Global Production Sharing and Sino–US Trade Relations

*Prema-chandra Athukorala, Nobuaki Yamashita**

Abstract

This paper examines Sino–US trade relations, focusing on the ongoing process of global production sharing, involving splitting of the production process into discrete activities that are then allocated across countries, and the resulting trade complementarities between the two countries in world manufacturing trade. The results suggest that the Sino–US trade imbalance is basically a structural phenomenon resulting from the pivotal role played by China as the final assembly centre in East Asia-centered global production networks.

Key words: global production sharing, Sino–US trade, trade balance
JEL codes: F14, F23, O53

I. Introduction

Over the past decade, the widening bilateral trade deficit has been the focal point of Sino–US economic relations. This is often portrayed as a cause of the overall US current account imbalance. The real public concerns in the USA in the debate regarding the "China deficit" are rooted in the perceived economic threat of import competition. In the late 1990s, when imports from China were dominated by traditional labor-intensive manufactures, such as clothing and footwear, unemployment and wage suppression faced by unskilled workers in the USA were the focus of the debate.[1] Since the late 1990s, the apparent rising sophistication of imports from China, in particular the sharp increase in computer and electronic product imports, has fueled concern that the rise of China poses a direct threat to the US position as

* Prema-chandra Athukorala, Professor, Research School of Pacific and Asian Studies, Australian National University, Canberra, Australia. Email: Prema-chandra.athukorala@anu.edu.au; Nobuaki Yamashita, Research Fellow, School of Economics and Finance, La Trobe University, Melbourne, Australia. Email: N.Yamashita@latrobe.edu.au.

[1] Throughout this paper, unless stated, the term "China" is used to refer to the Chinese mainland.

a technology superpower. These concerns have fueled calls for new legislation in the USA to prevent unfair practices. In February 2005, the US Senate passed the *Byrd Amendment*, a provision that encourages US companies to file anti-dumping lawsuits by awarding revenue collected from the resultant tariffs to litigating companies. The deteriorating Sino–US relations have also begun to spillover to other arenas, including international food-safety standards and US policy relating to the entry of Chinese firms (Shirk, 2007).

The policy debate on Sino–US trade relations has so far been based on the conventional notion of horizontal specialization, in which trade takes place in the form of final goods (goods that are produced from start to finish in a given country). It has largely ignored the ongoing process of global production sharing (splitting of the production process into discrete activities that are then allocated across countries) and the trade complementarities between the two countries.[2] Global production sharing provides opportunities for countries to specialize in different slices (tasks) of the production process depending on their relative cost advantages and other relevant economic fundamentals. In this context, trade flow analysis based on data coming from a reporting system designed at a time when countries were trading only in final goods naturally distorts values of exports and imports, leading to a falsification of current account imbalances (Jones and Kierzkowski, 2001).

Given the current state of the data, it is not possible to quantify the effect of international production sharing on bilateral trade imbalances: this would require a major overhaul of the international system of collecting trade data to record domestic value-added content at different stages of production. The COMTRADE database of the United Nations does, however, provide disaggregated data which permit separation of parts and components from final goods with a satisfactory coverage of trade in machinery and transport equipment, a commodity class in which most global production sharing is concentrated. Data extracted from this source, when combined with the available case-study-based evidence of global operations of multinational enterprises, permit us to paint a broad-brush picture of the implications of the ongoing process of global production sharing for Sino–US trade relations. Several recent studies have simply alluded to the importance of paying attention to global production sharing in the process of understanding the drivers of the Sino–US trade deficit (Bergsten *et al*., 2006; Fung *et al*., 2006). The present paper makes the first attempt to examine this issue systematically to the extent permitted by the available data. The key inference of the paper is that the Sino–US trade imbalance is a structural phenomenon,

[2] In the literature on international trade, an array of alternative terms have been used to describe this phenomenon, including international production fragmentation (Jones and Kierzkowski, 2001), vertical specialization (Hummels *et al*., 2001), slicing the value chain (Krugman, 1995) and outsourcing (Feenstra, 2008).

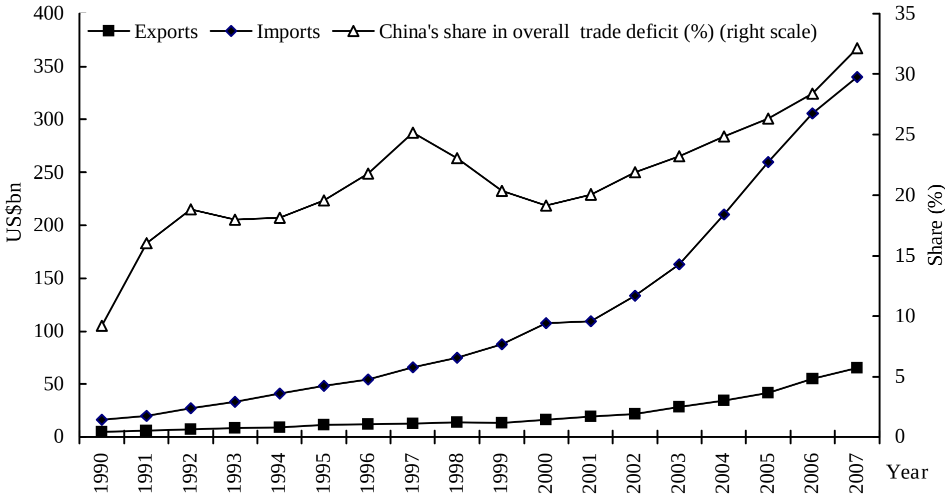
quite distinct from the overall trade imbalance of the USA, and it is related largely to the pivotal role played by China as the final assembly centre in global production networks.

