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# **How iPhone Widens the US Trade Deficits with PRC**

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*How iPhone Widens the US Trade Deficits with PRC*Yuqing Xing<sup>1</sup>

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Neal Detert<sup>2</sup>**Abstract:**

In this paper, we use the iPhone as a case to show that even high-tech products invented by American companies will not increase the US exports, but to the contrary exacerbate the US trade deficits. The iPhone contributed US\$1.9 billion about 0.8% of the US trade deficit with PRC in 2009. Unprecedented globalization, well organized global production networks, repaid development of cross-country production fragmentation, and low transportation costs all contribute to rational firms such as Apple making business decisions that contributed directly to the US trade deficit. Global production networks and highly specialized production processes apparently reverse conventional trade patterns so that developing countries, such as PRC, export high-tech goods—like the iPhone while industrialized countries, such as the US, import high-tech goods they themselves invented. In addition, conventional trade statistics greatly inflate bilateral trade deficits between a country used as export-platform by multinational firms and its destination countries. Based on the value-added approach, the iPhone trade would generate US\$48 million trade surplus for the US.

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## 1. Introduction

At the center of global imbalances is the bilateral trade imbalance between the People's Republic of China (PRC) and the United States (US). Most attention to date has been focused on macro factors, such as low savings in the US, insufficient domestic consumption in China, and PRC's exchange rate regime. A sharp appreciation on Chinese Yuan (CNY) has been argued as an effective means of mitigating the Sino-US bilateral trade imbalance. Little attention, however, has been given to the structural factors of economies and global production networks that have transformed conventional trade patterns and the way we look at trade statistics, particularly in calculating the value-added component of traded goods and differentiating between processed and ordinary exports.

In this paper, we attempt to explore the effects of some of these factors and attempt to show that production networks, unprecedented globalization and the profit maximization behavior of multinational enterprises play a crucial role in widening Sino-US trade imbalances. We use the iPhone, one of the key technological innovations in recent years created in the US and owned by an American multinational corporation, as an example in this exploration.

## 2. How iPhones Are Produced

iPhones are designed and marketed by Apple, one of the most innovative American companies. Aside from its software and the product design, the production of iPhones primarily takes place outside of the US. Manufacturing iPhones involves 9 companies, which are located in PRC, the Republic of Korea (hereafter Korea), Japan, Taipei, China, Germany and the US. The major producers and suppliers of iPhone parts and components include Toshiba, Samsung, Infineon, Broadcom, Numunyx, Murata, Dialog Semiconductor, Cirrius Logic, etc. All iPhone components produced by these companies are shipped to Foxconn, a Taiwanese company located in Shenzhen, PRC, for assembly into final products and then exported to the US and the rest of the world. Table 1 lists major suppliers and costs of iPhone components and parts.

By any definition, the iPhone belongs to the high-tech products category, where the US has an indisputable comparative advantage. In effect, PRC does not domestically produce any products that could compete with iPhones. The US also has absolute advantage in the smart phone category. Following the predictions of Ricardian theory and Hecksher-Olin theory, the US should export iPhones to PRC. On the contrary, PRC exports iPhones to the US. All ready to use iPhones have been shipped to the US from China. It is foreign direct investment, production fragmentation and production networks that have jointly reversed the trade pattern predicted by conventional trade theories. The manufacturing process of iPhones illustrates how the global production network functions, why a developing country such as PRC can export high-tech goods—at least according to the currently applied methodology for calculating trade statistics—and why the US, the country that invented the iPhone, becomes an importer.

