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University of Cape Town

Is Chinese Export Growth Detrimental to U.S. Welfare

Master's Dissertation

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1. INTRODUCTION

There is vast growing literature evaluating the potential economic consequences of China's unprecedented export growth over the last two decades. Speculation regarding the potential threat of Chinese export growth varies, with some predicting a significant threat to manufacturing in developed economies like the United States and Europe, while others believe low- and middle-income countries are most at risk. Rodrik (2006) and Feenstra and Wei (2007) focus on the structure and evolution of China's growing exports and find China's exports to be relatively sophisticated given China's level of development. Schott (2008) focus on the impact China's growing share of developed countries' imports will have on developed countries (like the U.S.) domestic sectors. The potential economic consequences considered range from the future of developed countries' manufacturing sectors, the welfare of the employees in these sectors and least we forget consumer welfare, where there is often a significant benefit. Studies focusing more on the export side, review the impact Chinese exports will have both on developed and developing countries' exports. For example Eichengreen, Rhee, and Tong (2007) and Hanson and Robertson (2007) address whether or not China's exports will displace other Asian countries exports, while Kiyota (2008) reviews the similarity between U.S. and Chinese exports into Japan.

The central question of this paper is whether China's unprecedented export growth is becoming detrimental to the U.S. in terms of increased export competition. Although this is a fairly controversial question in mainstream trade economics, there are in fact sound theoretical grounds for this question. This paper thus adds to the growing literature reviewing the U.S. - China economic interaction and five contributions are most noteworthy. This paper extends the literature on whether China competes with the U.S. by focusing on exports to two common regions. Therefore a much larger sample of common importing countries are considered than has previously appeared in the literature and these countries are aggregated to form the two regions. Second, this paper addresses whether the interaction between Chinese and U.S. exports varies by the level of development of the importing region. Thus a developed and developing region is used conditional on the members of these regions being significant trading partners with the U.S. and China. Third in order to gauge China's competitiveness with U.S exports three empirical methods are followed which use very detailed product level data. This data is used to identify across product and within product similarity between the U.S and China. while the estimation of the elasticity of substitution between Chinese and U.S. exports follows. Finally, the introduction of additional exporting competitors brings some contextualization on to the empirical results of the three core approaches

These additional competitors will hypothetically reveal whether China is significantly different from other developing countries or quite similar to developed countries in its interaction with U.S. exports. To my knowledge these five aspects have not been dealt with adequately in the recent literature that focuses on the Chinese - U.S. export interaction.

The findings of this paper have important policy implications in that the comparison of Chinese and U.S. exports provide useful information on how China's products compete with U.S. products and effect U.S. net welfare via terms of trade and other effects. Furthermore, given the huge Imbalance between China's and U.S.'s current accounts and a revived emphasis on the real economy; the long run significance of U.S. exports for the U.S. economy cannot be denied. Hence, in order to answer the central question relating to the impact of China's export growth on U.S. welfare, this paper measures the relative similarity of Chinese and U.S. export bundles to the selected regions in terms of composition, sophistication and relative substitutability in order to tease out whether Chinese exports are becoming relatively more competitive with U.S. exports, especially in those sectors that are significant to the U.S.

The answer to the central question of this paper is therefore essentially rooted in a comparison of trade flows *and* thus before analysing the data it is useful to draw on the predictions of available trade theory. When reviewing "traditional" international trade theory it would seem that developed countries like the United States export bundle should differ significantly from that of China's export bundle. In fact these models predict significant gains from China's rising export performance and these include improved terms of trade effects, higher factor returns in the relative exporting sectors and large gains in consumer welfare.

Of these traditional models, the *Ricardian* model suggests that countries with higher productivity will export products that differ from countries with lower productivity. However Samuelson (2004) extends the basic Ricardo Mills model and reveals that If China is exporting or growing through the production of goods that the U.S. has a comparative advantage, then U.S. terms of trade fall. Fundamentally if China is exporting similar products to the U.S., then the U.S. terms of trade will decline as does overall U.S. welfare in the *long run*. Yet If China's growth is export biased (in other words producing more of what China traditionally exports and U.S. imports), the growth will improve the U.S. terms of trade. Samuelson (2004) captures the essence of why this paper's review of the similarity and substitutability between Chinese and U.S. exports is insightful

With a similar tone, the standard *Heckscher-Ohlin* (HO) model suggests that relatively labour-abundant countries will export labour-intensive products while relatively capital-abundant countries will export capital-intensive products. Given that the United States is more capital abundant and/or more productive than China; traditional trade theory implies that the United States can be expected to export products that are different from China's products given the differences in productivity and factor endowments (given China's overwhelming labour force the HO model is explored in some detail).

However there is range of "new" trade theories as well, which emphasise other trade inducing factors. These "new" theories may give weight to the possibility of a large overlap in U.S. and Chinese exports. I will focus on two such models (although there are more), each emphasising two fundamental concepts related to the central thesis of this paper. First, Krugman's (1979-1980) *Love of Variety* trade model emphasises consumers' love of variety and the ability of large countries to supply this variety. In short this model emphasizes the key concept of *horizontal product differentiation* (across product variation) and given China's size and thus propensity to export a large variety of products, there could well be a great deal of overlap between the U.S and China. However when this overlap does occur Krugman's models predicts welfare gains for both countries via increased variety and lower prices.

Flam and Helpman (1987) introduce a second key concept, *vertical product differentiation* (within product variation), which refers to varying quality attributes of the same broadly defined product. Hence, China and the U.S. may both export televisions but the attributes of these televisions may vary to the extent that they are essentially not in competition. The key theoretical findings of both traditional *and* new trade theory are explored in further detail in Section 2.

The theoretical findings in Section 2 introduce the central hypothesis of this paper which is whether over time, China is shifting and growing exports in products that are significantly similar to U.S. exports. If this is found to be true then one may conclude that China's export growth is detrimental to U.S. welfare as predicted by Samuelson (2004) and to a lesser extent the HO model.

The empirical methodology used to test this hypothesis follows the theoretical findings in Section 3. This is in the hope to give the reader a clear insight into how the data is utilised in order to form the selected regions for the empirical analysis. The empirical tools used for the analysis of the data are introduced briefly as well in Section 3. These include testing similarity via export composition and unit values as well as estimating the elasticity of substitution between exported products based on relative prices.

This paper utilizes very detailed information about Chinese and U.S. *non agricultural* exports to their respective top trading partners, while bilateral trade between China and the U.S. is not considered. There is fair amount of overlap in China's and the U.S.'s major trading partners (other than Japan) and these common trading partners are aggregated into the two regions for computational ease, one representing the developed countries of the European Union and the other the developing countries of Asia. Additional data describing other partner (competitor) countries' exports into these regions is evaluated as well. The source and nature of the data is briefly described in Section 4.

Before reviewing the key results of the empirical analysis a simple background data analysis is performed in Section 5. This includes China's export performance in terms of market share, product market penetration, market concentration and export composition relative to that of the U.S. and other major trading partners for roughly the last one and half decades. This is followed by the main empirical results in Sections 6, 7 and 8 where first compositional similarity is measured. This includes measuring export overlap with the use of similarity indices, which is assumed to be a measure of *across product variation*. The unit value calculations follow and are assumed to reflect the heterogeneity of Chinese products relative to the U.S. (and other trading partners) not captured by the similarity index calculations. Unit values a proxy for prices are assumed to capture a degree of the *within product variation* in the data thus revealing detail regarding the relative sophistication of the exported products. Using unit values accurately for this empirical purpose can be a complex process given the problems associated with the recording of trade data. Thus an additional contribution of this paper is the identification, presentation and solution to common problems associated with unit value

The third approach in measuring China's export growth as a potential threat to U.S. exporters is the estimation of the elasticity of substitution for various HS two-digit chapters. The understanding of the theoretical argument for a valid estimation of the elasticity of substitution is imperative when interpreting the results. The theory relating to the estimation of the elasticity of substitution is therefore presented and discussed in some detail before selecting the appropriate specification and interpreting the results.

