 44.58% and 6.49% to 4.34%, respectively. In terms of overall economic activity, high-skilled laborers are in greater demand while demand for mid-skilled and low-skilled labors continues to decline.

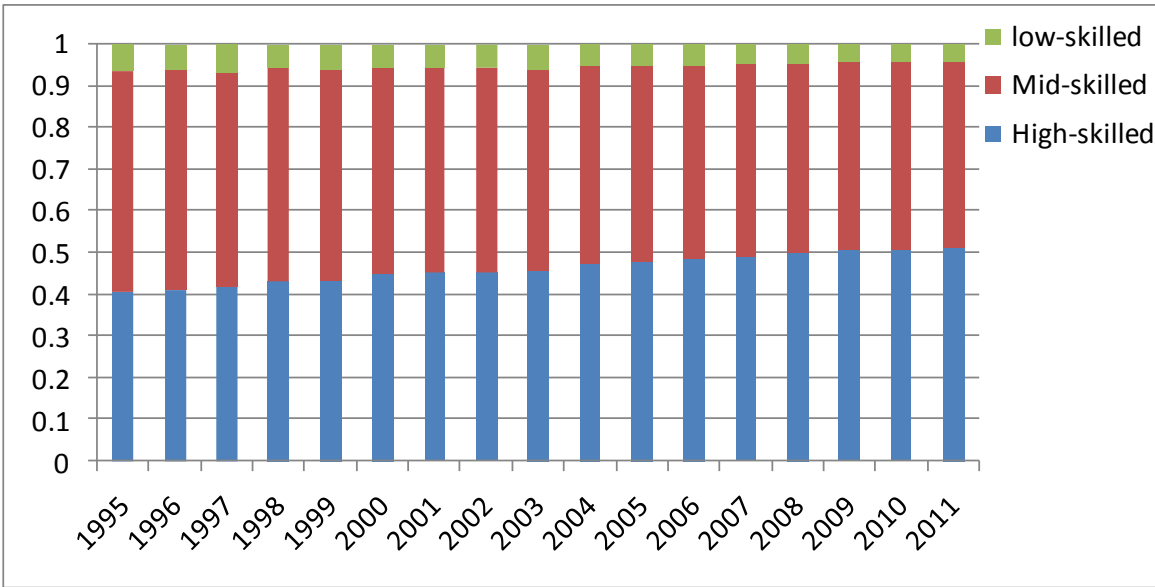


Figure 6 the Trend of US Employment by Skills from 1995-2011 (share in total hours)

Source: WIOD and authors' calculation.

By using the employment by skill types rather than the total employment in each industry as the requirement vector in equation (13), we can trace how employment by skills is directly and indirectly affected by the changes in different final demands. Tables 4 and 5 show the results of the decomposition of employment changes by skills. During the period from 2000 to 2003, the total hours worked by mid-skilled workers declined, while the hours worked by low-skilled and high-skilled workers increased. The major factor driving the employment of all three skill levels is final consumption and the major factor depressing the employment of all three skill levels is labor productivity. Additionally, exports to China create more jobs while imports from China

reduce jobs for all three skill levels. Both exports and imports from China are affecting the mid-skilled labors more than the other two skill levels. This corresponds to the data in Table 5. Since the economic recession of 2007, labors of all three skill types are losing jobs, but the mid-skilled labors lose the most.

Table 4. Decomposition of Employment Changes by skills (2000-2003) (million hours)

Factors	Changes in employment		
	High-skilled	Mid-skilled	Low-skilled
Change in Total Employment	314.92	-7800.56	300.58
Final Consumption	9023.99	17305.82	2437.67
Final Investment	76.47	608.04	223.26
Total Exports	-201.60	-502.04	-70.92
--Exports to China	(65.29)	(147.92)	(28.36)
Production Technology	-936.15	-2034.73	-345.10
Structural Changes in Total Intermediate Imports	-187.54	-400.31	-76.01
--Structural Changes in Intermediate Imports from China	(-98.73)	(-212.63)	(-43.23)
Structural Changes in Total Final Imports	-384.46	-856.34	-204.45
--Structural Changes to Total Final Imports from China	(-230.54)	(-497.00)	(-108.68)
Labor Productivity Changes	-7075.52	-21925.51	-1665.10

Note: In this table, employment refers to hours worked by persons engaged.

Table 5. Decomposition of Employment Changes by skills (2007-2011) (million hours)

Factors	Changes in employment		
	High-skilled	Mid-skilled	Low-skilled
Change in Total Employment	-65.61	-11271.04	-4554.24
Final Consumption	7048.02	12455.36	1557.80
Final Investment	-501.74	-2782.78	-748.09
Total Exports	1095.23	2023.61	337.74
--Exports to China	(411.38)	(767.45)	(122.86)

Production Technology	-467.31	-1531.53	-233.65
Structural Changes in Total Intermediate Imports	-847.03	-1634.51	-283.68
--Structural Changes in Intermediate Imports from China	(-372.86)	(-590.45)	(-103.10)
Structural Changes in Total Final Imports	-89.69	-157.38	-24.19
--Structural Changes to Total Final Imports from China	(-135.32)	(-246.95)	(-48.17)
Labor Productivity Changes	-6299.11	-19636.40	-5159.10

Note: In this table, employment refers to hours worked by persons engaged.