The rest of the paper is organized as follows. Section II offers an overview of trends and patterns of China's trade to set the stage for the analysis. Section III surveys Sino–US trade patterns, emphasizing the emerging patterns of the two counties' involvement in global production networks and the implications for bilateral trade flows. Section IV focuses on the econometric analysis of the determinants of trade flows. Section V presents concluding remarks.

II. Sino–US Trade Gap: An Overview

Bilateral trade between China and the USA has grown persistently since the early 1980s, particularly with China's growth rate acceleration from the mid-1990s, and after China's accession to the World Trade Organization (WTO) in 2001 (see Figure 1). The value of US imports from China rose from US$16bn in 1990 to US$340bn in 2007. In 2003, China became the second largest source of US imports, behind Canada, but ahead of Mexico and Japan. US exports to China have also grown persistently since the 1980s. Total exports in 2007 amounted to US$65bn, up from US$5bn in 1990. Therefore, bilateral economic ties between the two countries have been characterized by a steadily growing trade imbalance: the trade deficit of the USA increased from US$11bn in 1990 to US$274bn in 2007, the largest deficit that the

Figure 1. Sino–US Trade, 1990–2007



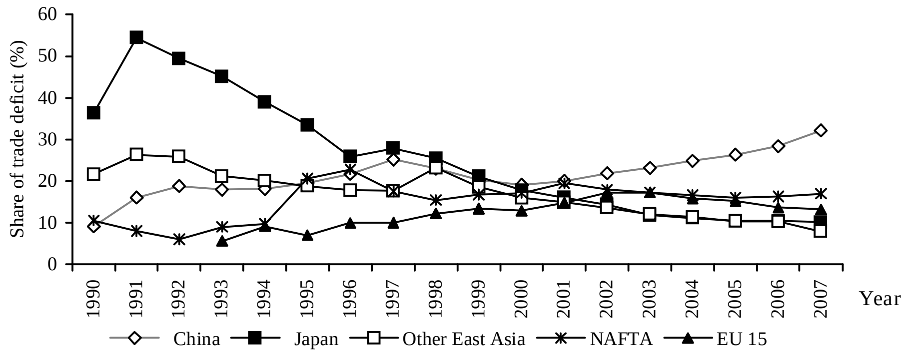
Source: Based on data compiled from the United Nations COMTRADE Database (1990–2007).

USA has ever had with any country. The bilateral trade deficits as a percentage of US GDP increased from 0.2 percent in 1990 to 0.9 percent in 2000, and then to 1.9 percent in 2007 (BEA, 2008).

The USA's deficit with China has been the single largest bilateral trade deficit worldwide since 1999. After its accession to the WTO, China substantially reduced barriers to imports, and became the fastest growing market for US exports. However, WTO accession also gave foreign companies the confidence to move their assembly plants within global production networks to China. As a result, China's exports to the USA continued growing at an accelerated pace.

Figure 2 illustrates the Sino–US trade deficits in the context of the USA's growing overall trade deficits. Not only has the US deficit with China increased, but the overall US deficits with all other economies have also expanded. In 2007, the Sino–US deficit amounted to 32 percent of total US trade deficits, equating to almost three-quarters of the total US trade deficits with the rest of the world. Moreover, from 1999, the widening Sino–US deficit has been significantly counterbalanced by a sharp decline in the relative importance of US bilateral trade deficits with Japan and the other East Asian economies. Between 1999 and 2007, the increase of China's share in total US trade deficits from 20.4 to 32.1 percent was accompanied by a decline in the deficit with Japan from 21.1 to 10.2 percent. The combined share of the other East Asian economies also declined from 16 to 7.9 percent (BEA, 2008). As shown in Figure 3, the widening Sino–US trade surplus over the past 10 years has been accompanied by widening bilateral deficits with Japan and

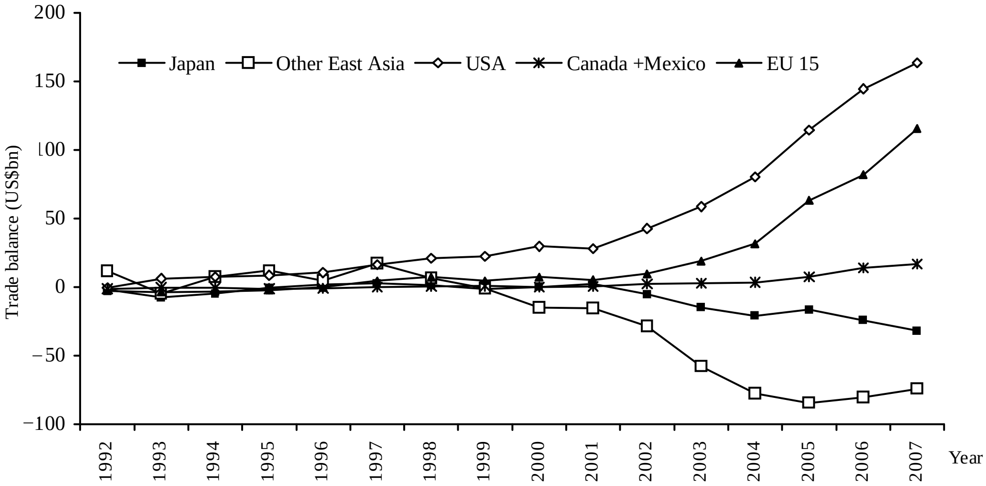
Figure 2. The Share of China and Other Major Trading Partners in US Trade Deficits, 1990–2007



Source: Based on data compiled from the United Nations COMTRADE Database (1992–2007).

Notes: NAFTA, North American Free Trade Agreement. EU 15 refers to Austria, Belgium, Luxembourg, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden and the UK.