The overall results reveal China performs very well in the initial background analysis with huge gains in market share growth and product penetration (1994 - 2006). With respect to similarity like, Kiyota (2008), Schott (2008) and Zhou (2006), I find China to becoming more similar to the U.S. in export composition over time. Yet relative to other developing countries especially in Asia its performance is not stellar. The most significant finding at the aggregated level is China's significant restructuring into machinery exports an area that dominates the U.S. export basket (and comparative advantage) to both regions. However there are early signs that China is unlikely to challenge U.S. machinery exports over time as China's export growth in machinery is fuelled by intensive rather than extensive growth. In order to bring a finer resolution to this analysis focus is thus given to the machinery sector when the results of the within product variation (unit values) and substitutability analysis are presented.

The calculation of the unit values at various levels of aggregation suggests that it is very likely that China and the U.S. are in fact exporting very different products, given I find U.S. products to be consistently selling at premiums over 200%, irrespective of the destination market. There are however some weak indications that China may be closing this gap but the empiricals are not conclusive.

The findings of the similarity indices and unit values introduce the possibility that the rising across product similarity and large price difference could be the result of importers substituting U.S. for Chinese products. Additionally, based on China's low labour costs and "managed" exchange rate there is also the possibility that the respective exported products are more similar in quality than suggested by the unit value analysis. Hence, if a high degree of substitutability is found between Chinese and U.S. exports then one could conclude that China may well be a significant threat to U.S. welfare. The results however, suggest that for China and the U.S. the elasticity of substitution is either not theoretically valid so one cannot consider the respective products to be substitutes or where the concept is valid; substitutability seems significantly lower when compared with the elasticity of substitution between the U.S. and other competitors. This is especially true for machinery exports (which are of most interest) with the elasticity of substitution between the U.S. and China equalling roughly -0.85, while I find this value to be significantly higher when considering Great Britain, Japan, Brazil and India as export competitors with the U.S.

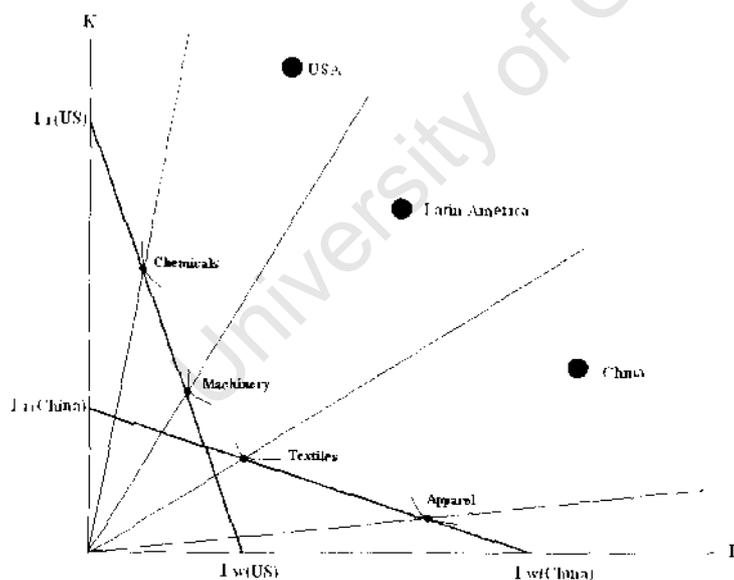
The remainder of this paper is structured as follows. Section 2 provides a brief description of the relevant theories of international trade. Section 3 stresses the intuitions and methodologies relied upon in the latter empirical analysis; Section 4 provides a short overview of data used in the analysis; Sections 5,6,7 and 8 describe the major results of the paper; Section 9 concludes this paper.

2. THE ROLE OF TRADE THEORY IN EXPLAINING CHINA AND U.S. EXPORT SIMILARITY

This central question of whether China's export growth is a significant threat to U.S. welfare is rooted in the evaluation of competitive trade flows. Trade theory by definition attempts to model and explain trade flows, while sometimes accounting for the welfare effects on consumers, factors prices and producers. It is essential that the central thesis of this paper is well grounded in theory in order to explain why there would or would not be competition between China and the USA's non agricultural exports.

When reviewing 'traditional' versus 'new' trade theory, we find a contradictory set of predictions regarding the level of overlap between China and the USA's export baskets. This is consistent with the mixed results in the literature where it is uncertain whether China is a threat to the U.S. manufacturing sector. Traditional trade models predict that U.S. exports are different from China's exports in the sense that the number of overlapping exported products should be rather small. If China and the United States export different products, differences in the quality and variety of Chinese and U.S. exports will not be an issue. On the other hand 'new' trade theories create more scope for potential overlap although one must be careful not to ignore the theoretical subtleties of these 'newer' models.

Figure 1. International specialization according to relative factor endowments



2.1. Old trade theory

The HO model draws a connection between a country's relative endowments (factors of production) and the mix of goods that a country should specialize in or produce profitably. Figure 1 above adapted from Schott (2008) represents a Lerner diagram where the two factors are labour (L) and capital (K). Dollar-value isoquants are displayed for four industries - apparel, textiles, machinery and chemicals. These industries are distinguished in terms of their capital intensity. Each isoquant also represents one dollar of output for the respective industry given the combinations of capital and labour.

Under standard assumptions, the four industries' unit-value isoquants carve out three 'cones of diversification', i.e. three sets of relative endowment vectors, selecting a unique mix of two industries in each cone (Dixit and Norman (1980) and Leamer (1984)). A country's endowments of labour and capital determine the cone in which it resides. In Figure 1, the capital-abundant states of the U.S. inhabit the most capital abundant cone, while relatively capital scarce China is in the most labour-abundant cone. The countries of Latin America are assumed to reside in the middle cone.

If any of the countries produce in an industry outside the cone in which that country resides they will receive negative profits. Countries therefore specialize in the two industries anchoring their cones of diversification which are most closely related to their endowments (Schott 2008). A key message of Figure 1 is that relatively high production costs keep industries out of industries in conflict with their comparative advantage. Workers in the U.S. are thus insulated from price changes in products caused by the emergence of China. This is because there are in different cones of diversification which are defined by their initial endowments. If China's entry into world markets drives down the price of labour-intensive apparel, the relative returns to capital and labour in any country producing these goods will also change.

Schott (2008) describes this more technically with reference to the 'price-wage' arbitrage, that is, the fact that relative wage lines are defined by the price of the goods. Thus if the price of a good falls, it takes more capital and labour to produce one dollar's worth of output, so the isocost lines tangential to the dollar-value isoquants adjust.

- The negative profits that the relatively capital-abundant countries of the European Union would earn in labour-intensive apparel and textiles, for example, can be seen by comparing the amount of capital and labour that can be bought for one dollar in the EU (via the downward sloping isocost line defined by $1/r(\text{EU})$ and $1/w(\text{EU})$) with the amount of capital and labour needed to produce one dollar's worth of output (the dollar-value isoquants)

In Figure 1 the price-wage arbitrage breaks down between the USA and China as these countries specialize in different industries. Thus there are no common price changes to affect relative returns to factors such as wages. In fact, in Figure 1 the USA enjoys a significant welfare gain when for example, the price of textiles falls as now its consumers have more income available to spend on other products and this positive result should not be overlooked.

The various sets of specialization displayed in Figure 1 provide our initial theoretical insight into the question regarding export competition between the U.S. and China. Given that the pattern of specialization or product mix is defined by countries' relative endowments, one would expect there to be little competition between China and the U.S. This is based on the premise that China is relatively unskilled and labour abundant, while the U.S. is more skilled and capital abundant. Thus fundamentally the HO model predicts China and the U.S. to have few industries in common.

However, Figure 1 does introduce the possibility of competing for export demand in other countries, although the number of industries would still be limited. In Figure 1, Latin America occupies the middle cone of diversification, with the labour-intensive portion of its product mix overlapping with China and the capital-intensive portion with the U.S.