**Table 1 . Apple iPhone 3G's Major Components and Cost Drivers**

<b>Manufacturer</b>	<b>Component</b>	<b>Cost</b>
Toshiba (Japan)	Flash Memory	US\$24
	Display Module	US\$19.25
	Touch Screen	US\$16.00
Samsung (Korea)	Application Processor	US\$14.46
	SDRAM-Mobile DDR	US\$8.50
Infineon (Germany)	Baseband	US\$13.00
	Camera Module	US\$9.55
	RF Transceiver	US\$2.80
	GPS Receiver	US\$2.25
	Power IC RF Function	US\$1.25
Broadcom (USA)	Bluetooth/FM/WLAN	US\$5.95
Numonyx (USA)	Memory MCP	US\$3.65
Murata (Japan)	FEM	US\$1.35
Dialog Semiconductor (Germany)	Power IC Application Processor Function	US\$1.30
Cirrus Logic (USA)	Audio Codec	US\$1.15
<b>Rest of Bill of Materials</b>		<b>US\$48.00</b>
<b>Total Bill of Materials</b>		<b>US\$172.46</b>
<b>Manufacturing costs</b>		<b>US\$6.50</b>
<b>Grand Total</b>		<b>US\$178.96</b>

Source: Rassweiler (2009)

### 3. iPhones and the US Trade Deficits with PRC

iPhones were introduced to the US market in 2007 to large fanfare, selling an estimated 3 million units in the US in 2007, 5.3 million in 2008, and 11.3 million in 2009 (Hughes 2010). Globally, iPhone sales have been estimated at 3.7 million, 13.7 million,

and 25.7 million in 2007, 2008, and 2009, respectively, with the majority of those sales coming in advanced markets in Europe, Japan, Singapore, and Korea (Hughes 2010).

The iPhone was not introduced to the PRC market until late 2009 and as such, the shipment of iPhones from PRC to the US becomes a part of the US trade deficit. Table 2 shows iPhone exports in units and US dollars from PRC to the US (all units sold in the US were assembled in PRC), as well as estimated trade balances in iPhones between the two countries.

Table 2 summarizes China's iPhone exports to the US and corresponding bilateral trade deficits associated with iPhone trade. Using total unit manufacturing costs as the unit price of iPhones exported to the US, we estimate that, in 2007 US\$687 million worth of export from PRC to the US was attributed to iPhones. In 2009, that amount exceeded US\$2 billion. Since iPhones were not sold in China until late 2009 and the sales of iPhone were very limited, iPhones shipped to the US from China became a part of the US trade deficits with China. Assuming that parts supplied by Broadcom, Numonyx and Cirrus Logic<sup>3</sup> were imported from the US, which valued at US\$121.5 million, in 2009 iPhones contributed US\$1.9 billion trade deficit, equivalent to about 0.8% of the total US trade deficit with PRC. It is estimated that iPhone sales would rise to 21.3 million units in the US by 2011 (Hughes 2010), almost doubling the current sales. Under the existing production patterns, in which all iPhone are exclusively assembled in PRC, the contribution of the high-tech product iPhone to the Sino-US trade deficit would be expected to rise further as more and more American purchase iPhones.

However, most of the bilateral deficit associated with iPhone trade was not originated from PRC as Chinese workers contributed a very small portion of the value-added to an iPhone sold in markets. The decomposition (Table 1) on the production costs of the iPhone shows that, it costs only US\$6.50 per unit to assemble all parts and components into a ready to use iPhone. The assembly cost accounts for merely 3.6% of the total manufacturing cost (e.g. the shipping price).

**Table 2. iPhone Trade and the US Trade Deficit with PRC**

Year	2007	2008	2009
iPhone Sales in the US* (million Units)	3.0	5.3	11.3

<sup>3</sup> It is also possible that these companies have the components produced outside of the US.

Shipping Price/unit** (the US dollar)	229	174	179
PRC's Export to the US in iPhone (million US dollar)	687	922.2	2,022.7
PRC's Trade Surplus with the US in iPhones	N/A	N/A	1,901.2 <sup>4</sup>
PRC's iPhone exports to the US based on value added ( million US dollar)	19.5	34.35	73.45
Value added / total exports	2.8%	3.7%	3.6%
PRC's trade surplus with the US in iPhones based on Value-added	N/A	N/A	-48.1 <sup>5</sup>

Sources: \* Hughes (2010); \*\* Rassweiler (2009)