Figure 3. China's Bilateral Trade Balances, 1992–2007



Source: Compiled from the United Nations COMTRADE Database (1992–2007).
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other East Asian economies.[3] From 2004 to 2007, the combined deficits with Japan and the other East Asian economies equated to 85 percent of the Sino–US trade surplus. As we will see in the following section, China's widening trade deficits with its regional trading partners, which mirror China's widening surplus with the USA, are closely associated with China's increasingly important role as the focal point of final assembly within regional production networks.

III. Global Production Sharing and Sino–US Trade Patterns

To assist in the understanding of Sino–US trade relations, data on the changing patterns of geographic profile and commodity composition of US trade are summarized in Tables 1 and 2. Chinese mainland's share in total US merchandise imports increased from 6.5 percent in 1995–1996 to 15.5 percent in 2005–2006 (see Table 1).

[3] It is important to note that Chinese estimates of the US trade deficit have always been lower than the US figures because of different ways the USA treat imports from and exports to Chinese mainland that pass through Hong Kong SAR. Fung *et al.* (2006) find that the US official data tend to overstate the actual deficits by approximately 17 percent, while the degree of underestimation involved in the Chinese official estimate is as high as 33 percent. This discrepancy does not seem to create a serious problem when examining overall trends in the trade gap.

Table 1. Geographic Profile of US Trade (%)

Trade partners	Primary products		Manufactured goods								Total trade	
			Total		Machinery		ICT products		Miscellaneous manufactures			
	1995–1996	2005–2006	1995–1996	2005–2006	1995–1996	2005–2006	1995–1996	2005–2006	1995–1996	2005–2006	1995–1996	2005–2006
Imports												
Chinese mainland + Hong Kong SAR	1.4	1.7	9.5	21.6	4.5	18.2	8.1	33.4	27.4	39.7	7.8	16.0
Chinese mainland	1.3	1.7	7.9	21.0	3.7	18.0	6.5	33.0	22.6	37.8	6.5	15.5
East Asia	6.2	4.2	37.1	24.1	47.1	32.1	63.5	36.6	26.8	17.0	30.7	18.7
Japan	0.8	0.5	19.2	10.8	26.2	16.1	24.9	9.2	8.3	4.3	15.4	8.1
Korea	0.3	0.7	3.7	3.3	4.5	4.6	7.5	5.3	3.0	1.0	3.0	2.6
Chinese Taiwan	0.3	0.2	4.8	2.8	4.9	3.2	8.3	5.1	5.6	2.3	3.9	2.1
ASEAN	4.7	2.7	9.4	7.3	11.5	8.3	22.8	16.9	9.9	9.5	8.4	6.0
NAFTA	37.1	33.3	25.2	23.6	28.5	28.3	17.2	19.5	13.5	13.7	28.0	26.6
Mexico	8.9	9.4	8.5	10.4	10.2	14.0	10.9	15.7	7.1	7.8	8.6	10.2
EU 15	10.3	9.9	19.4	19.8	17.2	17.3	9.3	7.2	15.3	13.1	17.9	17.4
World	100	100	100	100	100	100	100	100	100	100	100	100
Exports												
Chinese mainland + Hong Kong SAR	5.3	10.8	4.1	6.2	4.0	6.6	4.7	9.5	3.3	5.4	4.3	6.8
Chinese mainland	3.1	9.7	1.8	4.3	1.8	4.7	1.1	5.6	1.2	3.1	2.0	5.0
East Asia	35.1	19.4	23.6	16.6	24.9	18.1	31.0	24.8	23.5	17.8	25.2	16.8
Japan	20.3	9.4	9.1	5.3	8.6	4.8	10.2	5.0	12.4	8.2	10.9	5.9
Korea	6.2	3.7	4.0	3.1	4.4	3.3	4.3	4.3	3.0	2.9	4.3	3.1
Chinese Taiwan	4.0	2.3	3.0	2.4	3.1	2.6	3.6	3.4	2.1	2.5	3.1	2.3
ASEAN	4.6	4.0	7.5	5.8	8.8	7.4	13.0	12.2	5.9	4.1	6.8	5.5
NAFTA	21.0	34.6	32.1	36.4	32.5	36.5	27.9	33.3	28.3	31.3	30.0	35.8
Mexico	7.3	14.0	8.8	13.0	8.3	12.8	10.3	17.1	9.9	10.7	8.5	13.1
EU 15	18.0	14.2	21.2	21.1	21.0	18.7	22.7	17.3	22.6	26.3	20.9	20.1
World	100	100	100	100	100	100	100	100	100	100	100	100

Source: Compiled from the United Nations COMTRADE Database (1995–2006).

Notes: ICT, information and communication technology. ASEAN, Association of South East Asian Nations. NAFTA, North American Free Trade Agreement. EU 15 refers to Austria, Belgium, Luxembourg, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden and the UK.

The corresponding market share losses have come predominantly from the other East Asia exporting economies, in particular Japan, Korea and Chinese Taiwan. In the early stages of China’s export takeoff, conventional labor-intensive manufactured goods, reported in the United Nations trade data system as “miscellaneous manufactures” (category 8 of the Standard International Trade Classification (SITC)) dominated US imports from China. Since then, commodity composition of imports has shifted dramatically away from these products towards machinery and transport equipment, in particular information and communication technology (ICT) products (falling under SITC categories 75, 76 and 77).