This scenario involving an overlapping third country highlights one additional insight into the 'closeness' of competition between China and the U.S. If for example, China grew and thus accumulated more capital, it could move into higher capital intensive cones and compete with U.S. exports in machinery to Latin America, yet this will be true only if China has relatively more capital than Latin America. Therefore, the level of competition may be reviewed by looking across both Chinese and U.S. industries and asking how many products they export in common, to a third country such as the developing countries of Latin America or Asia.

Figure 1 essentially reveals how across product variation (horizontal differentiation) differs between the U.S. and China, while as Schott (2008) reveals it can be adapted to introduce within product variation (vertical differentiation) as well. One could reinterpret the industry isoquants in Figure 1 as representing vertically differentiated products in a single industry. Instead of apparel, textiles, machinery and chemicals, consider four different types of televisions: cheap black and white tube televisions, colour tube televisions, rear-projection televisions and plasma displays.

These vertically differentiated products might each be located on a separate dollar-value isoquant in Figure 1, and countries would choose to produce a different level of quality in the television market depending upon their relative endowments. This is indicative of the product variation that takes place within common product classification codes used to track countries traded products, even under the most disaggregated HS-10 digit classification system- Empirically this means that one must account for the possibility of vertical differentiation even if one finds there to be significant overlap in horizontal differentiation.

Samuelson (2004) applies Ricardo - Mill arithmetic in his discussion of the welfare predictions of Ricardian theory. This paper offers some good insights into the question of whether China's export growth is bad for the U.S. My paper only presents the key findings of his paper and does not explicitly lay out the various calculations. As any sensible trade economist would know the phrase or words "negative competition" and "threat" in the same sentence as free trade must be treated with some scepticism. Ricardian theory does predict that a select few (producers) do lose in the short run but when considering the laws of comparative advantage in a multifactor n goods and n countries case, both net national product and consumer welfare are hypothesized to rise for all countries concerned even in the long run. This effect of the winners outweighing the losers overtime is famously termed as Schumpeter's "creative capitalist destruction." In fact the Ricardo Mill analysis reveals that even if China's productivity increases dramatically in the good China exports then the both the U.S., and China still experience substantial gains in real income. This is similar to the HO model where China and the U.S. are in different cones of diversification and producers are fairly insulated from price and productivity shocks. So are the classical economist's views of free and fair trade enough consolidation for the U.S. policy makers?

Unfortunately not, as often "original" traditional trade theory is static in nature and the hypothesised surplus benefits are not necessary a given. Hence, one must consider what the welfare implications are if China's progress over time takes place in the products in which the US. previously had a comparative advantage. In this case the Ricardo-Mill's arithmetic implies with these the new Ricardian productivities that this invention abroad (in China) gives China some of the comparative advantage that had belonged to the United States. This can induce a significant loss in per capita real income in the U.S. and as long as the productivities remain the same, post China's invention, then this will be a permanent loss. In this case the U.S does not even receive a net benefit from cheaper imports but now experiences new net harmful terms of trade'.

'Samuelson 2004 goes beyond the basic arithmetic and finds this result to be fairly quantitatively robust in the latter part of his paper.

2.2. New trade theory

Thus far traditional trade theory has revealed that there is some hypothetical scope for U.S. concern regarding China's drastic export growth. However it is not clear what factors could induce China to progress into the UN cone of diversification or area of comparative advantage given China's relatively low levels of productivity and divergent endowments.

The "new school" of trade models predict the possibility in horizontal overlap in products even if there is dissimilarity in China and U.S. endowments. Rodrik (2006) finds China is exporting more sophisticated products than its GDP per capita or overwhelming labour abundance should imply. At the root of the HO model, trade is based on inter industry trade i.e. trade increases between two countries when their comparative advantages diverges. However there is a wide variety of literature that finds a large share of international trade takes place within industries between relatively similar trading partners, see for example Grubel and Lloyd (1975).

This dissonance between traditional trade theory and data has led to the development of 'new' trade theory models that emphasize consumer's love of variety and horizontal product differentiation as drivers of international trade (see, Krugman, 1980). Fundamentally, Krugman's (1980) *Increasing Returns to Scale* model articulates a connection between country size and the range of goods a country will produce

Fundamentally Krugman suggests that it is consumers' love of variety that induces countries to engage in intra-product trade. An important implication of this prediction is that the number of horizontal varieties a country produces is predicted to be a function of the resources at its disposal or the overall size of its economy. The findings of Hummels and Klenow (2005) support this theory, as they find a positive correlation between a country's size and the number of product categories that country exports. Yet one must be clear what is meant by "size of the economy" as this can be defined as either total GDP and/or the size of the labour force. This definition results in a paradoxical prediction for China's production of variety as according to World Bank (2008), in 2006 the real GDP's (2000 prices) of China and the United States were 11,411 billion and 2,092 billion U.S. dollars respectively. On the other hand, in 2006 the labour force of China and the United States were 782.5 and 156.9 million respectively. Nevertheless Krugman's (1980) *Increasing Returns to Scale* model explicitly defines economy size as equivalent to the labour force

Other than economy size, Schott (2004) and Kiyota (2008) discuss a sticky assumption related to "love of variety models", which originates from the implicit Armington (1969) assumption. Under the Armington (1969) assumption U.S. exports will be priced lower than China's exports if the United States has a higher productivity than China. In love-of-variety models, price differences between two different varieties thus do not originate in quality differences but rather productivity differences. The basic love-of-variety model assumes that a variety's price is a constant markup over productivity-adjusted marginal cost. The relative price between varieties x and y is presented in (1) below: where P_x and P_y are the prices of varieties x and y , respectively; w is the wage; and a_x and a_y are productivities. Hence, because the Armington assumption assumes that each country of origin corresponds to each variety, the model implies that the higher the countries' productivity, the lower the export price will be.

$$\frac{P_x}{P_y} = \frac{w/a_x}{w/a_y} \quad (1)$$

This prediction seems counter intuitive given the data usually finds lower export prices for China relative to the U.S. love-of-variety models thus introduce some theoretical grounds for possible overlap in Chinese and U.S. exports at the level of hot horizontal product differentiation but fall short in explaining the relationship between quality and price, which is essential in the U.S. and Chinese export interaction. Another issue is that the welfare implications in love of variety models are not negative when overlap does occur but positive via increased variety and lower prices.

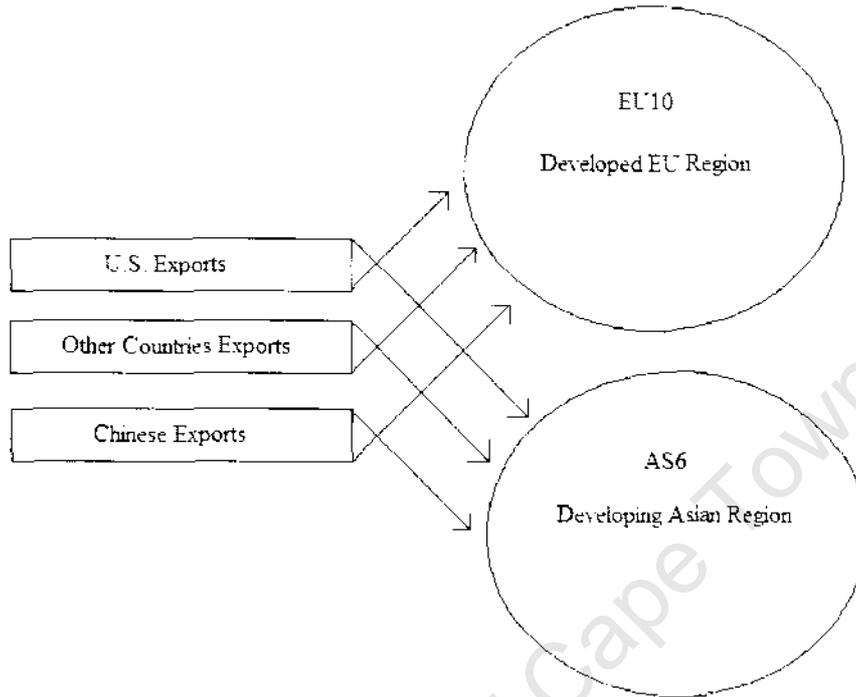
An adjacent issue to the relationship between quality and price is that horizontal product overlap is only tracked by very narrow product categories in trade datasets and some proxy for vertical differentiation (quality within the same product category) remains relevant. The quality-ladder model developed by Grossman and Helpman (1991) address the relationship between varying quality and prices (within product variation), which is not addressed in Krugman's (1979-80) models. The quality ladder model predicts that more productive countries export higher quality and higher priced products relative to less productive countries. Thus if China starts to produce and export colour tube televisions, a product the U.S. is exporting, then the U.S. climbs the "quality ladder" and begins to produce and export plasma displays. Therefore the progress in China exports where the U.S. holds a comparative advantage is possible but it is likely that over the time that that the U.S. will adjust its area of comparative advantage over time. Schott (2008) draws on this theory where he finds the U.S. manufacturing sectors to be moving out of labour intensive industries and into skill and capital intensive industries in response to cheap imports.

