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East Asian Value Chains and the Global Financial Crisis

Genet Zinabou

August, 2010

Executive summary

Measuring the scale and impact of global value chains (GVCs) is extremely difficult. We know, for example, that a large part of the electronic components that China imports from is Asian neighbours are intermediate inputs that are simply assembled in China before being exported to Western consumers. But, we don't have a good sense of what proportion of these imports end up in products destined for export and what proportion are consumed in China's fast-growing domestic market. The large swings in Chinese trade during the global financial crisis offers us a unique opportunity to gain a better understanding of these relationships.

During the global financial crisis, Chinese electronic exports to Canada and the U.S. fell off dramatically, declining by more than 50% between July 2008 and January 2009. Interestingly, Chinese electronics imports from its Asian neighbours fell off by just a little bit more at 60% and began to recover one month earlier. Furthermore, as the recovery began to take hold both the timing and scale of the rebound in Chinese exports of electronics to Canada and the U.S. and in Chinese imports of these products from its Asian neighbours were remarkably similar. This seems to support the belief that in this sector global value chains play an extremely important role with a large share of Chinese imports coming from the immediate region which are then assembled and sent on to markets in the West. A more rigorous evaluation of the data confirms that value chains play an extremely important role in the electronics sector in China with a high degree of Chinese imports in that sector directly tied to exports to other markets and with no lags, even in the monthly data. GVCs play a less important role in other, for example in Machinery a smaller portion of Chinese imports appear to be linked directly to exports and the lags are greater.

East Asian Value Chains and the Global Financial Crisis

1. Introduction:

When on September 15, 2008 Lehman Brothers filed for bankruptcy, setting off a financial crisis that has been acclaimed as the most severe financial crisis since the 1929 stock crash, Asian economies were not overly worried. Since the crisis originated from the financial system in the United States and parts of Europe, Asian nations thought themselves to a large degree sheltered from its effects. However, it soon became clear that they had been wrong. The financial crisis quickly translated into a serious global economic downturn and by the end of 2008, Asian economies had slowed down substantially with China recording 9% growth (down 4% from 2007) and Japan recording negative growth of -0.7% (compared to 2.3% in 2007). The outlook for 2009 is even darker, with GDP growth predictions of 6.5% and -6.8% for China and Japan, respectively, and similar forecasts for the rest of Asia (Global Outlook 2009).

In a speech at the 40th Asian Development Bank Annual Meeting on February 14, 2009, Takatoshi Kato, IMF Deputy Managing Director, laid out the channels of transmission of the crisis to Asia. His first point concerned the myth of Asian independence from business cycles of advanced economies. Whereas some have interpreted the growth of intra-Asian trade as a sign of a shift from Asian export dependence on industrialized countries to Asian regional interdependence, the opposite is true. Asian economies have in fact grown even more dependent on exports to the U.S. and other developed countries and have hence become more exposed to shocks in these economies. The explanation as suggested by Mr. Kato and other experts is that intra-Asian trade is largely in parts and intermediate inputs or, in other words, that it is the reflection of growing global value chain production whose final products are still destined for export to the industrialized world (Kato 2009).

The question that arises is how large intra-Asian trade in intermediate products actually is and to what degree Asian economies remain dependent on those of the developed world. In 2008, the IMF Asia and Pacific department estimated that the share of intermediate goods in trade flows in emerging Asia is around 65 percent, much higher than the corresponding figure for developed economies, which lies at about 40 percent. A study by Rumbaugh and Blancher specifically focused on China, who has been recognized as playing the central role of main importer of intermediate goods and exporter of final goods to the developed world, and estimated the share of China's imports that are for processing and re-exporting at 50 percent (2004).

What we hope to do in this paper is to contribute to the debate surrounding global value chain production by making use of the natural experiment provided by the current global economic crisis. If it is true that a large share of Asian intra-regional trade is in parts and intermediate inputs for final goods eventually exported to the industrial world and that Asian economies are consequently highly vulnerable to business cycle shocks in the developed economies, then we expect the financial crisis to have a significant negative impact on exports from the region to developed economies and a corresponding significant negative impact on intra-regional trade. Furthermore, if it is true that China plays the central role of assembly hub for intra-Asian products and final exporter to the

rest of the world, we assume that any trends will appear strongly in Chinese trade patterns.

In order to test this hypothesis, we will make use of Trade Atlas data of Chinese exports and imports, which are recorded on a monthly basis and range from January 1995 to June 2009. After a thorough examination of the trends in Chinese trade flows since 1995 with a focus on the months of the financial crisis, we will employ a slightly modified version of the standard gravity model of trade to measure the strength of the dependence of China's imports from other East Asian nations on China's exports to the final goods markets of North America and Europe. But first, we will briefly provide some background to the debate surrounding global value chain production.

2. Background:

In 2008, the IMF reported that intra-regional trade accounted for over 50 percent of total trade in Asia and that trade in intermediate goods within Asia is much higher than in other parts of the world. The share of intermediate goods in manufactured good flows in emerging Asia, for example, was estimated at about 65 percent, 8 percent higher than in 1992 and 25 percent higher than the equivalent figure of 40 percent for similar trade among more developed economies. China plays a key role in these statistics, importing substantially from other East-Asian nations and exporting large amounts of goods to the rest of the world.

Experts are in agreement that the reason behind this phenomenon is increasing specialization in vertical production stages, also termed global value chain production. The general story line is that China imports parts and intermediate goods from throughout the East-Asian region, assembles them into final products and exports these to the U.S. and other markets outside the region.

Furthermore, while intra-regional trade in Europe has been observed to be mostly in final goods and is widely attributed to preferences for product variety, intra-Asian trade is largely in intermediate inputs and is thought to stem more from the exploitation of comparative advantages and economies of scale made possible by falling transport and communication costs (IMF 2008).

The concept of comparative advantage, which dates back to David Ricardo in the early 19th century, forms the backbone of classic trade theory. Whereas it was originally developed with respect to trade in final products, the theory is no less relevant for the production of intermediate goods. As Hekscher and Ohlin showed, differences in comparative advantages arise largely from differences in factor endowments. From this result, it can be deduced that if the production of a certain final product requires the input of a number of different factors of production that are concentrated across different countries, then it can be profitable for the countries to split up the production process according to this distribution of production factors; in other words, it is profitable for these countries to trade in factors of production. In the electronics industry, for example, China seems to be importing parts and components from higher-wage countries like Japan, Taiwan and South Korea and assembling them into final products which it then exports to overseas markets like the U.S. This phenomenon is much in line with the theory of comparative advantage, because China is well-endowed with cheap labour and therefore has a comparative advantage in assembly, whereas Japan, Taiwan and South

Korea have better access to capital and advanced technology and so have the comparative advantage in producing the electronic parts that China then assembles into final products (Zebregs 2004).

The theory of economies of scale is another influential theory used to explain developments in intra-Asian trade. The concept proposes that as the production of a good increases, average production costs fall, which can be due to high initial start-up costs or simply efficiency gains over time as best practices are identified. This provides another rationale for vertical specialization, since total production costs of a certain good across a number of countries can be reduced if each country focuses only on a limited number of production steps, accomplishing economies of scale in that production step and thereby decreasing average production costs (Aminian et al. 2008).

Of course, both these theories assume that trade costs (such as transport and communication costs as well as tariffs) are zero. The moment this assumption is relaxed, it is no longer certain that benefits are to be had from specialization as the gain in reduced production costs might be outweighed by the additional trade costs.

Since the 1980s, there has been a growing literature surrounding what may be called "New Trade Theory" and "New Economic Geography", terms often traced to Paul Krugman. In his 1991 paper, Krugman points out that geography is underestimated as a determining factor of trade and develops a trade model that shows transportation costs (which depend directly on geography) to be a determinant factor in the localization of industries. He concludes that high transportation costs lead to a geographic concentration of firms within a given industry. The implication is that lowering transportation costs will in turn lead to a dispersion of firms. In line with this theory, the growth of intra-Asian trade in recent years can be seen as a dispersion of firms within the same industry across national borders as a result of falling transport costs.