Over the two periods from 2000 to 2003 and 2007 to 2011, the effects of exports to China and intermediate imports from China on total employment in three skill types are increasing while effects of final imports are decreasing. However, the marginal effects of imports and exports on all three skill types are weakening, but the effects of final-imports are weaken the most, while those of exports are weaken the least (see Table 6). This implies that the gap between negative and positive effects of US-China trade on employment is being bridged. We also find that for all three skill types, the marginal effects are weakening, but the effects on low-skilled weaken the most while the effects on high-skilled weakened the least. This indicates that an increase of one thousand dollars US-China trade is affecting high-skilled jobs more than low-skilled jobs.

Table 6 Marginal effects of US-China trade on employment by skills (hours/thousand dollars)

	2000-2003			2007-2011		
	High-skilled	Mid-skilled	Low-skilled	High-skilled	Mid-skilled	Low-skilled
marginal effects of exports to CHN	5.54	12.55	2.41	4.49	8.37	1.34
marginal effects of intermediate-imports from CHN	-8.44	-18.19	-3.69	-5.10	-8.08	-1.41
marginal effects of final-imports from CHN	-6.80	-14.65	-3.20	-3.47	-6.33	-1.24

In terms of the effects on skills in different sectors (Table 7), we find that for high-skilled and mid-skilled labors, most job gains and losses happen in the “Renting of M&Eq. and Other Business Services” and “Electrical and Optical Equipment” sectors; while the low-skilled labors are most

affected in the “Agriculture & Food”, “Textiles & related” and “Leather & related” sectors. Exports to China are benefiting high-skilled labors primarily in the “Renting of M&Eq. and Other Business Services” sector, but the intermediate-imports from China are impacting mostly all three skill levels in the same sector. This may reflect that for US-China trade in “Renting of M&Eq and Other Business Services”, exports have higher skill intensity than the imports. Exports to China are creating most low-skilled jobs in the “Agriculture & food” sector, while final-imports from China are depressing most low-skilled jobs in the “Textiles & related” and “Leather & related” sectors. Table 7 also shows that during the period of 2007 to 2011, the greatest effects of exports to China and intermediate-imports from China on all three skill types are increasing, but the greatest effects of final-imports from China on all three skill types are decreasing. This reflects the same fact as Tables 1 and 2 that the impact of manufacturing final-imports from China is weakening.

Table 7. Most affected sectors by skills (million hours)

	2000-2003		
	High-skilled	Mid-skilled	Low-skilled
effects of exports to CHN	Renting of M&Eq. and Other Business Services (+15.91)	Electrical and Optical Equipment (+18.51)	Agriculture & Food (+6.30)
effects of intermediate-imports from CHN	Renting of M&Eq. and Other Business Services (-32.14)	Renting of M&Eq. and Other Business Services (-36.61)	Renting of M&Eq. and Other Business Services (-5.67)
effects of final-imports from CHN	Electrical and Optical Equipment (-99.32)	Electrical and Optical Equipment (-129.57)	Textiles & related (-21.10)
	2007-2011		
effects of exports to CHN	Renting of M&Eq. and Other Business Services (+139.46)	Renting of M&Eq. and Other Business Services (+120.91)	Agriculture & Food (+31.76)
effects of intermediate-imports from CHN	Renting of M&Eq. and Other Business Services (-170.34)	Renting of M&Eq. and Other Business Services (-147.69)	Renting of M&Eq. and Other Business Services (-25.15)
effects of final-imports from CHN	Electrical and Optical Equipment (-56.50)	Electrical and Optical Equipment (-58.57)	Leather & related (-12.75)

V. Conclusion

In this paper, we attempt to decompose the employment decline during 2000-2003 and 2007-2011. We use the method of Structural Decomposition Analysis which is based on a world input-output table (WIOT) framework, and a new public database--the world input-output database (WIOD) which more accurately captures the inter-industry links in US-China trade. The result shows that the job losses over these two periods are primarily caused by labor productivity changes, while imports from China, including intermediate and final imports, only account for 3.11% during 2000-2003 and 3.58% during 2007-2011 of the job losses in the US. This percentage is much smaller than the findings of Autor, Dorn and Hanson (2013a). This is probably because our research is not limited to the manufacturing sectors and reflects the increase in the number of jobs in the non-manufacturing sectors which could have been overlooked by other researchers.

In terms of the marginal effects of imports or exports on employment, we find that the negative impact is due to imports of intermediate products rather than final goods, but over these two periods, the marginal effects of US-China trade on US employment are weakening, and the effects of final imports weaken the most. Comparing those two periods, we find the effects of US-China trade on US employment have shifted from manufacturing towards services sectors, and the negative effect has switched from final imports to intermediate imports. The “renting of M&Eq. and business services” sector saw the greatest overall job gains as well as losses. When it comes to different skill levels, our research indicates that an increase of one thousand dollars US-China trade affects high-skilled jobs more than low-skilled jobs. Moreover, for high-skilled and mid-skilled labors, the greatest gains and losses are in the “Renting of M&Eq. and Other Business Services” and “Electrical and Optical Equipment” sectors; while low-skilled labors are gaining most jobs in the “Agriculture & Food” sector, but losing most jobs in the “Textiles & related” and “Leather & related” sectors.

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