The various theoretical predictions for Chinese and U.S. export overlap can be summarized as follows. The level of overlap between China and the United States is small if the predictions of the HO and Ricardian models are correct. However, given the possibility of dynamic progress overtime an overlap of Chinese products with U.S. products which originally held a comparative advantage for the U.S. would result in significant welfare losses for the U.S. assuming the U.S. does not innovate further. Krugman's love-of variety models predict a significant (horizontal) overlap of exported products, assuming the quality of export products are the same, while the welfare implications are hypothesized to be positive for both the U.S. and China. The vertical product differentiation models predict that the overlap of horizontally defined export products will be large but the quality and price of exports will be higher for the U.S. relative to China and so in this case U.S. welfare will be insulated from Chinese export growth.

The above theoretical analysis uncovers the central hypothesis of this paper. This is, if China's export basket is found to be becoming significantly similar to U.S. exports (especially products which hold a comparative advantage for the U.S.) to the designated regions and over time; then the net welfare effects are a real concern for the U.S. as there will not just be short run adjustment costs but possible long run losses. Finding the best measure of similarity is the objective of this paper and three empirical measures are drawn upon; across product overlap (horizontal differentiation); within product overlap (vertical differentiation) and finally the elasticity of substitution are all applied in some detail to achieve this purpose. These three measures are described in more detail in the next Section.

3. EMPIRICAL METHODOLOGY

Figure 2. Overview of empirical method



The general empirical approach used to test the central hypothesis of this paper is illustrated in Figure 2. Detailed trade data tracking U.S , Chinese and other countries exports into an aggregated European Union Region and Asian region is analysed in this paper. Thus once this data is available one can now review whether the respective Chinese and U.S. export baskets are becoming more similar over time; whether the interaction between the two exports baskets differ by the development of the importing region and finally how China's performance relative to the U.S. compares with other countries. For the purposes of this paper only non agricultural exports are considered and this is defined more formally later. This approach now allows one to test the various predictions of trade theory discussed in Section 2, given that trade flows are compared at a very detailed level (more on the data later).

The members of the two regions in Figure 2 are derived from reviewing China's and the U.S. top 25 trading partners for the years 1994 and 2006. These 25 countries represent the market shares that the majority of both China and the U.S.'s most significant export destinations account for relative to total non agricultural Chinese and U.S exports. For the purposes of this paper however all bilateral trade between China and the U.S. is excluded. Table I presents the top trading partners by region and developmental status For more detail on the selection and the actual shares of U.S. and Chinese exports that these trading partners account for, refer to Appendix 1).

Table 1. The Top 25 Trading Partners of the U.S. and China by Region and Development

| Country | Region | Development | Country | Region | Development |
|---------------|-------------|-------------|---------------|--------|-------------|
| Japan | AS | Developed | South Africa | AF | Developing |
| Australia | Australasia | Developed | India | AS | Developing |
| Austria | EU | Developed | Indonesia | AS | Developing |
| Denmark | EU | Developed | Malaysia | AS | Developing |
| Finland | EU | Developed | Philippines | AS | Developing |
| France | EU | Developed | Rep. of Korea | AS | Developing |
| Germany | EU | Developed | Thailand | AS | Developing |
| Great Britain | EU | Developed | Brazil | LA | Developing |
| Ireland | EU | Developed | Chile | LA | Developing |
| Italy | EU | Developed | Mexico | LA | Developing |
| Netherlands | EU | Developed | | | |
| Spain | EU | Developed | | | |
| Sweden | EU | Developed | | | |
| Canada | none | Developed | | | |
| Switzerland | none | Developed | | | |

Notes: Countries sorted alphabetically by development and then region. Region affiliations are mutually exclusive. AS=Asia. LA=Latin America. AF= Africa. EU = European Union

The top export destinations were calculated independently for both the U S and China, and the inclusion of the lower ranked destination country's shares of U.S. and Chinese non agricultural exports are by no means arbitrary as they are based solely on rank This paper finds significant market share overlap between the U.S. and China and this result adds value to central question of this paper. Most notably Japan is a significant export market for both the U.S. and China, while Germany, Great Britain and Korea are all in the top 10 export destinations for both the U S and China. Kiyota (2008) reviews the interaction between Chinese and U.S. exports to Japan and I in turn perform a similar analysis for common European and Asian destination countries, which are selected from the sample of 25 above. These European and Asian countries are selected such that a significant share of U.S. and Chinese exports are accounted for.

The sample period under review in this analysis is from 1994 to 2006 and is constrained by the availability of complete disaggregated HS six-digit import data for the 25 partner countries outlined in Table 1. Data describing imports from not only China and the U.S., but other competitor countries is required as well. The additional competitors that are used in the overall analysis of this paper are a fairly random selection of the top trading partners in Table 1 and are assumed to bring a finer resolution to the potential changes in the export overlap and unit values between China and the U.S. Thus if one were to find that China has become more similar to the U.S. in its export bundle to European countries, it is essential that one compares this with the performance of other exporting countries, especially those with similar levels of development to that of China.

The quality of the data was assessed by analysing total bilateral trade between all 25 partner countries as well as imports from the U.S. and China into each partner country. The year on year growth rates in imports was then calculated and this revealed if missing or no data was present for a given year, for each partner countries' imports, from each of the 26 countries the remaining 24 partners plus the U.S. and China). This determines the size of the sample period as well as which additional competitors have complete trade data. The only significant trading partners that are omitted due to data constraints is Belgium (data is only available after 1999), while bilateral trade between Hong Kong and China is excluded based on the fact that although the share of Chinese exports Hong Kong holds is significant, the origins of these goods are ambiguous (Feenstra and Hanson 2000)

Referring to Appendix 1, I find that the Asian and European countries are significant trading partners for both China and the U.S. A selection of the developing Asian countries and developed European Union countries are therefore aggregated to form the European Union ten (EU10) region and the Asian six (AS6) region. The members of these two regions are displayed in Table 2.

Table 2. The Members of the EU10 and AS6 regions

| Region1 | Countries | Region2 | Countries |
|----------------|------------------|----------------|------------------|
| EU10 | Austria | AS6 | India |
| | Denmark | | Indonesia |
| | Finland | | Malaysia |
| | France | | Philippines |
| | Germany | | Rep. of Korea |
| | Ireland | | Thailand |
| | Italy | | |
| | Netherlands | | |
| | Spain | | |
| | Sweden | | |

Notes: Great Britain is not included in the EU10 in order to take advantage of the common monetary regime in the EU. Japan is excluded from the Asian region because of its developed status. Other Asian countries have either insignificant trade shares or incomplete data and thus are not included in the Asian region.

The relevant countries of the European Union and Asia are aggregated for computational ease and although country specific factors (such as preferential trade agreements) that affect a destination country's propensity to import Chinese or U.S. products are not accounted for; aggregating the data into regions allows for the explanation of more of the variation in both Chinese and U.S. exports. Additionally, from a U.S. policy perspective it is more revealing to compare U.S. and Chinese exports in as many markets (that are significant to the U.S.) as possible versus just one or two individual countries.