Being solely an iPhone assembly center, PRC first imports all components and then re-exports them as the final assembled product to the US. The imported components from other countries greatly inflate the export value. If iPhone exports from China to the US were calculated based on the value-added contributed by Chinese workers, i.e., the assembling cost, the value of China's iPhone exports to the US would be much smaller at only US\$73.5 million. Accordingly, the trade deficit associated with iPhone trade would be also drop substantially. As mentioned earlier, China imported US\$121.5 million components from the US companies Broadcom and Numunyx for assembling iPhones. Based on value added approach, the US would have no deficits but US\$48 million trade surplus with China in iPhones related trade! The sharp contrast of the two different trade deficit measurements indicates that conventional trade statistics are not consistent with the trade where global production networks and production fragmentations determine cross-country flows of parts, components, and final products. Bilateral trade imbalances between a country used as a final assembler and its destination markets are greatly inflated by trade in intermediate products. These statistics provide a distorted picture about bilateral trade imbalances.

<sup>4</sup> When calculating trade deficits between PRC and the US in iPhones, we assume that all parts supplied by Broadcom and Numunyx were imported from the US.

<sup>5</sup> The trade balance is calculated as the difference between the total value-added created in China and the value of imported parts from Broadcom and Numunyx.

#### 4. iPhone Production and the Appreciation of the CNY and other Asian Currencies

The CNY's appreciation has been called for by many observers as a means to solve global imbalances, and the Sino-US trade imbalance in particular. In this section we use iPhone trade to examine the impact of a CNY appreciation on the high-technology contribution to the trade deficit. The calls for appreciation of the CNY vary from a needed 10% to 40% increase against the US dollar. We take a midline approach here to CNY appreciation and assume that it appreciates 20% from its current price of 6.82 CNY to the US dollar<sup>6</sup>. We also assume and there is no productivity growth at the Chinese assembling factory.

An appreciation of 20% will raise the iPhone assembly cost to US\$7.8 per unit, from US\$6.5, and add US\$1.3 to the total manufacturing costs. This would be equivalent to a 0.73% increase in total manufacturing costs. It is doubtful that Apple will pass this US\$1.3 to American consumers as the increase is negligible and Apple would have little to gain by passing a tiny price increase to iPhone users. Even a 50% appreciation of CNY against the dollar would not bring a significant change in total manufacturing costs, as the assembling cost--contribution of Chinese workers to a ready to use iPhone is very little, only 3.6%. Therefore, it is unlikely to anticipate a CNY appreciation lowering many components of the trade deficit, in this case the portion due to iPhone trade.

Realizing the limit of CNY appreciation on China's trade surplus because of the role of processing exports played, Thorbecke (2010) proposed a joint appreciation of East Asian currencies against the dollar to mitigate the imbalance between China and the US. Now, we analyze how the joint appreciation of the currencies of the economies involved in producing iPhone affect iPhone trade. Similarly, we assume that all these currencies: CNY, Korean Won, Japanese Yen and Taiwanese Dollar appreciated against the US dollar 20%. Excluding parts supplied by Broadcom, Numonyx and Cirrus Logic, which together costs US\$10.75 per unit, we assume the rest of parts are produced in these Asian economies<sup>7</sup> and there are no technological progress or productivity gains in any factories making these components, then, the joint appreciation would be expected to raise the unit cost of iPhones to US\$212.60, or US\$33.64 higher.

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<sup>6</sup> Onada Currency Converter, 09 April 2010, <http://www.oanda.com/currency/converter/>

<sup>7</sup> Infineon is a German company. Here we assumed all parts provided by Infineon would be produced in its factories in Asia. Therefore, the expected increase presented here represents the upper boundary of the increase associated with the joint currency association.

Under the scenario of the 20% joint appreciation, the manufacturing cost could rise 19%, much higher than in the case of unilateral appreciation of CNY.

The Apple could cope with the rising cost triggered by the join-appreciation with three strategies: (1) passing the increased cost to consumers by raising the price of iPhone to \$534 per unit, a 6.8% increased in the retail price; (2) expecting productivity growth cross the production network of iPhones to offset the impact of the join appreciation; and (3) absorbing the rising cost with profit margin adjustment.