Table 2. Commodity Composition of US Trade by Partners

	Year	Chinese mainland + Hong Kong SAR		East Asia					NAFTA		EU 15	World
		Total	Chinese mainland	Total	Japan	Korea	Chinese Taiwan	ASEAN	Total	Mexico		
Imports												
Primary products	1995–1996	3.2	3.5	3.7	1.0	2.0	1.6	10.3	24.3	18.8	10.5	18.3
	2005–2006	2.7	2.7	5.7	1.7	7.0	2.9	11.5	32.0	23.4	14.6	25.6
Manufactures	1995–1996	95.4	95.7	94.7	97.4	96.5	97.0	88.0	70.3	77.1	84.7	78.3
	2005–2006	96.0	96.1	91.6	95.4	91.1	93.8	85.8	63.1	72.5	80.9	71.0
Machinery and equipment	1995–1996	26.4	26.3	70.3	77.9	67.8	58.5	62.7	46.5	54.4	44.0	45.8
	2005–2006	43.3	44.1	65.2	75.7	68.6	57.4	52.4	40.3	52.0	37.7	38.0
ICT products	1995–1996	23.0	22.4	46.2	36.0	55.3	48.2	60.7	13.7	28.3	11.6	22.3
	2005–2006	37.0	37.6	34.6	20.2	36.7	43.5	49.9	13.0	27.3	7.3	17.7
Miscellaneous manufactures	1995–1996	58.8	58.5	14.6	9.0	16.8	24.2	19.8	8.1	13.8	14.4	16.8
	2005–2006	38.5	37.7	14.1	8.2	6.3	16.9	24.4	7.9	11.8	11.6	15.5
Total	1995–1996	100	100	100	100	100	100	100	100	100	100	100
	2005–2006	100	100	100	100	100	100	100	100	100	100	100
Exports												
Primary products	1995–1996	21.6	27.6	24.6	32.8	25.5	22.4	11.9	12.4	15.1	15.3	17.7
	2005–2006	24.4	29.8	17.6	24.1	18.3	15.1	11.3	14.7	16.3	10.8	15.3
Manufactures	1995–1996	75.2	71.1	73.2	65.4	72.2	74.5	85.6	83.8	80.8	79.7	78.3
	2005–2006	73.8	68.7	79.8	72.8	79.7	82.9	86.0	81.9	80.0	85.1	80.8
Machinery	1995–1996	45.6	43.8	48.1	38.3	49.2	48.8	62.6	52.9	47.1	49.1	48.7
	2005–2006	46.8	45.4	51.4	38.4	51.6	53.1	64.7	48.7	46.6	44.6	47.8
ICT products	1995–1996	23.9	12.6	27.1	20.5	21.8	25.2	41.8	20.5	26.4	24.0	22.0
	2005–2006	26.3	20.8	27.5	15.7	25.8	27.1	41.5	17.4	24.4	16.1	18.7
Miscellaneous manufactures	1995–1996	9.5	7.7	11.7	14.2	8.8	8.5	10.9	11.8	14.4	13.5	12.5
	2005–2006	9.0	7.1	12.0	15.7	10.7	12.3	8.5	9.9	9.2	14.8	11.3
Total	1995–1996	100	100	100	100	100	100	100	100	100	100	100
	2005–2006	100	100	100	100	100	100	100	100	100	100	100

Source: Compiled from the United Nations COMTRADE Database (1995–2006).

Notes: ICT, information and communication technology. ASEAN, Association of South East Asian Nations. NAFTA, North American Free Trade Agreement. EU 15 refers to Austria, Belgium, Luxembourg, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden and the UK.

Between 1995–1996 and 2005–2006 the share of miscellaneous manufactures in total imports from Chinese mainland declined from 58.8 to 37.7 percent, and the share of machinery increased

Table 3. Share of Parts and Components in US Machinery Trade (%)

	Imports		Exports	
	1995–1996	2005–2006	1995–1996	2005–2006
Machinery and transport equipment [a]				
Chinese mainland+ Hong Kong SAR	32.1	24.4	45.6	56.0
Chinese mainland	25.0	24.2	36.1	50.8
East Asia	45.6	36.8	57.5	62.1
Japan	42.2	33.3	51.1	49.4
Korea	60.3	31.0	51.2	58.2
Chinese Taiwan	54.9	52.6	55.4	58.4
ASEAN	43.6	40.9	67.7	73.2
NAFTA	35.7	34.6	58.8	52.7
Mexico	42.7	37.7	68.9	61.9
EU 15	43.7	38.9	54.3	52.4
World	42.1	34.9	54.4	52.4
ICT products				
Chinese mainland+ Hong Kong SAR	31.9	20.9	59.2	72.7
Chinese mainland	23.5	20.7	51.2	72.8
East Asia	51.8	44.6	71.3	77.4
Japan	51.8	51.3	60.7	53.6
Korea	70.4	38.6	64.4	78.3
Chinese Taiwan	57.6	52.9	78.6	81.1
ASEAN	43.5	40.4	79.8	85.7
NAFTA	55.6	39.0	63.2	57.3
Mexico	50.5	36.2	70.4	65.9
EU 15	54.9	48.9	54.9	51.1
World	51.2	36.1	60.9	61.0

Source: Compiled from the United Nations COMTRADE Database (1995–2006).