The selection of the countries in the two regions remains fairly arbitrary but they are all significant trading partners of both China and the U.S. Each member of the respective regions shares a common geographic location and level of development which makes pooling or averaging the data acceptable. In fact the exact formation of the regions is ancillary to central thesis of this paper as long as a significant number of developing Asian and developed European trading partners of both China and the U.S. are represented. This regional setup now allows for not only the analysis of the competitiveness between China and the U.S.'s exports but also whether their interaction is dependent on the importing market's level of development.

The relative Chinese and U.S. shares of total exports to the two regions seem quite similar in 1994 and 2006 while the nominal values of Chinese and U.S. exports into these regions are also similar (see below). Therefore it appears there is no obvious proximity bias in terms of the net value of trade flows, yet transport costs are likely to cause significant differences in the composition of the respective export bundles, although this bias is diminished by increasing the explained variation of each country's exports via aggregation as well as the introduction of time variation in the data. In summary the analysis of export competitiveness is determined by the data describing imports from the U.S., China and other competitor countries into these two regions.

Before implementing and interpreting the three core empirical measures of similarity, I first review the composition of Chinese and U.S. exports at the aggregated level as this reveals whether there is any scope for significant competition. For example, if China produces and exports machinery that matches the U.S. in quality and all other attributes but these machinery exports only account for 3% of Chinese total exports versus 50% for the U.S. Then in this case U.S. policy makers would be relatively less concerned if say machinery exports accounted for 40% of Chinese exports. Clearly in this second scenario the Chinese threat will be more significant. Therefore a fairly detailed background study of Chinese and the U.S. exports to the respective regions is performed.

Once this background analysis is complete, the hypothesis regarding horizontal product overlap is reviewed. The empirical method implemented is Ringer and Kreinin's (1979) export similarity index (ESI). This approach simply measures how similar two countries' exports are in terms of the composition of exported products as defined by product codes in trade data. The exact calculation is described in Section 6. The ESI takes a value between zero and one (one indicates perfect horizontal overlap) and if China's ESI with the U.S. is found to be rising significantly over time then this provides evidence in favour of China's export growth being a possible threat to U.S. welfare. This empirical technique concludes the measurement of *across product variation*.

In terms of the literature, Schott (2008) found China's imports into the U.S. to be becoming more similar with OECD countries' imports into the U.S. Yet, although China outperforms most developing countries with respect to the trends in similarity between 1972 and 2005, it bottoms the list when compared to developed countries. Zhou (2006) reviews Chinese and other developing and developed countries' (including the U.S.) exports to the world and finds rising similarity in the composition of Chinese and U.S. exports from 1980 to 2003, though similar to Schott (2008) this rising similarity is found to be much farther away from the similarity between the U.S. and other developed economies.

It must be noted that similarity indices fail to capture the significant level of heterogeneity in trade data sets and thus if one finds rising similarity across products, then these products must possess similar attributes to be regarded as competing products. The HO model revealed the possibility for countries' cones of diversification to be differentiated vertically, with countries with more capital and skilled labour producing more sophisticated products. A common method to account for this heterogeneity in trade data is the calculation and analysis of unit values which are calculated by dividing trade value by quantity. Unit values thus reveal some proxy for price and higher unit values for the same horizontally defined product are assumed to reveal differences in sophistication and other attributes. Thus for the central hypothesis of this paper an accurate measure of *within product variation* is essential.

With respect to the literature, Schott (2004) found that high wage countries use their endowment advantage to add features or quality to their varieties that are not present among the varieties emanating from low-wage countries. The problems associated with Armington assumptions in *love of variety* models are again highlighted where it is found that unit value patterns are inconsistent with new trade theory models that have producer prices varying inversely with producer productivity. This is to the extent that skill- and capital-abundant countries enjoy relatively high productivity then their varieties should sell at a discount relative to the varieties from labour-abundant countries. Schott (2004) finds they do not. In most of the recent literature measuring China's relative within product variation, Kiyota (2008/ Schott (2004), Schott (2008) and Zhou (2006); China's exports are found to be selling at a significant discount relative to developed countries like the U.S. This may suggest that China's export growth is less of a concern for U.S. policy makers than the analysis of growing horizontal product overlap suggests.

The final test of the central hypothesis regarding China's potential threat to the U.S. via increased export similarity is the estimation of the elasticity of substitution. This is to account for the possibility of importing countries substituting U.S. products for Chinese products based on the fact that Chinese products are cheaper. However there are some key theoretical considerations when performing this estimation. Firstly, the exported products under consideration have to be similar enough but "not too similar" for the estimation to be valid. Testing directly for this condition reveals a great deal on how similar products are within various *chapters* of the U.S. and Chinese export baskets.

Secondly, the path of the relative prices needs to be independent of other factors and so income, time, non price preferences and other prices all need to be controlled for in the estimations. These and other issues of measurement are discussed in detail before performing panel regressions for the various chapters of the respective countries' export baskets. The detail regarding the nature of the data used in these empirical methods follows.

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4. PRODUCT LEVEL TRADE DATA

Data describing U.S and Chinese exports to all partner countries, excluding bilateral trade between the U.S. and China, was downloaded from the World Trade Integrated Solution (WITS) database using the UN COMTRADE data source. Import data describing the U.S., Chinese and other competitor's imports into the various members of the two respective regions is assumed to mirror the exports of the U.S., China and other competitor's. A closer inspection of the data itself revealed that the import data is more complete than its export counterpart and later more suitable for the calculation of unit values. The data was downloaded at the highest possible level of disaggregation which in this case is the harmonized schedule (HS) six- digit classification system.

Schott (2008) describes the advantage of highly disaggregated product-level trade data, as providing a much sharper resolution of the sophistication of countries' export bundles than traditionally available industry-level trade data for two reasons. First, while all countries generally export in all industries (e.g. 'machinery'), they exhibit substantial heterogeneity in their product participation within industries. This referred to as across product variation. Second, product-level international trade data permit the examination of trading-partner heterogeneity within product markets via unit values (e.g. 'dollars per dozen shirts'). The HS six-digit classification does not capture all the heterogeneity of countries product participation and thus it is these unit values which are assumed to capture the additional within product variation.

The data was downloaded under the 1992 harmonized schedule six digit (HS6) classification for the period 1994 to 2006. Only non agricultural products are considered and these products are defined by the WTO (2005) definition of non agricultural products under the HS 1992 nomenclatures'. The HS six-digit (1992) product classification has been chosen for its consistency throughout the sample period and therefore makes tracking the exports of unique products through time possible. Thus if a particular HS product code appears in 1994, this product will have the same code in 2006. One disadvantage of using this classification is that the final dataset does not capture the production and export of all new products and further disaggregation of existing product lines, as reflected in revised versions of the HS classifications in 1996,2002 and 2007. Yet this cost is a minor one, given the high level of disaggregation that is captured under the HS six-digit classification

³ This is defined by all hs2 chapters above and including hs25 while a number of hs4 subheadings are deleted in this range and I do not include the hs97 data either. nor further information contact the autism

For each year of the sample under consideration, each country's export of a given HS six-digit code is associated among other variables, a total trade value, quantity and quantity unit type (once missing values are dealt with). These three variables are of most interest throughout this paper's analysis. All trade values irrespective of the exporting country and destination are measured in nominal U.S. dollars terms. Unit values calculations are therefore performed using relative prices such that any inflation bias in year on year comparisons is minimized. A more detailed discussion of the various quantity measures and their implications follows later.