Since Krugman, other papers have focused more specifically on the driving forces behind offshoring and product fragmentation. Among the more recent and influential papers is Grossman and Rossi-Hansberg (2008) where a fall in transportation and communication costs is recognized to have the same effect as a productivity increase of offshore production, in other words, increases the comparative advantage held by offshore production. Meanwhile, Hummels et al. formally illustrate that even a small reduction in trade barriers (i.e. falling transport costs and tariffs) can provide strong incentives for vertical specialization, since trade costs are incurred numerous times as an unfinished good crosses multiple borders before finalization. This result also offers an explanation for the disproportionate rise in recent years in trade in intermediate goods when compared to the rise in overall trade and GDP. According to Hummels et al., as trade barriers fall, trade in final goods will increase, but vertical specialization across national borders and consequently vertical trade will increase by even more (2001).

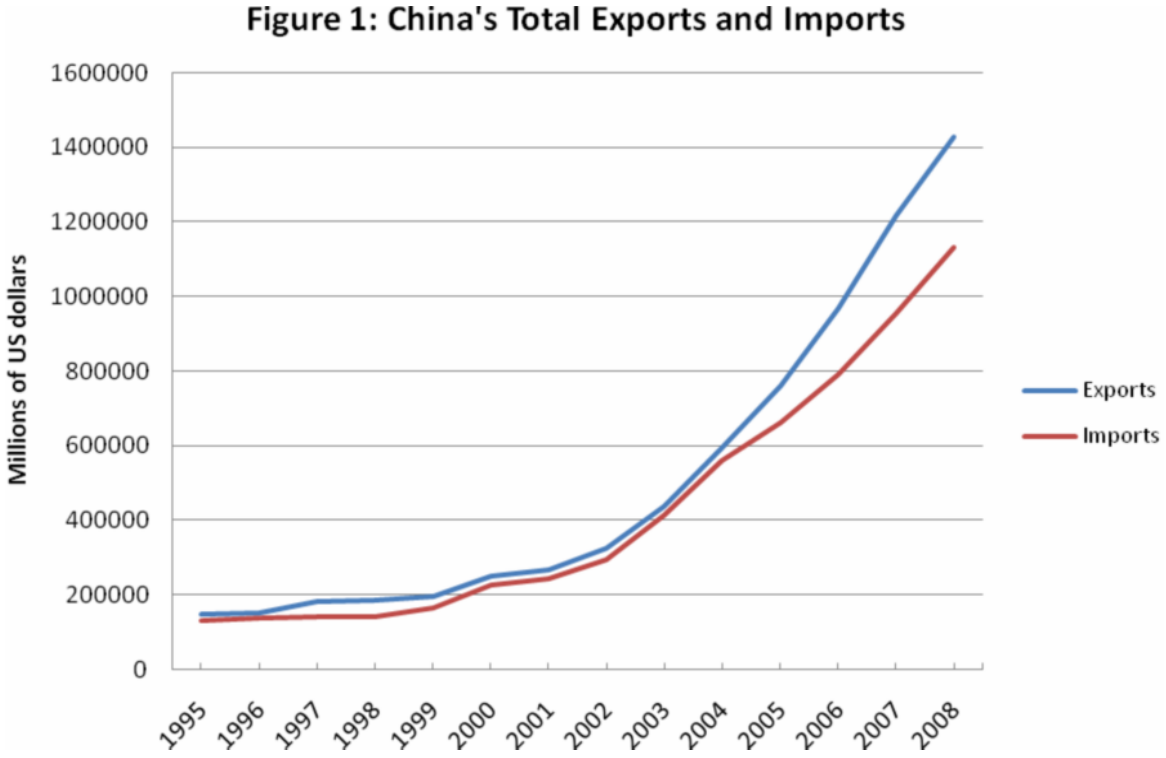
In short, the global value chain trend in East Asia can largely be explained by differences in comparative advantages among the economies involved in the different steps of the production process (differences in endowments of labour, capital, and technological know-how), by the force of economies of scale, and by the recent rapid fall in trade barriers, mainly transport and communication costs but also tariffs.

Now, to what extent are global value chains actually established in China? What does the data say?

3. Data Description:

1. Trade volumes, GDP, and global supply chains

Between 1995 and 2008 China's export volume increased by 860% and imports by 757%. Meanwhile, nominal GDP grew by approximately 494%. This means that over this period, the ratio of Chinese trade to GDP increased from 38.6% to 59.2% (64.3% in 2007), which in turn has two main implications. Firstly, the excess of export growth over GDP growth suggests that a significant part of goods exported by China are not fully produced within the country. Therefore, China must be importing intermediate goods and thereby be partaking in global value chain production. Secondly, the higher trade to GDP ratio makes the Chinese economy as well as its partners in value chain production more vulnerable to fluctuations in foreign markets now than they were 14 years ago.



2. China's partners in global value chain production

In line with the theory that China is increasingly involved in the assembly of parts and inputs sourced from other Asian countries into final products for destination markets overseas, a substantial and rising proportion of Chinese exports goes to North America and Europe, largely the U.S., Germany and the Netherlands, while over half of its imports come from Japan, Taiwan, South Korea and other Asian countries.

Exports:

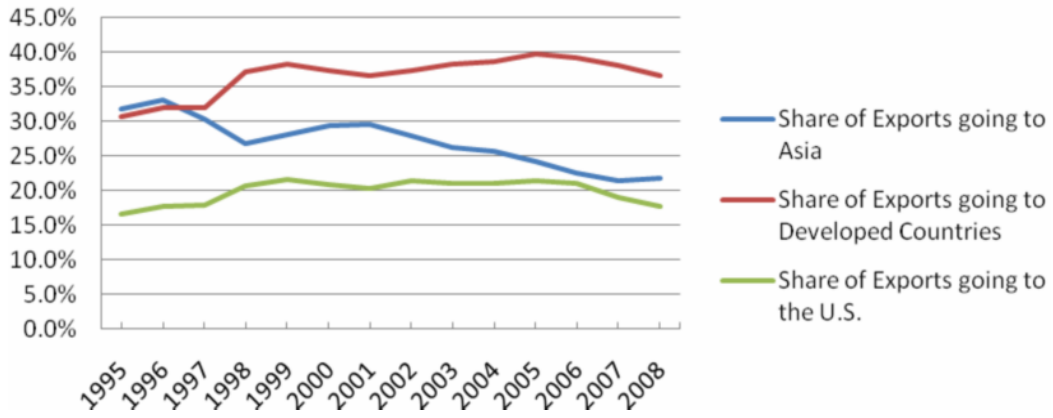
In 1995, China's top 3 export destinations were Hong Kong, Japan, and the U.S.; by 2008, the U.S. had moved into first position and both the Netherlands and the United Kingdom had moved up the ranks, occupying the positions of 6th and 7th largest destinations for Chinese exports, respectively.

Table 1: China's Top Export Destinations, 1995-2008

	1995		2008	
Rank	Country	*Millions of US$*	Country	*Millions of US$*
1	Hong Kong	*35983.427*	United States	*252326.564*
2	Japan	*28466.685*	Hong Kong	*190772.423*
3	United States	*24713.498*	Japan	*116176.472*
4	Korea, South	*6687.805*	Korea, South	*73905.188*
5	Germany	*5671.451*	Germany	*59191.758*
6	Singapore	*3500.636*	Netherlands	*45921.163*
7	Netherlands	*3232.066*	United Kingdom	*36078.932*
8	Taiwan	*3098.059*	Russia	*33011.264*
9	United Kingdom	*2797.665*	Singapore	*32325.188*
10	Italy	*2067.166*	India	*31516.472*

Exports to the developed countries outside Asia[1] accounted for 31% of Chinese total exports in 1995; this figure had risen to 37% by 2008 with exports to the U.S. alone accounting for about 18%. Over the same period, the share of total exports going to Hong Kong fell from 24.2% to 13.4%. Considering that Hong Kong acts as a conduit for many Chinese exports to elsewhere, the proportion of total exports going to industrialized countries overseas obtained in this data is likely underestimated, though less and less over time. Meanwhile, the share of exports going to other Asian countries[2] decreased from 32.3% to 24%.