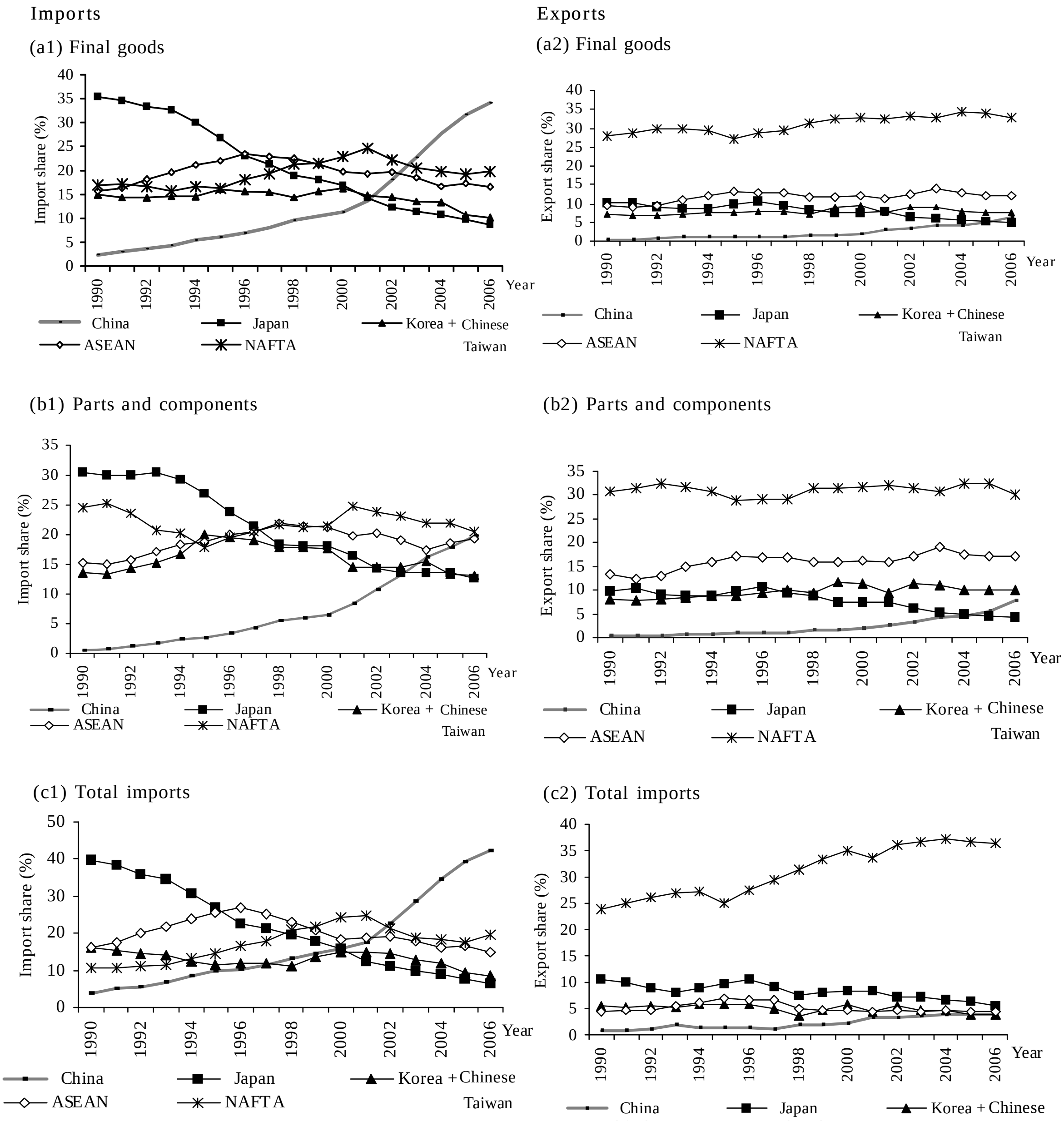
Notes: [a] Including ICT products. ICT, information and communication technology. ASEAN, Association of South East Asian Nations. NAFTA, North American Free Trade Agreement. EU 15 refers to Austria, Belgium, Luxembourg, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden and the UK.

from 26.3 to 44.1 percent. The share of ICT products increased from 22.4 to 37.6 percent, contributing to over 40 percent of the total import increment (see Table 2).

To gain further insight into the growing importance of overseas assembly as a source of imports for the USA and the pivotal role played by China in the international division of labor, we disaggregated data on machinery trade into parts and components, and final goods using the classification system developed in Athukorala (2005). The results are presented in Table 3 and Figure 4.

The share of parts and components in US machinery exports is generally much higher with all trade partners compared to the share in imports (see Table 3). Moreover, on the import side, the shares have declined considerably across all import trading partners. This

Figure 4. US Trade in ICT Goods Disaggregated into Parts and Components, and Final Goods, 1990–2006 (%)



Source: Compiled from United Nations COMTRADE Database (1995–2006).

Notes: [a] Including ICT products. ICT, information and communication technology. ASEAN, Association of South East Asian Nations. NAFTA, North American Free Trade Agreement.

decline is much sharper for the ICT products subcategory within the broader category of machinery and transport equipment. These contrasting export and import patterns are generally consistent with the USA's comparative advantage in skill-intensive and capital-intensive activities in production processes within global production networks in vertically integrated industries (Feenstra, 2008). Within the broader context, one can observe three peculiarities relating to China's role in international production sharing in terms of her trade with the USA.

First, the share of parts and components in US exports to the other East Asian economies, in particular ASEAN countries, is much higher compared with that of exports to China (see Figure 4b2). This pattern is consistent with case study-based findings that US firms located in East Asian countries and regions undertake further processing and assembly of parts and components originally designed and produced in the USA as part of their engagement in China-centered regional production networks (Athukorala, 2007, 2009).

Second, the share of parts and components in US imports from China are remarkably low compared with the figures for the other East Asian economies (see Figure 4b1). In 2006, parts and components accounted for approximately 20 percent of total ICT imports to the USA; that is, final goods accounted for nearly four-fifths of total imports (see Figure 4 a and b1). Consequently, the increasing trend of China's penetration is much sharper in final goods compared to the figures based on the standard gross trade data (see Figure 4 a and c1).

Third, two-way trade in parts and components seems to account for a much larger share of trade between the USA and other East Asian economies, in particular ASEAN countries, compared with trade with China. These contrasting patterns reflect China's role as the centre of final goods assembly within East Asia-centered global production networks.

The structural shift in China's exports away from the traditional labor-intensive products towards ICT products has been widely perceived as China moving towards becoming an advanced-technology superpower, and the sophistication of its export basket is rapidly approaching the levels of those of most advanced industrial nations (e.g. Rodrik, 2006; Yusuf *et al*., 2007). A closer examination of data suggests that such an inference is fundamentally flawed. In reality, what we observe is the rapid consolidation in China's final-assembly stages of East Asia-centered global production networks of these products (Bergsten *et al*., 2006; Sung, 2007).