Table 3 displays a summary of the trade data and classification system used throughout this paper, whereby only non agricultural products are considered. Note this paper makes use of both the harmonized six-digit and Section 23 classifications. Each unique six-digit code is referred to as a "good" or "product" while for higher levels of aggregation concordance is used with the Section 23 classification to aggregate these products into different "sections". The total number of unique six-digit products per section are displayed in the final column of Table 3 with the total number of unique products equalling 425L

One can also aggregate the HS four-digit or HS six-digit classifications in to the HS two-digit classification. The HS two-digit classification not presented in Table 3) consists of 98 chapters and these chapters reflect various common groups of HS sixdigit products. This chapter breakdown is used in the estimation of the elasticity of substitution in Section 8. For example under section 16 (machinery) exports there are two HS two-digit chapters namely chapter 84 (Nuclear reactors, boilers, machinery and computers) and chapter 85 (electrical machinery, equipment and parts). These two chapters therefore contain all the HS six-digit machinery products. Hence like the HS four and six-digit classifications, concordance is possible between the Section 23 and H5 two-digit classifications.

Before analysing the data further it is useful to know what share of Chinese and U.S. total exports are accounted for by the regional setup displayed in Table 2. The EU10 region accounts for 17% and 21% of Chinese exports in 1994 and 2006 and roughly 19% of the U.S 's exports in both 1994 and 2006. The AS6 region accounts for 6% and 12% of Chinese exports In 1994 and 2006, while 10% and 9% f or US. exports in 1994 and 2006. Consequently, when excluding bilateral trade between China and the U.S. these two regions account for well over a quarter of Chinese and the U.S total non agricultural exports in both 1994 and 2006.

Table 3. HS 1992 four and six digit products by Section 23

| Section23 Code | Section Description | Four-digit HS 1992 Examples | Six-digit HS 1992 product Examples | Total Number of HS6 products |
|----------------|----------------------------|---------------------------------------|--|------------------------------|
| C05 | Mineral products | Copper ores and concentrates | Quartz, Bentonite, Asbestos | 151 |
| C06 | Chemical products | Nitrates | Barium carbonate, Isobutyl acetate | 733 |
| C07 | Plastic products | Silicones, in primary forms | Erasers, of vulcanized rubber | 189 |
| C08 | Raw hides | Articles of leather | Leather of reptiles, Handbags | 62 |
| C09 | Wood products | Articles of wood | Wood charcoal, Parquet panels | 79 |
| C10 | Paper products | Newspapers & periodicals | Newsprint rolls or sheets, Ingrain paper | 149 |
| C11 | Textiles & clothing | Woven fabrics of flax | Dresses of wool, Men's swimwear | 784 |
| C12 | Footwear | Footwear | Hats, Ski boots | 55 |
| C13 | Non-metallic minerals | Ceramic articles | Articles of peat, Building bricks | 138 |
| C14 | Precious stones and metals | Imitation jewellery | Diamond dust or powder | 52 |
| C15 | Base metals | Ferroalloys | Powders, alloy steel | 587 |
| C16 | Machinery | refrigerators, freezers etc | Refrigerators, hand tool parts | 762 |
| C17 | Transport equipment | Locomotive parts | Railway cars, Mobile cranes | 132 |
| C18 | Specialised equipment | Optical elements, parts & accessories | Contact lenses, projectors, microscopes | 230 |
| C20 | Misc manufactured articles | Toys, puzzles, parts etc | Puzzles, golf clubs, computer games | 148 |

Notes: Number of products refers to the 1992 6-digit Harmonized System (HS) categories. Both the section and HS 1992 classification categories are consistently defined across the sample period and are therefore the same in both 1994 and 2006. Only non agricultural products as defined by the WTO are represented.

Source: UN Comtrade, author's calculations

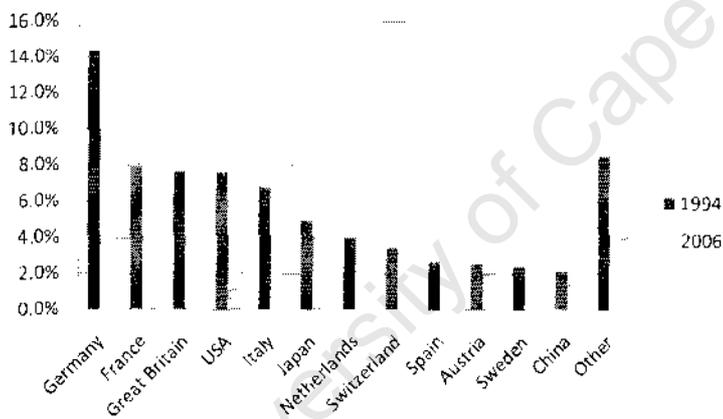
5. BACKGROUND ANALYSIS

To provide greater context for potential of Chinese and U.S. export similarity in the designated regions, I begin with a simple comparison of China's performance in the EU10 and ASS regions in terms of market share, market concentration and product penetration to that of the U.S. This perfunctory analysis reveals that China's performance over the selected time period to be most impressive.

5.1. Market shares

Figures 3 and 4 reports the U.S., Chinese and other countries market share of the EU10 and ASS regions relative to the total non agricultural import values (V) of the two regions, for the first and last years of the sample. The market share of partner / in year t is the sum of the partners non agricultural imports to the EU10 and AS6 regions as a share of all countries non agricultural imports into the EU10 and AS6 regions.

Figure 3. Competitor market shares in the EU10 Region, 1994 to 2006

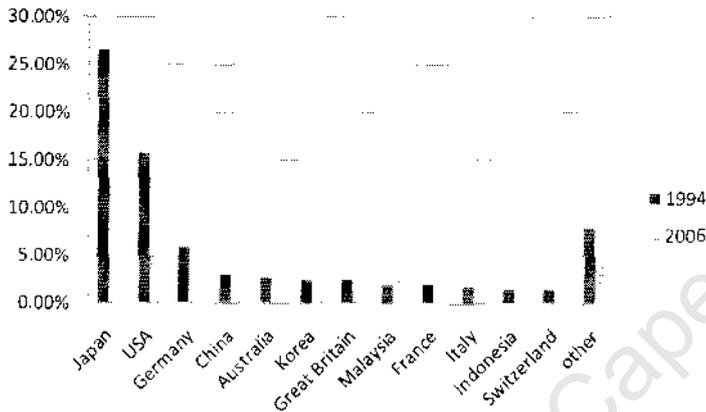


Notes: Market shares do not add to 1 as not all of the EU10 trading partners are presented. For the full list of partners and market shares refer to Appendix 2

Source: Author's calculations

The market shares displayed in Figure 3 convey several messages (for the full list of partners and market shares refer to the Appendix 2) First, the EU10 region's imports are dominated by the partner countries of the European Union as they account for over 50% of the market share, while Japan and the U.S. are the other dominant developed countries. Second, in both 1994 and 2006, the developed countries in the sample seem to hold the bulk of the market share at roughly 65% in both periods. Finally, China outperforms all other partners in the sample with its market share increasing by roughly 5% and growing by just over 200% between 1994 and 2006

Figure 4. Competitor market shares in the A56 Region, 1994 to 2006



Notes: Market shares do not add to 1. For the full list of partners and market shares refer to the Appendix 1
Source: Author's calculations

In Figure 4 China again shows impressive market share growth with its market share increasing by just over 9% and growing by 300% (for the full list of partners and market shares refer to Appendix 2). The ASS region seems to be more concentrated relative to the EU10 market in 1994 with Japan, Germany and the U.S. accounting for close to 50% of the market. Yet one should note the respective 13% and 7% decline in Japan's and U.S.'s market shares resulting in a less concentrated market in 2006. Finally unlike the EU10 region, developing countries other than China hold significant market shares in the ASS region. Examples of this are Korea, Malaysia and Indonesia. In fact the Asian competitors in the sample, excluding Japan held well over a third of this market in 2006. Table 4 below displays the partners with the top 10 greatest gain in market share for each region. China tops this list in both regions. Finally, China's change in rank in absolute market share from 1994 to 2006 has also been most impressive, especially in the EU 10. China's rank rose from 12 to 2 in the EU10 region and 4 to 2 in the A56 region.