Figure 2: Share of Chinese Exports by Destination



[1] The U.S., Germany, the United Kingdom, France, Canada, Belgium, the Netherlands, Italy, Spain, and Australia (selected as they were the top 10 industrialized importers of Chinese exports outside Asia)
[2] ASEAN-5+3 selected as they are China's top 8 trading partners within Asia, excluding Honk Kong

Imports:

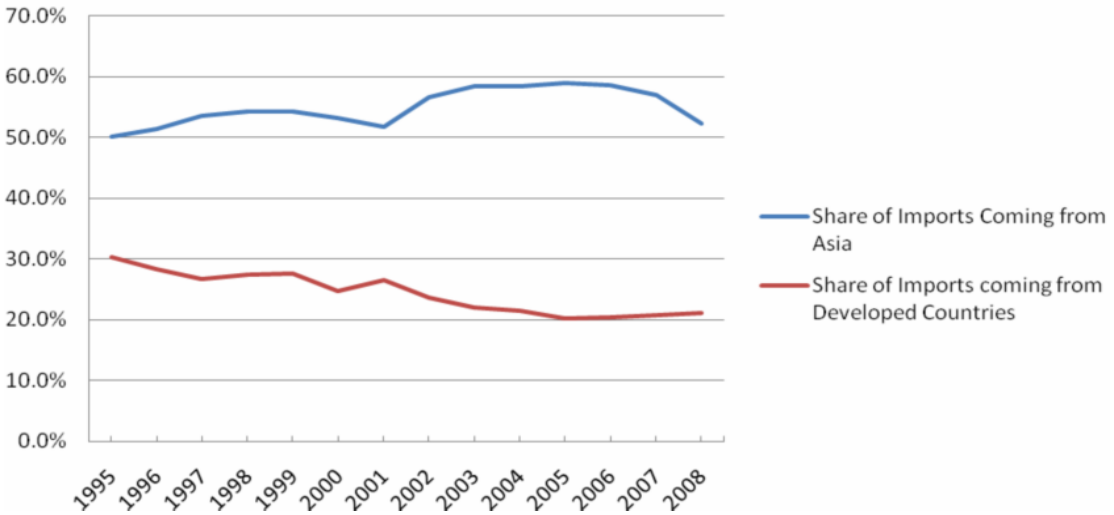
China's top 3 import sources in 1995 were Japan, the U.S., and Taiwan. By 2008, the U.S. had slipped into fifth position and was replaced by South Korea as second largest importer to China.

Table 2: China's Top Import Sources, 1995-2008

	1995		2008	
	Country	*Millions of US$*	Country	*Millions of US$*
1	Japan	*29004.529*	Japan	*150634.070*
2	United States	*16118.291*	Korea, South	*112153.704*
3	Taiwan	*14783.944*	Taiwan	*103325.022*
4	Korea, South	*10293.234*	China[3]	*92315.513*
5	Hong Kong	*8590.713*	United States	*81486.113*
6	Germany	*8037.859*	Germany	*55909.974*
7	Russia	*3798.640*	Australia	*36283.823*
8	Singapore	*3397.831*	Malaysia	*32111.958*
9	Italy	*3115.047*	Saudi Arabia	*31071.814*
10	Canada	*2681.312*	Brazil	*29632.218*

Imports from Japan, South Korea, Taiwan, China, Malaysia, India, Singapore, Thailand, the Philippines and Indonesia made up 50.1% of total imports in 1995. This percentage had risen to 56.9% by 2007 before dropping to 52.2% in 2008. Over the same period, the share of imports from developed countries outside the region dropped from 33.3% to 21.1%.

Figure 3: Share of Chinese Imports by Origin



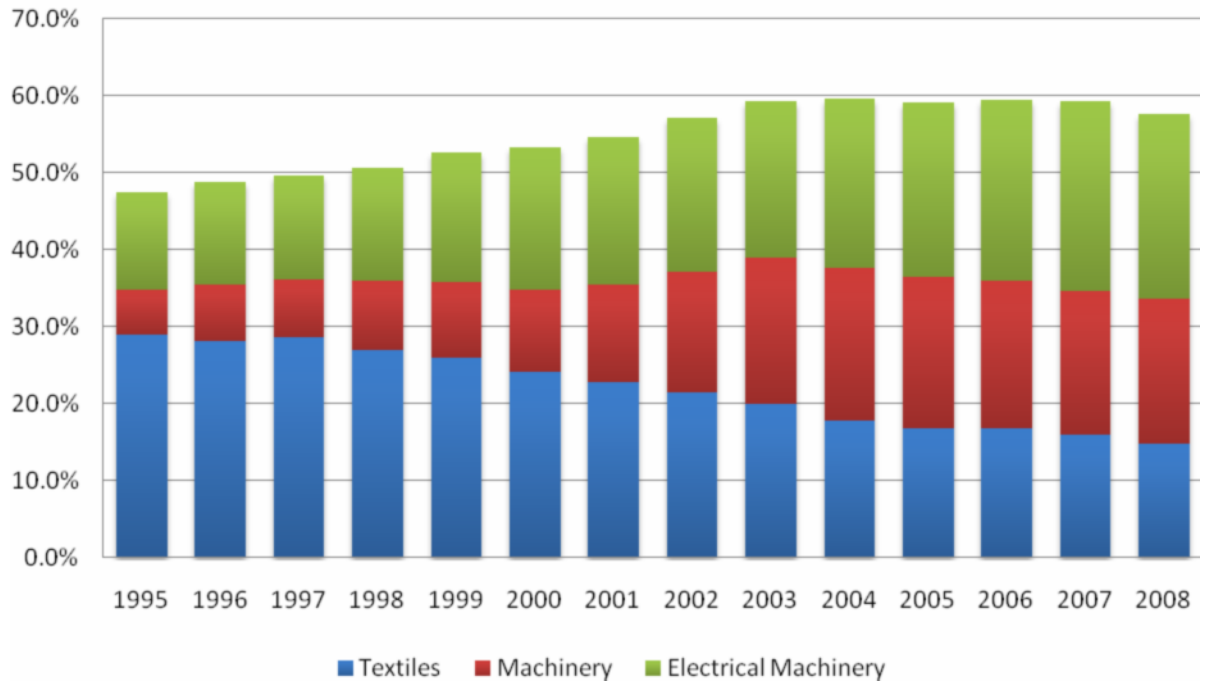
[3] Re-imports

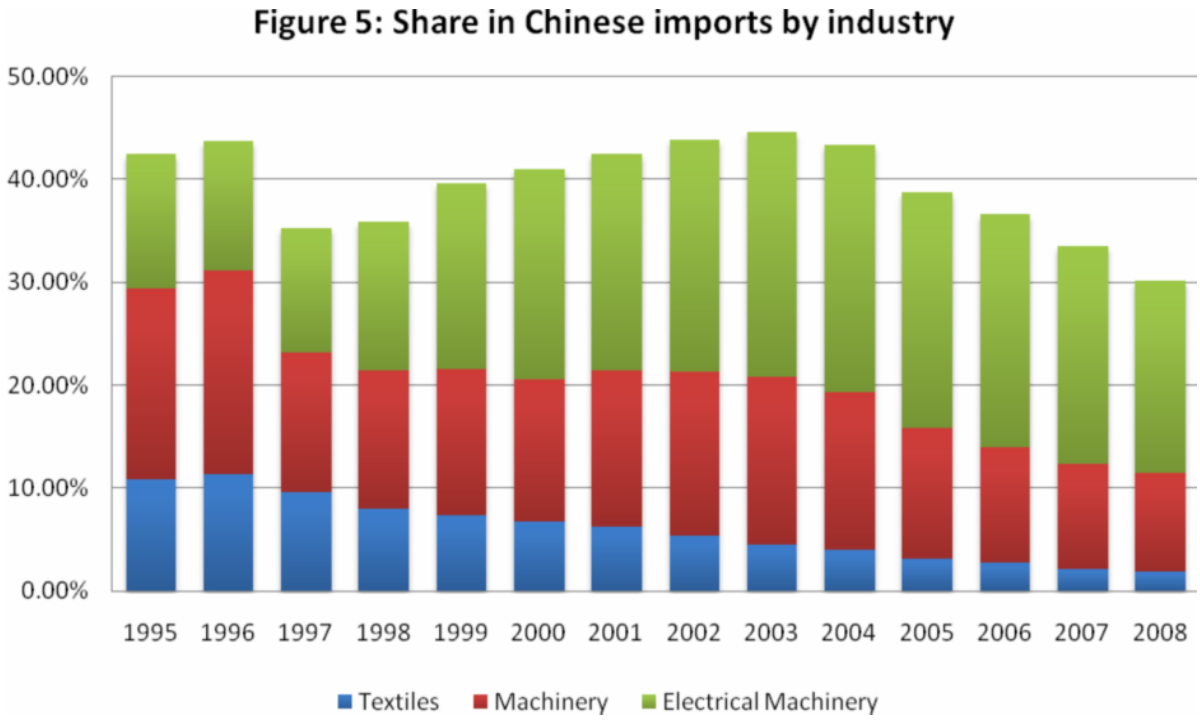
In general, exports to the overseas developed world have grown faster than imports from it, whereas China's imports from other Asian countries have grown faster than its exports to them. This supports the notion of China's increasingly important role as assembly hub and final exporter in Asian value chain production and reiterates the fact that China's export-based economy and in turn the economies of its Asian import suppliers have become more vulnerable to foreign markets outside the region.