It is clear from the discussion so far that Chain's emergence as an important player in global production networks is an important factor in widening Sino–US trade deficits.

IV. Determinants of Trade Flows

In this section we will conduct an econometric analysis on the determinants of US trade, to test whether trade with China has a specific effect on the overall international trade patterns of the USA beyond what can be expected in terms of the standard determinants of bilateral trade flows. The analytical tool used for this purpose is the gravity equation, which has now become a standard tool for analyzing bilateral trade flows. We augmented the basic gravity model in a number of ways to yield the following equation:

$$LnTRD_{ij} = a + b_1 \ln GDP_i + b_2 \ln GDP_j + b_3 \ln PGDP_i + b_4 \ln PGDP_j + b_5 \ln DST_{ij} + b_6 ADJ_{ij} + b_7 \ln RULC_{ij} + b_8 \ln RER_{ij} + b_9 DCH + b_{10} \ln DJP + b_{11} DTW + b_{12} DAS + gT + e_{ij},$$

in which subscripts *i* and *j* refer to the USA and its trade partner, and *Ln* denotes natural logarithms. The variables are listed and defined below, with the postulated sign of the regression coefficient in parentheses.

TRD	Trade (imports (*MP*) or exports (*EX*)) between *i* and *j*
GDP	Real gross domestic product (GDP) (+)
PGDP	Real per capita GDP (+)
DST	Distance between the economic centres of *i* and *j* (–)
ADJ	A binary dummy variable assuming the value 1 if *i* and *j* share a common land border and 0 otherwise (+)
RULC	Relative unit labor cost of manufacturing between *j* and *i* (*EX* +; *MP* –)
RER	An index of bilateral real exchange rate (*EX* +, *MP* –)
DCH	Intercept dummy variable for China (+ or –)
DJP	Intercept dummy variable for Japan (+ or –)
DTW	Intercept dummy variable for Chinese Taiwan and Korea (+ or –)
DAS	Intercept dummy variable for the six major member countries of ASEAN
T	A set of time dummy variables to capture year-specific fixed effects
a	Constant term
e	Stochastic error term
b_1 to b_{12}	Coefficients of individual explanatory variables.

The four explanatory variables *GDP*, *GDPP*, *DST* and *ADJ*, are the standard gravity-model arguments and do not require further discussion. Among the remaining variables, the relative unit labor cost (*RULC*, relative manufacturing wage adjusted for labor productivity) is presumably a major factor impacting on spread of global production sharing (Jones and Kierzkowski, 2001). In a context where both capital and components have become increasingly mobile, relative cost of production naturally becomes an important consideration in cross-border production. *RER* is included to capture the impact of the overall macroeconomic climate on export performance. Another important determinant of trade flows within global production networks is the cost of "service links" connecting "production blocks" in different countries and regions. However, in our model, distance (*DST*), adjacency (*ADJ*) and per capita income (*PGDP*) capture certain aspects of such costs. Technological advances during the post-World War II era have certainly contributed to a remarkable reduction in international communication costs. However, there is evidence that geographical distance is still a key factor in determining international transport costs, in particular, shipping costs (Evans and Harrigan, 2003). Delivery times are also affected by geographical distance. Timely delivery can in fact have more influence on vertical trade than final trade because of multiple boarder-crossing of parts and components within global production networks. The common border dummy (*ADJ*) would capture possible additional advantages of proximity that are not captured by the standard distance measure. The inclusion of *PGDP* as an explanatory variable allows for the fact that, as countries grow richer, the quality of their trade-related infrastructure and institutional arrangements tends to improve, reducing the cost of maintaining the services links.

The China dummy (*DCH*) is expected to capture the "China effect" on other variables. Dummy variables are also included for Japan (*DJP*), Chinese Taiwan and Korea (*DTW*), ASEAN (*ASN*) and Mexico (*DMX*), guided by the empirical regularities in trade patterns observed in the previous section. We observed that China's export expansion of labor-intensive manufactures and ICT products has been in direct competition with these countries and regions. Finally, the time-specific fixed effects (*T*) are included to control for general technological change and other time-varying factors.

The model was estimated using annual data for manufacturing trade over the period 1992–2005. The data cover all US trading partners, each of which accounted for 0.1 percent or more of total world manufacturing exports in 2000–2001. There are 41 trading partners that satisfied this criterion. Of these, Hong Kong SAR was combined with Chinese mainland because of their peculiar trade links. Therefore, our dataset includes 40 countries and regions. Trade data are disaggregated into components and final products following the procedures detailed in Athukorala (2005). The data sources and methods of variable construction are explained in Table 4.

We use the random effect estimator as our preferred estimation technique.[4] The alternative fixed effect estimator is not appropriate because our model contains a number of time-invariant variables. In our data panel, the data series on reporting-country GDP and PGDP have only "within variation" (i.e. the same data series for GDP and PGDP of a given reporting country is applicable to its trade with all trading partners). It is not possible to retain one or both of these variables and time dummies in the same regression because of multicollinearity.

[4]For details on this estimation technique, see Wooldridge (2008).