Table 4. Largest gains in market share, 1994 to 2006

| EU10 REGION | | | | |
|-------------|-------|-------|--------|----------|
| Partner | 1994 | 2006 | Change | % change |
| China | 2.16% | 6.70% | 4.54% | 210.4% |
| Ireland | 0.89% | 1.55% | 0.66% | 74.6% |
| Korea | 0.89% | 1.38% | 0.49% | 55.7% |
| Chile | 0.17% | 0.41% | 0.24% | 139.5% |
| Netherlands | 3.99% | 4.22% | 0.23% | 5.8% |
| India | 0.47% | 0.62% | 0.14% | 30.6% |
| Mexico | 0.21% | 0.35% | 0.14% | 66.3% |
| Brazil | 0.50% | 0.59% | 0.08% | 16.8% |
| Philippines | 0.15% | 0.21% | 0.07% | 44.4% |
| Australia | 0.24% | 0.27% | 0.03% | 13.1% |
| Malaysia | 0.55% | 0.58% | 0.03% | 4.9% |

| AS6 REGION | | | | |
|-------------|-------|--------|--------|----------|
| Partner | 1994 | 2006 | Change | % change |
| China | 3.02% | 12.24% | 9.22% | 304.8% |
| Thailand | 0.74% | 1.91% | 1.17% | 157.0% |
| Malaysia | 2.07% | 3.10% | 1.03% | 49.6% |
| Indonesia | 1.60% | 2.37% | 0.78% | 48.7% |
| Philippines | 0.39% | 0.86% | 0.47% | 120.7% |
| India | 0.51% | 0.87% | 0.36% | 70.5% |
| Chile | 0.43% | 0.73% | 0.30% | 70.0% |
| Korea | 2.55% | 2.79% | 0.24% | 9.5% |
| Switzerland | 1.43% | 1.64% | 0.21% | 14.6% |
| Ireland | 0.19% | 0.37% | 0.18% | 97.7% |

Notes: Table lists EU10 and AS6 top ten absolute changes in non agricultural import market share between 1994 and 2006.

Source: Author's calculations.

5.2. Product penetration

China's rapid export growth in the AS6 and EU10 regions, both in absolute export growth and market share has been most impressive at the most aggregated level. Schott (2008) describes how this increase in market share may either be the result of an increase in the exports of incumbent products or an increase in the number of products exported. Table 5 focuses on China's performance in the latter by examining rian agricultural product penetration by section. Product penetration is described under each section as the percentage of HS-six digit line items a given country exports out of all possible HS six-digit line items.

Table 5. Chinese product penetration in the EU10 and AS6 regions

| Section Description | EU10 | | Section Description | AS6 | |
|----------------------------|------------|------------|----------------------------|------------|------------|
| | 1994 | 2006 | | 1994 | 2006 |
| Base metals | 57% | 89% | Chemical products | 60% | 88% |
| Paper products | 56% | 87% | Misc manufactured articles | 67% | 90% |
| Wood products | 66% | 92% | Base metals | 70% | 87% |
| Non-metallic minerals | 71% | 96% | Paper products | 82% | 96% |
| Precious stones and metals | 60% | 85% | Wood products | 88% | 100% |
| Transport equipment | 55% | 80% | Transport equipment | 84% | 95% |
| Plastic products | 77% | 98% | Precious stones and metals | 78% | 89% |
| Mineral products | 52% | 73% | Plastic products | 90% | 99% |
| Machinery | 77% | 97% | Machinery | 90% | 99% |
| Chemical products | 66% | 85% | Textiles & clothing | 83% | 92% |
| Textiles & clothing | 81% | 98% | Footwear | 89% | 98% |
| Specialised equipment | 94% | 98% | Raw hides | 91% | 98% |
| Misc manufactured articles | 97% | 98% | Non-metallic minerals | 81% | 87% |
| Footwear | 100% | 100% | Specialised equipment | 93% | 99% |
| Raw hides | 92% | 81% | Mineral products | 95% | 100% |
| Total Penetration | 72% | 92% | | 86% | 96% |

Notes: Table lists EU10 and AS6 top ten absolute changes in non agricultural import market share between 1994 and 2006.

Source: Author's calculations.

Each cell in Table 5 reports the percentage of products in each section exported by China to the EU10 and AS6 regions. The sections are sorted by the greatest gains in product penetration for both EU10 and AS regions. The total number of products in each section is reported in the final column of Table 3 and remains consistent throughout the sample period. Table 5 reveals that there has been a greater degree of product penetration in the EU10 region relative to the AS6 region in all sections except MISC manufacturing articles, in which there has been a significant increase of 23%. The findings of Table 5 suggest that China exceptional export performance may be driven by the production of new products over time. Product penetration by the U.S. was calculated as well but the results reveal the U.S. presence in the various varieties to remain fairly constant. Total penetration in the EU10 and AS6 regions, both in 1994 and 2006 was just over 94% for the U.S, hence China has shown significant catch up with the U.S. in this regard.

Table 6 ranks the partners with the biggest absolute gain in penetration between 1994 and 2006 and reveals China's performance in the EU10 region to be one of the best over the sample period. On the other hand, China showed significant product penetration in the AS6 region already in 1994. Yet it still ranks as one of the top 10 partner gains in penetration for this region

Table 6. Largest gains in product penetration, 1994 to 2006

| Partner | EU10 | | | Partner | AS6 | | |
|----------------|------------|------------|------------|--------------|------------|------------|------------|
| | 1994 | 2006 | Change | | 1994 | 2006 | Change |
| India | 57% | 78% | 21% | Malaysia | 52% | 81% | 29% |
| China | 72% | 92% | 20% | Mexico | 14% | 35% | 21% |
| Mexico | 37% | 54% | 17% | Spain | 47% | 66% | 20% |
| Australia | 41% | 57% | 16% | Philippines | 32% | 50% | 18% |
| Thailand | 45% | 60% | 15% | South Africa | 20% | 36% | 15% |
| Malaysia | 37% | 51% | 14% | Indonesia | 61% | 76% | 15% |
| Korea | 57% | 70% | 13% | Canada | 46% | 60% | 14% |
| Chile | 16% | 29% | 13% | Brazil | 25% | 38% | 13% |
| South Africa | 42% | 55% | 13% | Finland | 27% | 38% | 11% |
| Indonesia | 39% | 51% | 12% | China | 86% | 96% | 10% |
| Average | 44% | 60% | 15% | | 41% | 58% | 17% |

Notes: Table lists EU10 and AS6 trading partners with the top ten absolute changes in the regional non agricultural import product penetration between 1994 and 2006.

Source: Author's calculations.

Overall, China's nominal non agricultural exports grew in the M6 region from US \$ 7.5 million in 1994 to US\$ 100 million in 2006 and US\$ 21 million in 1994 to US\$ 180 million in 2006, in the EU10 region. To gauge the relative importance of product penetration in these increases, I decompose China's overall non agricultural export growth into that which is attributable to continuously produced goods (the 'Intensive' margin) and that which is due to the net adding and dropping of products (the 'extensive' margin).