Under strategy (1), a 20% joint appreciation at most would reduce iPhone imports at most by 6.8% since price elasticities of import demand are general lower than one. In other words, despite of the assumed complete exchange rate pass-through, the impact of the proposed 20% joint appreciation on China's iPhone exports to the US is relatively small.

On the other hand, under either strategy (2) or (3), the proposed join appreciation will not affect the demand for iPhones at all, thus the bilateral trade imbalance will not be changed. It is highly possible that the productivity growth associated with rising global sale volume will mitigate the negative impact of the join currency appreciation. Economies of scales play a critical role in leading productivity growth in the production of iPhones in the short run. Rising volume of iPhone shipment continuously reduces the unit cost of the iPhone. It cost US\$265 to produce an iPhone when it was introduced in 2007. Within one year, the unit cost of the iPhone dropped to US\$178 and the functions and memory of newly produced models are much more powerful than before (Hesseldahl 2008).

As mentioned previously, that global sales of iPhones reached 25.7 million in 2009, six times higher than after its inception in 2007. It is projected that the sales of iPhones globally will continue to rise, reaching an estimated 45 million in 2011 (Hughes 2010). The economies of scales created by the surging sale volume should further reduce the production costs. Hence, the productivity growth along the production chains of iPhones will likely offset, at least part of the cost increase due to the proposed a joint appreciation.

**Table 3. Profit Margin of iPhones**

	2007	2008	2009
Unit Price*	US\$600	US\$500	US\$500

Unit manufacturing costs*	US\$265.83	US\$174.33	US\$178.96
Profit margin**	US\$334.17	US\$325.67	US\$321.4
Profit Margin (%)**	55	65	64

Sources:\* Rassweiler (2009); Calculated by the author

Moreover, the Apple lowered the price of iPhone from US\$600 to US\$500 in 2009. Despite of US\$100 reduction in the price, the gross profit margin of the iPhone actually rose to 64% from 55%, thanks to the significant reduction in the production costs (Table 2). The more than 50% profit margin leaves the Apple with the flexibility to absorb increased manufacturing costs related to the joint appreciation. With demand for iPhones continuing to climb, both in the US and globally, and potential increases in manufacturing costs likely to be absorbed through productivity increases or through slight reductions in Apple's profit margins, neither a unilateral currency appreciation nor a joint currency appreciation will significantly affect or mitigate the US-PRC trade deficit related to iPhone trade. On the contrary, as more and more iPhones have been being shipped to the US from China, the US trade deficits with China continue to grow.

Another possible impact of the CNY appreciation against the US dollar is increasing the purchasing power of Chinese consumers for American goods, such as iPhones. When Chinese consumers purchase iPhones, the exports of the US to China will increase, thus alleviating the US trade deficits in the iPhone trade. Since its official introduction into the Chinese market in October of 2009 until January 2010, only an estimated 200,000 iPhones had been sold. As a proportion of the mobile and smart phone markets, the iPhone does not command the same market share as it does in the US or Europe, because of the high price. The price of an iPhone at the end of 2009 in mainland PRC was US\$1,000 per unit, double the US unit price. Compared with US\$10,000 GDP per capita in Beijing and Shanghai, the most developed metropolitan cities in China, iPhone's price tag remains relative more expensive. iPhone market in China would be limited and much smaller than its counter parts in the US and EU. Chao, Luk, and Back (2009) estimate that iPhone sales in PRC will increase to 2.9 million by the end of 2011. Compared with more than 20 million iPhone users in the US, it is highly unlikely that the number of iPhone users in China would be able to match that in the US in foreseeable future. Hence, trade in iPhone will continue to increase the US trade deficit with China as iPhones become a mainstream mobile phone in the US.

## 5. Could the iPhone be assembled in the US?

Besides exchange rates, we consider a hypothetical alternative solution for reducing the US trade deficit with China due to iPhone trade. That is to have all iPhones assembled in the US.