Table 4. Dataset Used in Regression Analysis: Definition of Variables, Source and Variable Construction, and the Country/ Region Coverage

Variables	Definition	Data source/variable construction
EXP	Value of US bilateral trade in US$ measured at 2000 constant price.	Trade data (in current US$) compiled from importer records of United Nations COMTRADE (1990–2007), deflated by the manufacturing sub-index of the US producer price index.
GDP, *PGDP*	Real GDP, and real per capita GDP at 1995 price	World Bank (2008)
DIST	Trade-weighted bilateral great-circle distance between major cities of each country or region	CEPII (2008)
ADJ	A binary dummy: 1 for economies which share a common land border and 0 otherwise	CEPII (2008)
RULC	The ratio of unit labor cost (ULC) in a given economy to that in the USA. ULC is measured as the ratio of the average manufacturing wage to manufacturing value added per worker.	Annual manufacturing wages data for USA: and all other countries are from BEA (2008)
RER	Real exchange rate: $RER_{ij} = NER * \frac{P_j^W}{P_i^D}$ where, *NER* is the nominal bilateral exchange rate index (US$ price of foreign currency), P^W is price level of country/region *j* measured by the producer price index, and P^D is the domestic price index of country *i* measured by the GDP deflator. An increase (decrease) in RER_{ij} indicates a deterioration (an improvement) in country/region *j*'s competitiveness in traded-goods production in *i* (the USA).	Constructed using data from the World Bank (2008) Following Soloaga and Winters (2001), mean-adjusted RER is used in the model. This variable specification assumes that countries or regions are in exchange rate equilibrium at the mean.
Country / region coverage	Argentina, Australia, Austria, Belgium, Brazil, Canada, Chinese Mainland +Hong Kong SAR, Costa Rica, Czech Republic, Denmark, Finland, France, Germany, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Malaysia, Mexico, the Netherlands, Norway, Philippines, Poland, Republic of Korea, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Chinese Taiwan, Thailand, Turkey, the UK.	

After undertaking experimental estimations, we opted for time dummies, which turned out to be superior to the alternative both in terms of economic plausibility and statistical significance. This specification means that the estimated coefficients of time dummies capture both the US income effect and other time-specific factors impacting on trade flows. The common border dummy (*BRD*) could not be retained in the final estimation because of its high (negative) correlation with the distance variable. This is not surprising given the US high intensity of trade with its two neighbours, Mexico and Canada. We also tested an additional dummy variable for North American Free Trade Agreement membership in place of the Mexico dummy. It turned out to be statistically insignificant over and above the other variables. The regression results are reported in Table 5.

The coefficient of the China dummy (*DCH*) is positive and statistically significant in all equations.[5] It is much larger in the import equations, indicating that, after controlling for the standard determinants of trade flows, China's exports have penetrated the USA at a much

[5] As the model was estimated in log, the percentage equivalent for any dummy coefficient is: [exp (dummy coefficient) – 1]*100.

Table 5. Determinants of US Manufacturing Imports and Exports, 1992–2005

Explanatory variables	Total manufacturing	Machinery and transport equipment: Parts and components	Machinery and transport equipment: Final goods	Total
Imports				
Ln GDP, exporter	0.84***	0.89***	0.68***	0.83***
	(3.50)	(3.40)	–2.63	–3.28
Ln PGDP exporter	0.40*	0.42*	0.67***	0.25
	(1.59)	(1.95)	(2.80)	(0.86)
Ln distance (*DST*)	–0.93*	–1.38***	–1.28**	–0.733
	(1.86)	(3.10)	(2.11)	(1.47)*
Ln relative unit labor cost (*RULC)*	–0.02	0.017	–0.373***	0.024
	(0.17)	(0.12)	(2.74)	(0.17)
Ln real exchange rate (*RER*)	0.01	–0.002	0.041*	0.004
	(0.71)	(0.11)	(1.71)	(0.31)
China dummy (*DCH*)	2.90***	2.40***	4.55***	2.60***
	(4.03)	(3.93)	(5.63)	(3.84)
Japan dummy (*DJP*)	0.53	1.19	2.01**	–0.37
	(0.60)	(1.37)	(2.34)	(0.34)
ASEAN dummy (*DAS*)	2.74***	3.51***	4.05***	1.78***
	(5.02)	(5.69)	(6.55)	(2.91)
Korea + Chinese Taiwan dummy (*DKT*)	1.79***	2.64***	2.79***	1.18***
	(4.97)	(7.21)	(8.32)	(2.76)
Mexico dummy (*DMX*)	1.23*	1.40**	2.13**	0.67
	(1.92)	(2.11)	(2.46)	(1.13)
Constant	–0.28	0.42	2.51	–0.90
	(0.03)	(0.05)	(0.28)	(0.09)
Observations	481	481	481	481
R^2 within	0.78	0.57	0.63	0.70
R^2 between	0.69	0.73	0.73	0.60
RMSE	0.18	0.32	0.29	0.21
Exports				
Ln GDP, importer	0.86***	0.89***	0.81***	0.75***
	(6.43)	(5.14)	(6.26)	(4.66)
Ln PGDP importer	0.33**	0.41**	0.41***	0.37**
	(2.36)	(2.19)	(4.03)	(2.46)
Ln distance (*DST*)	–0.81	–0.55	–0.58	–0.73
	(1.56)*	(1.69)*	(1.06)	(1.34)
Ln relative unit labor cost (*RULC)*	–0.02	–0.01	0.017	–0.06
	(0.36)	(0.11)	(0.18)	(1.10)
Ln real exchange rate (*RER*)	0.03*	0.01	0.07***	0.02**
	(1.63)	(0.25)	(3.43)	(2.18)
China dummy (*DCH*)	1.05**	1.05**	1.41***	1.27**
	(2.49)	(2.03)	(4.35)	(2.51)
Japan (*DJP*)	–0.54	–0.56	–0.66	–0.21
	(1.41)	(1.09)	(1.59)	(0.50)
ASEAN dummy (*DAS*)	2.00***	2.73***	1.56***	1.49***
	(5.34)	(5.25)	(4.31)	(4.27)
Korea + Chinese Taiwan dummy (*DKT*)	1.14***	1.54***	0.97***	0.98***
	(4.94)	(6.23)	(3.85)	(4.24)
Mexico dummy (*DMX*)	1.22*	1.26	1.29*	1.56**
	(1.75)	(1.62)	(1.83)	(2.16)
Constant	–0.81	–2.63	–3.35	0.06
	0.15	0.40	0.58	–0.01
Observations	478	478	478	478
R^2 within	0.696	0.648	0.707	0.674
R^2 between	0.612	0.495	0.280	0.670
RMSE	0.175	0.279	0.282	0.151