3. Which sectors are most affected?

China is well-recognized as a mass exporter of manufactured goods. These manufactured goods used to be principally from the textile industry. Over recent years, however, we have seen China shift from exports of textiles to exports of electronics and machinery (see Fig. 4). Between 1995 and 2008, the share of textiles in Chinese total exports fell by half, from 29.7% to 14.9%. Over the same time period, electronics' share in exports nearly doubled from 12.8% to 24.0% and machinery exports more than tripled their share, rising from 5.8% to 18.8%. When combined, these two industries made up 42.8% of China's total exports by 2008. However, while the share of electronics in China's imports has also increased from 14.7% in 1995 to 23.6% in 2008 (26.9% in 2007), machinery's share has dropped from 18.5% to 9.7%.

Figure 4: Share in Chinese exports by industry





Looking specifically at imports from within Asia shows that between 1995 and 2008, the share of China's electronics imports coming from other Asian countries[4] has risen from 52.1% to 57.4% (59.5% in 2007) while the corresponding share of machinery imports[5] has dropped slightly from 45.7% to 42.6%.
Over the same period, the share of China's exports going to the U.S., Canada, and Hong Kong[6] have decreased in both electronics and machinery, although the drop in electronics seems to be mostly due to a decrease in exports to Honk Kong.

[4] Japan, Taiwan, South Korea, Malaysia, and the Philippines, China's top Asian import sources in electronic machinery
[5] Imports from Japan, Taiwan, South Korea, Singapore, and Thailand, China's top Asian import sources in machinery
[6] The U.S. and Honk Kong are chosen here as they are China's top two export destinations and Canada is included as its trade relations with China are similar to those of the U.S.

Figure 6: Shifts in China's Machinery Sector

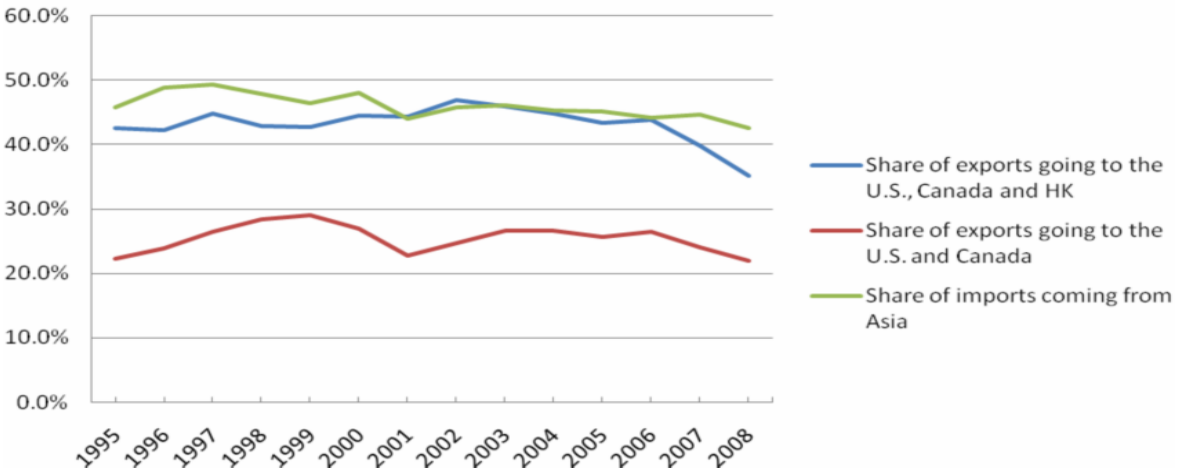
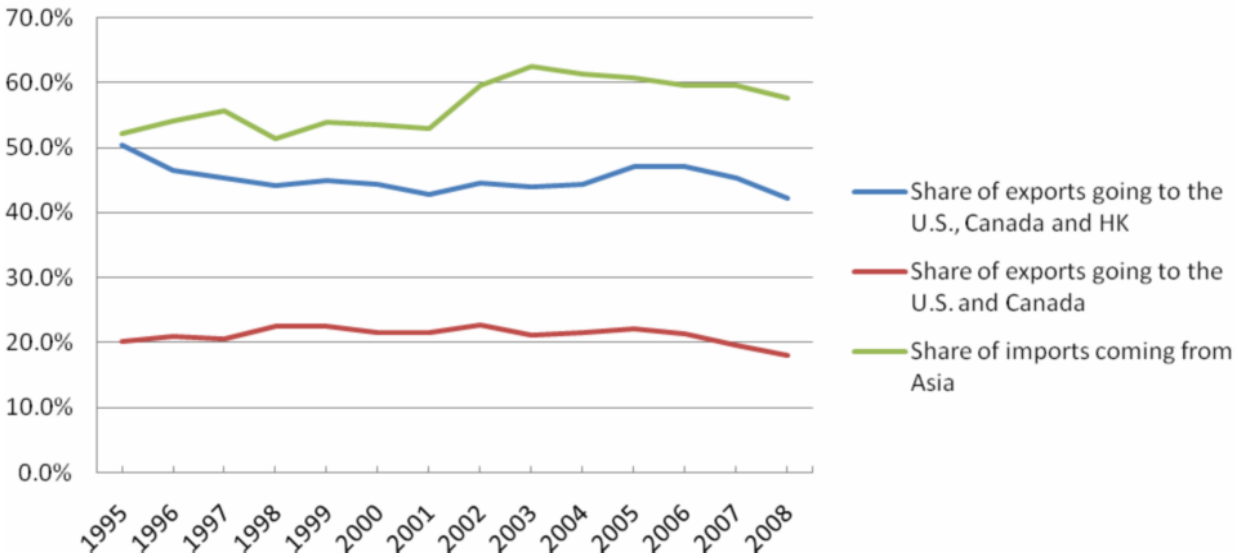


Figure 7: Shifts in China's Electrical Machinery Sector



4. When the financial crisis hit:

In the aftermath of the global financial crisis, the IMF has forecasted world-wide economic growth in 2009 to come in at -1.1%, but has predicted trade volumes to drop by 11.9%, so by a factor more than ten times higher than overall economic contraction (IMF 2009). In fact, WTO statistics record nominal drops in world exports (imports) of merchandise of 33.1% (32.8%) for the second quarter of 2009 compared to the same period in 2008, preceded by drops of 31.3% (30.0%) and 10.8% (8.7%) in the first quarter of 2009 and last quarter of 2008, respectively, compared to a year earlier (WTO 2009). These constitute the largest drop in trade since the Great Depression.
There are a number of factors that may explain this, but global supply chains seem to lie at the very centre of it. In a paper recently published by the OECD Economics

Department, the authors find that most of the drop in trade following the crisis can be explained by the contraction of global demand, magnified by a high income elasticity of trade. The authors present evidence that suggests that the world's long-term income elasticity of trade has doubled since the late 1980s and suspect this to be largely the result of increasing international fragmentation of production (Cheung and Guichard 2009). When a good-in-process has to cross multiple national borders before finalization, a decrease in exports of the final good results in multiple decreases in trade transactions, making the change in trade flows a multiple of the change in export demand. The key problem here is that trade is measured in gross value, whereas GDP is measured in terms of value-added (Yi 2009).