The role of PRC in the production chain of iPhones is primarily assembling all of the parts and components into the final product for re-shipment abroad. The skills and equipment required for the assembly are very basic and there is no doubt that American workers and firms are capable of assembling iPhones in the US. If all iPhones were assembled in the US, the US\$1.9 billion trade deficit in iPhone trade with China would not exist. Moreover, 11.4 million units of iPhone sold in the non-US market in 2009 would add US\$5.7 billion to the US exports.

There are two possible reasons for the Apple to use PRC as the assembly center for iPhones. The first would be because of fierce competition in the smart phone sector that forces the Apple to find a low-cost assembly location. In such a situation, the Apple would be faced with either a profit margin that is too low to be sustainable, or price-setting such that it would not be able to find buyers. The other possible reason is simply the profit maximization behavior of Apple and the demands of Apple's shareholders<sup>8</sup>.

As shown in Table 3, the gross profit margin of iPhone was 55% when the phone was launched in 2007, then rose to 64% in 2009 due to reductions in manufacturing costs. If the market was fiercely competitive, the expected profit margin would be much lower and close to zero in the case of perfect competition. The surging sales and high profit margin suggest that the intensity of competition is fairly low in the smart phone market, and the Apple maintains a relative monopoly position. Therefore, the hypothesis that the competition drives iPhones' assembly into China does not hold. It is the profit maximization behavior of Apple rather than the competition that pushes Apple to have all iPhones assembled in PRC. The unprecedented globalization and well developed production networks make it possible for the Apple to utilize a much cheap location outside of the US to maximizing its profits on iPhones.

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<sup>8</sup> The well developed production network could also be one of reasons for all iPhones being assembled in China. Make such an argument requires specific technical knowledge we do not have. So, we ignore such a possibility.

An interesting hypothetical scenario is that the Apple had all iPhones assembled in the US. Assuming that the wages of American workers is ten times as much as their Chinese counterparts and their productivity would be equal in 2009, if iPhones were assembled in the US, the total assembly cost would rise to US\$68 and total manufacturing cost would be pushed to approximately US\$240. Selling iPhones assembled by American workers at US\$500 per unit still leaves a 50% profit margin for the Apple. As iPhone sales increase globally, that profit margin would also increase. In this hypothetical scenario, iPhones, the high-tech good invented by the American company, would contribute to the US exports and the reduction of the US trade deficit, not only with PRC, but also with the rest of world. More importantly, the Apple created jobs for American low skilled workers, who could not be a software engineers needed by Apple. Giving up a small portion of profits and sharing them with low skilled American workers by the Apple would be more effective in reducing the US trade deficits and creating jobs in the US.

In a market economy, there is nothing wrong that a firm pursues profit maximization. Governments should not restrict such a behavior by any means. However, corporate social responsibility (CSR) has been adopted as a part of corporate values by many multinational companies, including Apple. It may be an effective policy option to practice CSR by creating jobs for low skilled workers, such as using American workers to assemble iPhones.

## **6. Concluding Remarks**

In this paper, we use the iPhone as a case to show that even high-tech products invented by American companies will not increase US exports, but to the contrary exacerbate US trade deficits. Unprecedented globalization, well organized global production networks, and low transportation costs all contribute to rational firms such as Apple making business decisions that contributed directly to the US trade deficit reduction.

Global production networks and highly specialized production processes apparently reverse trade patterns: developing countries such as PRC export high-tech goods—like the iPhone—while industrialized countries such as the US import the high-tech goods they themselves invented. High-tech products such as iPhones in this context do not help increase the US exports, but instead contribute to trade deficits. In

addition, conventional trade statistics greatly inflate bilateral trade deficits between a country used as export-platform by multinational firms and its destination countries. In the case of iPhone trade, China actually contributed only 3.8% of the United States' US\$1.9 billion trade deficit, the rest was simply a transfer from Japan, Korea, and Taipei,China.

If the US high-tech companies, such as the Apple, are willing to share their profits with low skilled American workers by keeping assembling jobs in the US, it would be more effective in reducing the US trade deficits than targeting the exchange rate policy of PRC.

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