Notes: Figures in parentheses are standard errors derived using the Huber-White consistent variance–covariance estimator. ***, ** and * represent statistical significant at the 1, 5 and 10 percent levels, respectively. Results for the time dummies are not reported. RMSE, root mean square error.

higher rate than other countries: sixteen times on average. The coefficient of *DCH* in the final goods export equation is strikingly large (4.55) and is almost twice that in the equation for parts and components and total manufacturing (see Table 5). This result is consistent with the dominant assembly bias in the emerging patterns of China's export specialization, which we observed in the previous section. The differences in magnitude among the coefficients of *DCH*, *DAS*, *DKT* and *DMX* in all four equations reported in Table 5 are also consistent with the observed differences between China and these economies in their role in global production networks. The much larger coefficient of the ASEAN dummy in the parts and components equation (3.51) is particularly noteworthy. As discussed, the explanation seems to lie in economic history; that is, the early choice of the region by multinational enterprises as a location for components assembly and testing in their global production networks.

On the export side, there is no evidence to suggest that US firms perform poorly in exporting to China compared with exporting to other economies. The coefficient of *DCH* is greater than unity and is statistically significant in all cases, suggesting that, once controlling for the other determinants, on average, exports to China from the USA have grown almost three times faster than exports to other destinations. The results for the dummy variables also do not reveal any notable difference in the rates of expansion of exports to the USA from China and Mexico. A comparison of the results for China and ASEAN corroborate our earlier observation of the growing complementarity among these countries and regions in their trade links with the USA within global production networks.

Among the other explanatory variables, the results for *GDP* and *PGDP* are quite consistent with those of previous gravity model applications to trade flow analysis (Soligo and Winters, 2001). The results for *DST* provide strong support for the hypothesis that cost of transportation and other distance-related costs are important determinants of imports to the USA. Interestingly, at the disaggregated level, the distance coefficients for components and final goods of machinery imports are much larger compared to the coefficients of other manufacturing and total manufacturing.[6] This difference is consistent with the hypothesis that vertical specialization, given the multiple border crossing involved in the production process, is much more sensitive to transport costs. The distance coefficients in the four export equations reported in Table 5 are much smaller in magnitude (and barely attain statistical significance) compared to the respective coefficients on the import side. This asymmetry in the distance effect in US foreign trade is an interesting issue for further investigation. One possible explanation is the increased concentration over time of US machinery exports, in particular ICT products, in high value-to-weight segments of

[6] The differences are statistically significant at the 1 percent level or better.

the production process within global production networks, which seems to have helped US exporting firms to overcome trade barriers associated with the distance effect.

The coefficient of *RULC* is statistically significant, with the expected (negative) sign only in the equation for final machinery imports. It suggests that, other things being equal, a 1-percentage point difference in unit labor cost among exporting countries and regions is associated with a 0.35-percent difference in the growth of exports of this product category to the US market. This unique result points to the importance of labor cost advantage in the rapid penetration of exports of these products from China and other developing countries in the US market.

Finally, to comment on the results for the real exchange rate (*RER*), on the import side, its coefficient is barely significant, with the unexpected positive sign in the equation for final machinery, and it is not different from zero. On the export side, the coefficient carries the expected positive sign in all four equations and it fails to achieve significance only in the machinery parts and components equation. The coefficients are, however, rather small, less than 0.1 in all cases. Overall, there is no evidence to suggest that the exchange rate plays a significant role in determining the widening US trade gap.[7] These results are generally consistent with the available evidence that global production sharing considerably weakens the link between the degree of exchange and trade performance, particularly when it comes to trade in components (Swenson, 2000; Feenstra, 2008).

V. Concluding Remarks

The evidence in this paper supports the view that, in a context where international fragmentation of production is becoming the symbol of economic globalization, the real story behind the Sino–US trade gap is much more complicated than what is revealed by the standard trade-flow analysis based on a data-reporting system developed at a time when countries were trading predominantly (if not solely) in final goods. The widely-held view that China’s rapid market penetration in the US economy is driven by unfair trade practices needs to be reexamined in light of the fact that the two economies are deeply interconnected and interdependent within global production networks. The growing trade deficit between the two countries has been underpinned by China’s emergence as the main point of final assembly in Asian production networks, based on its ample supply of labor, and moves taken by US firms to supply high-end parts and components from their Asian bases to

[7] In experimental regression runs, we also interacted *RER* with *DCH* and failed to detect any China-specific effect on the link between *RER* and trade flows.

China. In sum, the deficit is, to a large extent, a structural phenomenon driven by the process of global production sharing. It is akin to the substantial deficits in trade with the oil exporting countries based on their specific resource endowments, which the USA and the rest of the world have become accustomed to.

Based on the data in this paper, we can only focus on Sino–US trade in goods. Therefore, the inferences made in the paper need to be qualified because the difference between merchandise trade and services trade has become increasingly blurred as a result of the ongoing process of global production sharing. US firms have shifted components production and final assembly activities overseas and now manage services links involved in the global production networks from their home bases. In other word, as part of the ongoing process of global production sharing, the related services, particularly knowledge-based or information technology-enabled services that are beyond the traditional notion of internationally traded services, such as transportation, travel and tourism, have become increasingly tradable. There is evidence that exports of these new production-related services have significantly expanded since the late 1990s (CEA, 2007). The surplus in US services trade has expanded rapidly during this period, reaching US$75 in 2006. The largest subcategory in the services account is "other private services" trade, which captures many of the information technology-related services, and management and consultancy services, which are central to the process of global production sharing (CEA, 2007). An analysis that overlooks these exports could overstate the magnitude of the Sino–US trade imbalance, presumably by a wide margin.

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