Other factors that seem to have magnified the response of world trade to the economic recession include tightened trade credit conditions and protectionist reactions by trading nations. Furthermore, Cheung and Guichard suspect that a possible break-down or freezing of global supply chains during the crisis could account for another 10-20% of the observed drop in world trade.

If it is true that global supply chains played an important factor in determining trade flows during the financial crisis, we expect regions and industries significantly involved in this type of production to be especially affected. Specifically, we expect China's trade in electronics and machinery to have been heavily impacted by the crisis. Furthermore, we expect China's imports in these industries from its suspected major input goods suppliers in Asia to drop relatively in tandem with China's exports to its major final destination markets in North America and Europe.

Our data does indeed show a fairly proportional and synchronised response of Chinese exports and imports to the financial crisis (see Fig. 8). China's total exports fell by 52.4% between September 2008 and February 2009, while imports dropped 51.8% by January 2009 and began to recover again in February, a month earlier than exports. This one-month lag in recovery of exports behind imports is found in both the electronic machinery and the machinery sectors. Furthermore, in the machinery sector, exports also lagged imports by a month at the beginning of the crisis, still rising slightly between September and October 2008, while imports were already dropping. This could be a reflection of greater inventories or simply weaker value chain links in the machinery sector. Furthermore, imports dropped by more than exports in both sectors, although more prominently in electronic machinery where imports decreased 55.7% compared to a decrease in exports of 51.0%.

Table 3: % changes in Chinese imports and exports by sector

	All Sectors	Electronic Machinery	Machinery
% change in Chinese imports, Sep.-Jan.	-51.84%	-55.7%	-41.54%
% change in Chinese exports, Sep.-Feb.	-52.44%	-50.98%	-40.54%

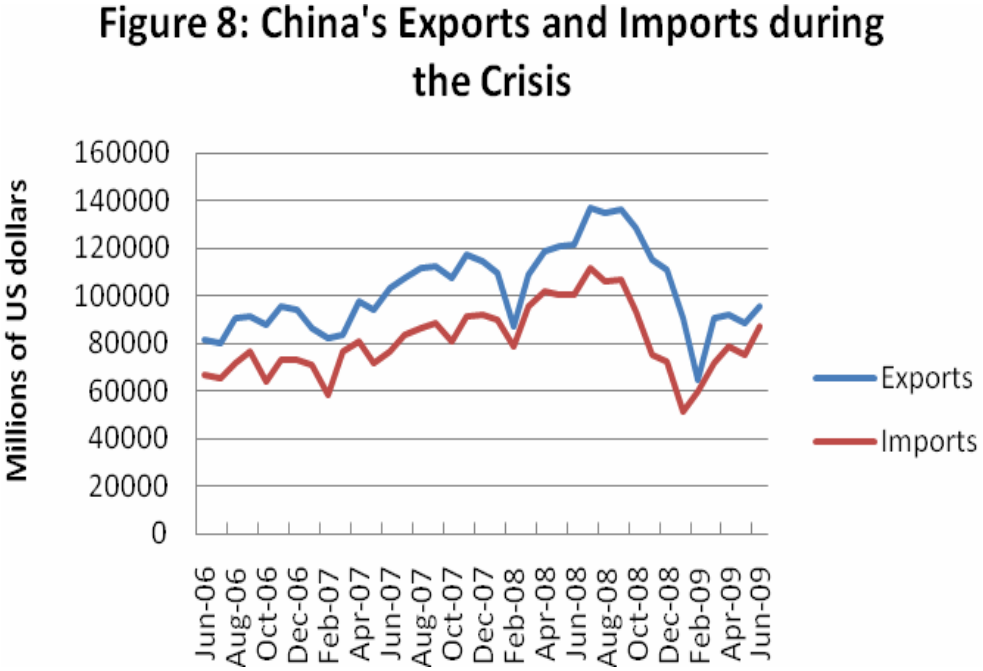


Figure 8: China's Exports and Imports during the Crisis
Millions of US dollars
160000
140000
120000
100000
80000
60000
40000
20000
0
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Oct-07
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Jun-08
Aug-08
Oct-08
Dec-08
Feb-09
Apr-09
Jun-09
Exports
Imports

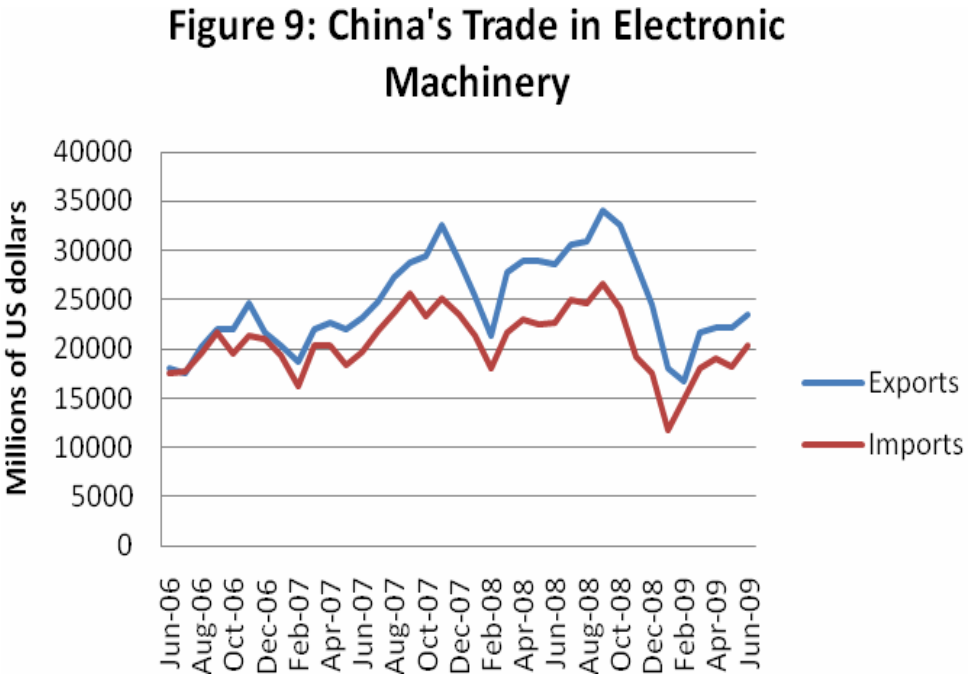
Figure 9: China's Trade in Electronic Machinery
Millions of US dollars
40000
35000
30000
25000
20000
15000
10000
5000
0
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Oct-07
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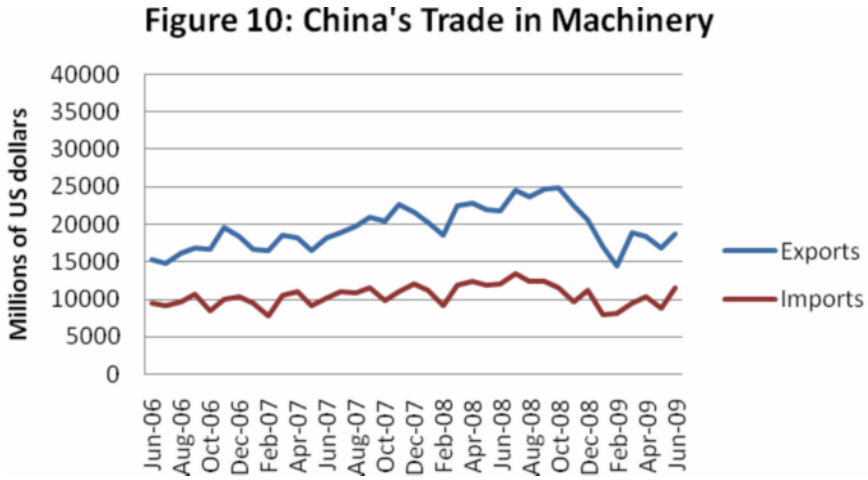
Dec-08
Feb-09
Apr-09
Jun-09
Exports
Imports



Compared to a year previous, both Chinese quarterly exports and imports during the crisis were down significantly. Compared to global trade flows, however, Chinese exports were less dramatically affected than exports for the rest of the world, while Chinese imports were more affected at first but recovered more quickly than the rest of the world.

For China, quarterly exports in the electronic machinery were more negatively affected than average total exports while imports in the same sector were slightly less affected. Additionally, both exports and imports of electronic machinery dropped faster in response to the crisis than total Chinese trade flows and began to recover sooner. However, China's trade in machinery was less impacted by the financial crisis than average Chinese trade.

Table 4:
Quarter over same quarter previous year percentage changes in Chinese exports and imports by sector

All Sectors	Q4 2008	Q1 2009	Q2 2009
Exports	4.33%	-19.72%	-23.37%
Imports	-8.94%	-30.78%	-20.23%
Electronic Machinery	**Q4 2008**	**Q1 2009**	**Q2 2009**
Exports	-5.59%	-24.04%	-21.40%
Imports	-15.38%	-26.72%	-15.66%
Machinery	**Q4 2008**	**Q1 2009**	**Q2 2009**
Exports	4.66%	-18.21%	-19.46%
Imports	-1.90%	-20.41%	-15.52%

Quarter over same quarter previous year percentage changes in world trade

World	Q4 2008	Q1 2009	Q2 2009
Exports	-10.8%	-31.3%	-33.1%
Imports	-8.7%	-30.0%	-32.8%

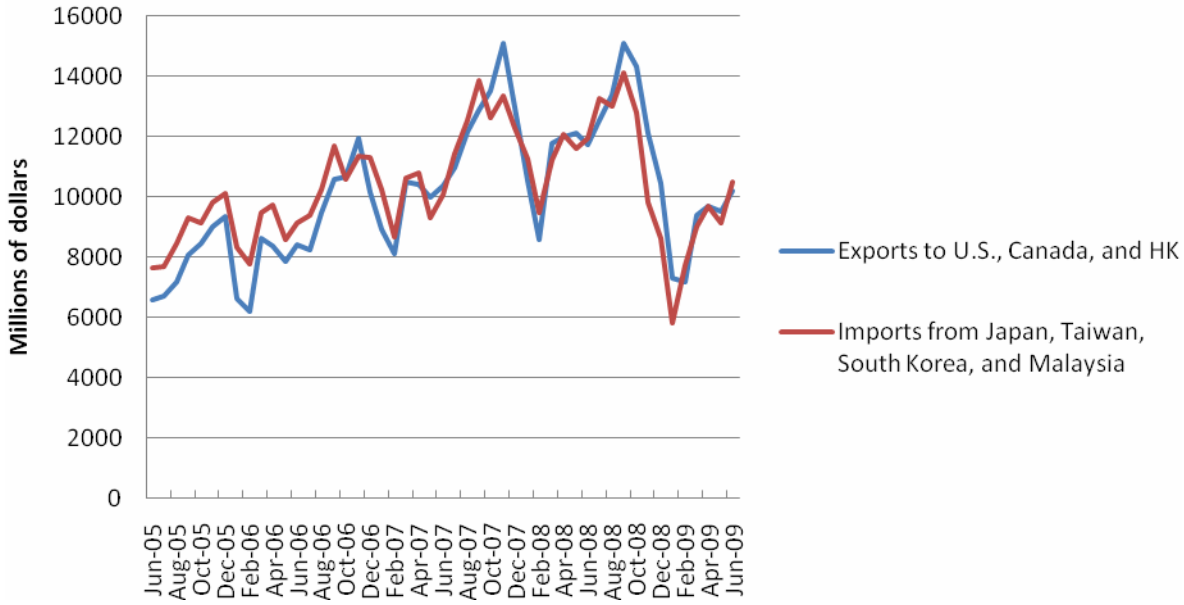
Sectoral trade responses vis-à-vis major export markets and import sources:
Chinese exports to the U.S., Canada, and Honk Kong were much more strongly affected in electrical machinery than in machinery as were imports from major Asian source countries. However, in both sectors, imports from the examined Asian countries showed a modestly larger response than exports to North America and Hong Kong.

Table 5: % changes in Chinese exports to the U.S., Canada, and HK and in Chinese imports from other Asian countries[7] per sector

	Electrical Machinery	Machinery
% change exports to the U.S., Canada and HK, Sep.-Feb.	-52.50%	-37.50%
% change imports from Asia, Sep.-Jan.	-58.90%	-45.68

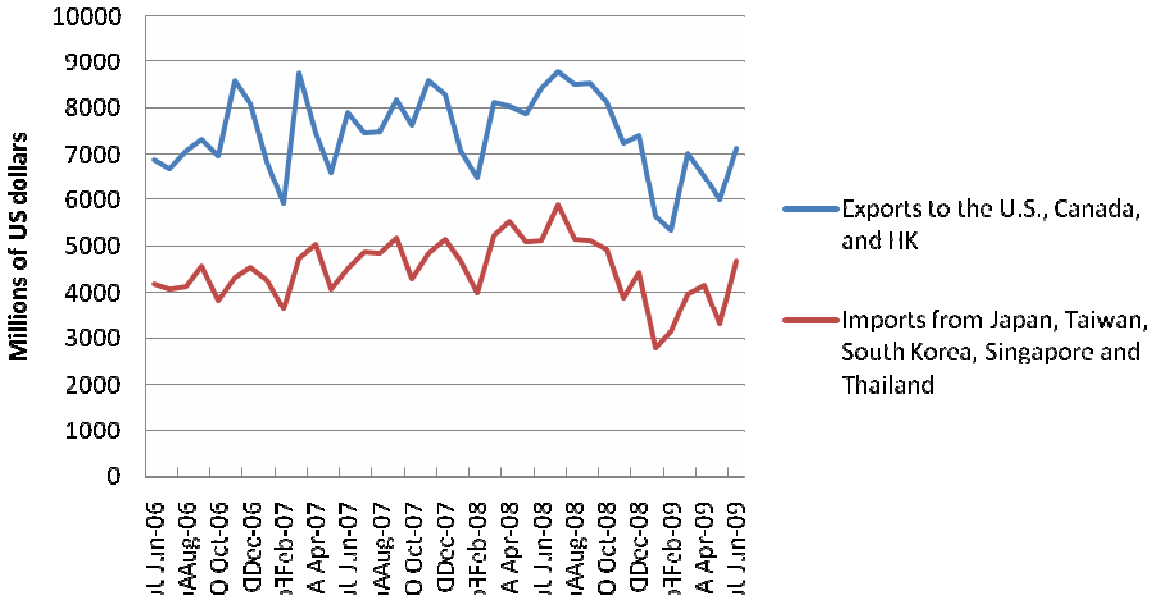
In the electrical machinery sector, exports to the U.S., Canada and HK and imports from Asia moved in almost perfect synchronization throughout the financial crisis, except for the one-month lag of export recovery in January 2009 (see Fig. 10). In the machinery sector, they were also relatively synchronized although not quite as closely as in the electronics sector (see Fig. 11). Interestingly, both machinery imports and exports began a downwards trend in July 2009 before the crisis officially started and experienced a small and temporary increase between November and December 2008.

Figure 10: Electrical Machinery Imports and Exports



[7] For electrical machinery, the Asian import source countries are Japan, Taiwan, South Korea and Malaysia; for machinery, they are Japan, Taiwan, Singapore and Thailand

Figure 11: Machinery Imports and Exports



4.Analysis of Trends:

Between 1995 and 2008, China's trade flows have increased at about twice the rate of GDP, supporting the belief that a significant share of Chinese trade is in intermediate goods. Over this period, China has shifted towards exporting more to industrialized countries outside Asia and importing more from other Asian countries. The U.S. has become China's main export destination while Japan, South Korea and Taiwan have become its top 3 import sources. This gives further credence to China's role as the assembly hub for Asia, importing parts and intermediate goods from other Asian countries and assembling them for final export to the U.S. and other overseas markets. It also means that China and its suppliers are more vulnerable to business cycles abroad than they used to be. Furthermore, China has seen a great shift away from textile manufacturing and towards trade in electronics and machinery, raising the question of the prevalence of global value chains in those sectors specifically. However, while imports of electronic machinery from China's main source countries in Asia have risen somewhat faster than total imports, the opposite is true for machinery imports, suggesting that global value chains might be more prevalent in electronics than in machinery.

The financial crisis set off in September 2008 has provided a rare opportunity to measure China's involvement in global value chains against real world data. If China is truly integrated into global supply chains in the manner it is thought, we would expect the financial crisis that originated in the U.S., China's biggest export destination, to have affected not only Chinese exports to the U.S. and other countries caught in the crisis, but by transmission, also Chinese imports from within Asia. Furthermore, we would expect the impact in the machinery and electronics sectors to be equally as strong as if not stronger than the impact on total Chinese trade volumes.

The data shows that China's trade has indeed been very negatively impacted by the financial crisis. In fact, exports to the U.S., Canada, and Honk Kong and even more so

imports from major Asian suppliers show stronger responses to the crisis than overall trade flows. Exports of electrical machinery dropped over 50% and imports close to 60%, while machinery exports fell 38% and imports 46%. The drops in exports and imports in both sectors occurred generally in tandem, with the exception of a one month lag in exports in January, when imports began to recover as exports continued to fall. These trends provide support once more the claim that global value chain production is an integral part to Chinese trade operations and that, while it is present in both the electrical machinery and the machinery sector, it is much more established in electrical machinery.

Regression Analysis:

We have until this point established that the trends in Chinese trade data over the past 15 years and throughout the recent financial crisis support the East Asian value chain phenomenon. To formalize these results, we will now use basic econometric techniques to determine the degree of interdependence between China's imports from within Asia and China's exports to overseas markets, mainly the United States.

Set-up:

We begin with the standard gravity model of trade and specify our null hypothesis as follows: Assuming that China is not involved in global value chain production, its imports from other Asian countries (here represented by Japan, Taiwan, South Korea, Singapore, Malaysia, Indonesia, Thailand and the Philippines as these constitute China's main import sources in Asia[8]) should not depend on overseas markets, namely North America and Europe, more so than they depend on regional economies' strengths.

The classic gravity model of trade predicts trade flows between two countries to be proportional to their combined economic weights (which can be measured in GDP) and the distance between them. The model is specified as follows:

$Trade_{AB} = c(GDP_A \times GDP_B)/D_{AB}$

where c is a constant and D_{AB} is the distance between countries A and B.

According to this model, China's imports from within Asia should depend on Chinese GDP, its supplier countries' GDPs and the distance between them. The model does not allow for the influence of a secondary demand such as we are arguing is provided by the U.S. and other developed nations outside Asia other than indirectly channelled through Chinese GDP. The model should therefore look as follows:

$M_{China\text{-}Asia} = c(GDP_{China} \times GDP_{Asia})/D_{China\text{-}Asia}$

(Equation 1)

As an alternative hypothesis, we propose the following: If it is true that a substantial proportion of Chinese imports from other Asian countries consists of intermediate goods that are then finalized for export to the U.S. and other overseas destinations, then output shocks of these external economies could directly influence Chinese intra-regional imports as well. We use the United States as proxy for the developed countries overseas that constitute China's main export market for value chain produced goods, since it is China's largest export market and was most directly affected by the crisis. We have the following:

[8] Excluding Hong Kong, which we have seen is more important as destination market than as an import source

$M_{China\text{-}Asia} = c(GDP_{China} \times GDP_{Asia} \times GDP_{US})/D_{China\text{-}Asia\text{-}US}$
(Equation 2)

The question that poses itself is the following: Which equation predicts Chinese-Asian trade flows better and what can consequently be said about the influence of US GDP on Chinese imports from within Asia?
We run three different regressions to determine the answers to these questions. For our first regression, we take standard logs of Equation 1 and 2 and model Chinese imports from Asia as a function of Chinese, Asian, and US GDP individually as well as combined. For simplicity purposes, distances are removed in this analysis, which proves to cause no particular harm[9]. Having seen in the data description section that there are few lags in the trends, we do not have to worry about time lags here and can simply set up our model as follow:
$LN(M_{China\text{-}Asia\ i}) = \beta_0 + \beta_1 LN\ (GDP_{China\ i}) + \beta_2 LN(GDP_{Asia\ i}) + u_i$
(Equation 3)
$LN(M_{China\text{-}Asia\ i}) = \beta_0 + \beta_1 LN\ (GDP_{China\ i}) + \beta_2 LN(GDP_{Asia\ i}) + \beta_3 LN(GDP_{US\ i}) + u_i$
(Equation 4)
For an extension, we add Canadian and EU GDP to American GDP to give a better representation of "western" demand. However, we have to remember that many European countries were themselves only indirectly affected by the banking crisis, which could actually lead to significant lags and skew the regression. Furthermore, since EU GDP data is only available starting in 2000, the data set for this regression is more limited.
Recognizing that GDP and trade values are relatively large and that a strong correlation between GDP and import levels could be indicative more of long-term causal effects rather than co-movement in short-term fluctuations, we also model changes in Chinese-Asian imports as a function of changes in Chinese, Asian, and US GDP. For our second regression, we therefore take the first differences over time of Equation 1 and again test for separate as well as combined effects.
$\Delta(M_{China\text{-}Asia\ i}) = \beta_0 + \beta_1 \Delta(GDP_{China\ i}) + \beta_2 \Delta(GDP_{Asia\ i}) + \beta_3 \Delta(GDP_{US\ i}) + u_i$
(Equation 5)
The two first regressions use quarterly data from 1995 until 2008 due to restrictions in GDP data. However, to fully capture the effects of the financial crisis and to examine the more direct relationship between China's exports to the developed world outside Asia and its imports from within Asia, we also run a simplified model using only import and export data, which is recorded monthly from January 1995 to June 2009. The model is as follow:
$LN(M_{China\text{-}Asia\ i}) = \beta_0 + \beta_1 LN(X_{China\text{-}US\ i}) + u_i$
(Equation 6)

[9] We have already seen that transportation and communication costs have become less and less significant over time. Furthermore, if anything, including the distance factor would add to the relative explanatory power of US GDP in the regression, since out of the countries included in the analysis, the US is the furthest away from China.

and

$\Delta(M_{China\text{-}Asia\ i}) = \beta_0 + \beta_1\Delta(X_{China\text{-}US\ i}) + u_i$

(Equation 7)

Lastly, starting from the fact that machinery and electronic machinery have become China's primary manufacturing export industries and that lags within these sectors are minimal, we run regressions 3, 5 and 6 separately for electronics and for machinery in order to determine the relative strengths of the influence of secondary demand in these sectors.

Estimation Results:

We find that Equation 4 does indeed have higher explanatory power than Equation 3 (see Tables 6-8) though the difference is not enormous. Trends in Chinese, Asian, and US GDP together account for 96.23% of trends in Chinese imports from within Asia, whereas Chinese and Asian GDP alone account for 92.58%. Furthermore, US GDP alone has higher explanatory power for Chinese-Asian trade than Chinese and Asian GDP combined, accounting for 94.37% of fluctuations in China's imports from its Asian neighbours.

It should be noted that the various GDP values used for the explanatory variables are inter-dependent and that this model hence exhibits multi-collinearity. Therefore, the individual coefficient values of $\beta_{1\text{-}3}$ are not necessarily truly reflective of the explanatory power of each individual variable. However, after running the model using only US GDP as well as US and Chinese GDP and US and Asian GDP combined, we can conclude that a one percent change in US GDP induces a change of approximately 3% in Chinese-Asian imports.

As expected, adding EU and Canadian GDP to that of the US also adds to the explanatory power of the model and yields an R^2 term of 98.51%. Furthermore, in the electronics sector, the influence of US GDP on Chinese Asian imports is slightly more pronounced than for all sectors combined, whereas in machinery it is slightly less pronounced. Equation 6 yields an R^2 value of 97.44% and a value of 0.9741 for β_1, suggesting that Chinese intraregional imports are indeed very dependent on exports to the US with an elasticity of almost 1. The results are close to identical in the electronics sector, while both R^2 and β_1 are lower for trade in machinery, falling to 90.21% and 0.7512, respectively.

Finally, as expected, the R^2 values for Equations 5 and 7 are much lower than those for the other models that deal with level variables. This can be attributed to short-term volatility in both changes in Chinese exports to the US and changes in Chinese imports from Asia, which could result from a number of circumstances such as price or inventory fluctuations. However, the R^2 value still falls at 44.35% for Equation 7 and at 39.63% for Equation 5. In fact, whereas changes in Chinese GDP and changes in Asian source country GDP do not prove statistically significant in determining shifts in intra-regional imports, changes in US GDP and changes in Chinese exports to the US do yield significant t-values. We obtain coefficients of approximately 0.07 and 1.76, respectively. The last figure in particular is extremely high, indicating that a decrease in Chinese exports to the U.S. translates into an even larger decrease in China's imports from other

Asian countries, which is exactly what happened following the financial crisis and which is very much in line with the theory of East Asian value chains. Again, the coefficient and R^2 values are even higher in the electronics sector and lower in the machinery sector.

Table 6: Estimation Results – All sectors (1995Q1-2008Q4 for all except Equation 6, which uses Monthly data from 1995Jan – 2009Jun)

Dependent Variable: LN($M_{China-Asia}$)	**Equation 4**	**Eq. 4 adding EU + Canada to US GDP**	**Equation 3**	**Eq. 4 as a function of only US GDP**	**Equation 6 (monthly data)**
Constant	-31.3884***	-26.5319***	-1.6929	-21.1349***	1.0739***
	(-6.98)	(-13.81)	(-0.74)	(-20.05)	(10.15)
LN(GDP_{Asia})	1.1145***	-.9174***	.2842		
	(4.62)	(-3.83)	(0.97)		
LN (GDP_{China})	-.2303	-.6779***	1.3354***		
	(-1.02)	(-5.46)	(20.00)		
LN (GDP_{US})	3.6655***	4.3232***		3.4253***	
	(7.10)	(16.08)		(30.10)	
LN (X_{US})					.9741***
					(80.87)
R^2	0.9623	0.9851	0.9258	0.9437	0.9744

1. t-statistics in parentheses.
2. *,**,*** denotes significance at the 10%, 5% and 1% level, respectively.

Table 7: Estimation Results – Electrical Machinery (1995Q1-2008Q4 for all except Equation 6, which uses monthly data from 1995Jan – 2009Jun)

Dependent Variable: $LN(M_{China-Asia})$	Equation 4	Eq. 4 adding EU + Canada to US GDP	Equation 3	Eq. 4 as a function of only US GDP	Equation 6 (monthly data)
Constant	-50.5401*** (-10.93)	-27.8337*** (-7.53)	-2.1799 (-0.70)	-33.1182*** (-31.71)	1.1472*** (13.56)
$LN(GDP_{Asia})$	1.1042*** (4.45)	-1.3958*** (-3.03)	-0.2481 (-0.62)		
$LN(GDP_{China})$	-0.7125*** (-3.07)	-0.4738* (-1.98)	1.8373*** (20.27)		
$LN(GDP_{US})$	5.9694*** (11.25)	4.5845*** (8.86)		4.5632*** (40.46)	
$LN(X_{US})$					.9770*** (82.56)
R^2	0.9770	0.9604	0.9210	0.9681	0.9754

1. t-statistics in parentheses.
2. *,**,*** denotes significance at the 10%, 5% and 1% level, respectively.

Table 8: Estimation Results – Machinery (1995Q1-2008Q4 for all except Equation 6, which uses monthly data from 1995Jan – 2009Jun)

Dependent Variable: $LN(M_{China-Asia})$	Equation 4	Eq. 4 adding EU + Canada to US GDP	Equation 3	Eq. 4 as a function of only US GDP	Equation 6 (monthly data)
Constant	-23.3706*** (-3.80)	-27.8337*** (-7.53)	-3.7425 (-1.51)	-17.1086*** (-12.61)	1.0321*** (6.22)
$LN(GDP_{Asia})$	1.0847*** (3.29)	-1.3958*** (-3.03)	0.5358* (1.69)	2.7868*** (19.02)	
$LN(GDP_{China})$	0.0237 (0.08)	-0.4738* (-1.98)	1.0586*** (14.69)		
$LN(GDP_{US})$	2.4228*** (3.43)	4.5845*** (8.86)			
$LN(X_{US})$					.7512*** (39.81)
R^2	0.9019	0.9604	0.8797	0.8701	0.9021

1. t-statistics in parentheses.
2. *,**,*** denotes significance at the 10%, 5% and 1% level, respectively.

Table 9: Estimation Results – All sectors unless indicated otherwise (1995Q1-2008Q4 for all except Equation 7, which uses monthly data from 1995Jan – 2009Jun)

Dependent Variable: $\Delta(M_{China-Asia})$	Basic Equation 5	Eq. 5 minus US GDP	Eq. 5 as a function of only US GDP	Equation 7	Equation 7 (Electrical Machinery)	Equation 7 (Machinery)
Constant	-8.1960*** (-4.30)	-0.0664 (-0.04)	-7.7579*** (-4.39)	66.7526 (0.38)	21.4764 (0.52)	-1.6530 (-0.05)
Δ (GDP_{Asia})	-0.0008 (-0.23)	0.0019 (0.44)				
Δ (GDP_{China})	0.0085 (0.68)	0.0181*** (1.18)				
Δ (GDP_{US})	0.0691*** (5.51)		0.0702*** (5.83)			
$\Delta(X_{US})$				1.7641*** (11.68)	1.6315*** (12.71)	0.2686*** (9.12)
R^2	0.3963	0.0365	0.3907	0.4436	0.4860	0.3272

1. t-statistics in parentheses.
2. *,**,*** denotes significance at the 10%, 5% and 1% level, respectively.

Conclusion:

It can be concluded that trends in Chinese trade since 1995 and especially the Chinese trade response to the financial crisis support the significant existence of global value chains in Chinese production networks. These networks seem to have expanded since 1995 and appear to be very prevalent in the electrical machinery sector and less prevalent in the machinery sector. Furthermore, China appears to be importing the majority of parts and intermediate goods from Japan, South Korea and Taiwan, three of the most industrialized nations in Asia and exports a growing amount to the U.S., Canada, Germany, the Netherlands and other developed countries overseas.

Regression analysis has shown that Chinese imports from within Asia are even more dependent on economic developments in the United States than on the strength of China's own economy or the economies of its suppliers. Furthermore, the finding that the coefficient for Equation 6 is greater than one is perhaps the most important result of our regression analysis, since it suggests that for every product China exports to the U.S., it imports several intermediate inputs from other countries in the East Asia region. Whereas this result continues to hold in the electronics sector, it does not hold in the machinery sector and while we still have reason to believe that value chain production is present in the machinery sector, it becomes clear from this paper that it is primarily the electronic machinery sector that is to a large degree integrated into vertical supply networks.

Clearly, the econometric model used in this paper is a simple one and while it still yields interesting results, there is room for expansion. One could for example include dummy

variables to control for differences in distances, tariffs and other trade barriers between the countries examined. Furthermore, the model suggested in this paper to measure the influence of secondary demand on bilateral trade flows could be built into a multi-lateral gravity model of trade that would be more reflective of the global supply chains that underlie so many of today's trade interactions.

For now, however, we can conclude that China does indeed act as the assembly hub and final export base for East Asian production networks, especially in electronics, and that, as the 2008 financial crisis has shown, China and its supply partners remain vulnerable to output shocks in the U.S. and other developed countries overseas.

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