Table 7. Decomposing China's regional export growth, 1994 to 2006

| Section Description | Margin | EU10 | AS6 |
|----------------------------|-------------------------|-------------|-------------|
| Base metals | Intensive Margin | 72% | 98% |
| | Extensive Margin | 28% | 2% |
| Paper products | Intensive Margin | 97% | 97% |
| | Extensive Margin | 3% | 3% |
| Wood products | Intensive Margin | 99% | 99% |
| | Extensive Margin | 1% | 1% |
| Non-metallic minerals | Intensive Margin | 100% | 100% |
| | Extensive Margin | 0% | 0% |
| Precious stones and metals | Intensive Margin | 98% | 97% |
| | Extensive Margin | 2% | 3% |
| Transport equipment | Intensive Margin | 97% | 95% |
| | Extensive Margin | 3% | 5% |
| Plastic products | Intensive Margin | 99% | 99% |
| | Extensive Margin | 1% | 1% |
| Mineral products | Intensive Margin | 100% | 99% |
| | Extensive Margin | 0% | 1% |
| Machinery | Intensive Margin | 96% | 99% |
| | Extensive Margin | 4% | 1% |
| Chemical products | Intensive Margin | 94% | 93% |
| | Extensive Margin | 6% | 7% |
| Textiles & clothing | Intensive Margin | 80% | 95% |
| | Extensive Margin | 20% | 5% |
| Specialised equipment | Intensive Margin | 99% | 100% |
| | Extensive Margin | 1% | 0% |
| Misc manufactured articles | Intensive Margin | 61% | 96% |
| | Extensive Margin | 39% | 4% |
| Footwear | Intensive Margin | 100% | 98% |
| | Extensive Margin | 0% | 2% |
| Raw hides | Intensive Margin | 100% | 100% |
| | Extensive Margin | 0% | 0% |
| Total | Extensive Margin | 97% | 99% |
| | Intensive Margin | 3% | 1% |

Notes: Table decomposes nominal Chinese export growth to the EU10 and AS6 regions over the period 1994 to 2006, according to the net increase due to continuously exported six-digit varieties within sections (the 'intensive margin') and the net growth due to the adding and dropping these varieties (the 'extensive margin'). Amounts are rounded to the nearest integer.

Source: Author's calculations

It is quite clear from Table 7 that almost all of China's export growth into the two regions is driven by the intensive margin, with the exception of mixed manufacturing articles exports to the EU10. Overall, the intensive margin accounts for over 97% of China's export growth in the EU10 and AS6 regions from 1994 to 2006. Note that the results in Table 7 may underestimate the importance of the extensive margin to the extent that the H51992 six-digit classification is used, which fails to adequately measure the development of new products subsequent to 1992.

Amiu and Freund (2008) performs a detailed analysis of China's export growth since 1992. Using more disaggregated HS-eight digit trade data, China's export growth to both the world and the US is found to be significantly concentrated in existing products (intensive margin).

It is now clear that China's surging export growth both in market share and in nominal terms over the sample period seems to be explained, not by China entering new product markets, but by producing and exporting more of the same varieties available each year. However the distribution of China's export composition of the various available varieties need not be constant over the sample period and hence may become more or less similar to that of the U.S. and other competitors. Amiti and Freund (2008) found significant distributional changes in China's exports to the U.S. with a significant reallocation of resources into machinery and electronics during the period 1992 - 2005. This paper finds similar trends at least at the aggregated level in the data describing Chinese exports to EU10 and ASS regions.

5.3. Market concentration

Before reviewing export similarity between China and the U.S. (at the horizontal level) it is useful to get some idea of how concentrated U.S. and Chinese exports to the EU10 and ASS regions are. I therefore calculate the share of total non agricultural Chinese and U.S. exports that the top 100 products (in terms of market share) account for. For the EU10 region, China's top 100 accounts for 54%, 55% and 60% in 1994, 2000 and 2006 respectively, while the U.S. top 100 accounts for 61%, 65% and 67% for the same years. For the ASS region China's top 100 accounts for 52%, 54% and 56% in 1994, 2000 and 2006 respectively, while the U.S. top 100 accounts for 63%, 70% and 68%. The fact that Chinese exports are less concentrated than U.S. exports provides a positive backdrop for the potential overlap in these two countries' export bundles.

6. ACROSS-PRODUCT SOPHISTICATION

In order for there to be any real competition between China and the U S' s export bundles, there would have to be overlap in the composition of their exports at the bare minimum. Therefore I now shift the focus onto which sections in China's export composition are dominating the growing trade flows, how the composition of China's exports to the EU10 and AS6 has changed over time and finally how China's export composition compares with that of the U.S. and other competitors

6.1. The composition of Chinese and U.S. exports by region

Table 8 displays each sections share of Chinese and U.S. exports to the EU10 for the first and last years of the sample period. In 1994 the distribution of the respective compositions seems quite divergent with the majority of China's exports concentrated in textiles, machinery, mixed manufacturing and footwear. These sections account for over 60% of Chinese exports to the EU10 region. On the other hand the U.S. composition is dominated by machinery, chemicals and transport equipment as these sections account for roughly 70% of U.S. exports.

In 2006, although China and U.S. are still quite dissimilar, it is interesting to note China's declining shares in textiles, footwear and mixed manufacturing while significantly growing its share in machinery, which has more than doubled. Thus this cursory analysis suggests there is some evidence of China becoming more similar to the U.S. in its exports composition to the EU10 especially with respect to machinery exports.

Table 8. The composition of Chinese and U.S. exports to the EU10 region

| Section description | 1994 | | 2006 | |
|----------------------------|-------|-------|-------|-------|
| | China | U.S. | China | U.S. |
| Mineral products | 1.5% | 3.0% | 0.9% | 3.4% |
| Chemical products | 4.9% | 11.6% | 3.1% | 19.7% |
| Plastic products | 3.1% | 3.8% | 2.4% | 3.3% |
| Raw hides | 8.0% | 0.2% | 2.8% | 0.2% |
| Wood products | 1.5% | 1.5% | 0.9% | 0.5% |
| Paper products | 0.6% | 2.9% | 0.5% | 1.7% |
| Textiles & clothing | 24.8% | 1.6% | 13.2% | 0.6% |
| Footwear | 8.5% | 0.2% | 3.6% | 0.0% |
| Non-metallic minerals | 1.5% | 0.7% | 1.5% | 0.8% |
| Precious stones and metals | 0.6% | 1.6% | 0.7% | 1.1% |
| Base metals | 5.1% | 2.7% | 6.6% | 3.1% |
| Machinery | 21.6% | 48.2% | 48.7% | 35.7% |
| Transport equipment | 0.7% | 10.8% | 2.2% | 17.5% |
| Specialised equipment | 4.1% | 9.7% | 4.2% | 11.8% |
| Misc manufactured articles | 13.5% | 1.4% | 8.7% | 0.8% |

Notes: Table displays the composition of nominal Chinese and U.S. exports by section to the EU10. Sections are mutually exclusive

Source: Author's calculations

The comparative Chinese and U.S. export compositions into the A56 region in Table 9 displays a similar pattern to that of their exports to W10 region. There seems to be very little similarity in 1994 with China having larger shares in mineral and chemical products relative to its exports to the EU10, while the U.S.'s export composition behaves very similarly to its EU10 counterpart. Again, China and the U.S. seem more similar in 2006, with China exporting fewer textiles and mineral products and significantly more machinery, which in this case has now almost tripled in share. So there is a definite indication of China restructuring its export composition more towards machinery, irrespective of the level of development of the importing region. Finally, an interesting question is whether China is more similar to the UW. in the developing (A56) or developed region (EU10)? These export compositions in Tables 8 and 9, although useful in gauging the relative composition of trade, do not seem adequate to answer this question, nor do they take advantage of the availability of the highly disaggregated data. I therefore turn my attention to the calculation and discussion of the similarity index

Table 9. The composition of Chinese and U.S. exports to the AS6 region

| Section description | 1994 | | 2006 | |
|----------------------------|-------|-------|-------|-------|
| | China | U.S. | China | U.S. |
| Mineral products | 15.8% | 2.9% | 5.8% | 3.1% |
| Chemical products | 13.2% | 10.1% | 8.0% | 10.5% |
| Plastic products | 1.6% | 3.5% | 2.6% | 3.9% |
| Raw hides | 1.8% | 0.6% | 0.8% | 0.2% |
| Wood products | 1.2% | 1.2% | 0.7% | 0.4% |
| Paper products | 0.6% | 3.8% | 0.8% | 2.1% |
| Textiles & clothing | 25.6% | 1.1% | 7.4% | 0.6% |
| Footwear | 2.5% | 0.1% | 1.0% | 0.0% |
| Non-metallic minerals | 1.2% | 0.7% | 2.1% | 0.8% |
| Precious stones and metals | 0.4% | 0.8% | 0.6% | 1.7% |
| Base metals | 13.1% | 5.7% | 16.0% | 5.5% |
| Machinery | 18.1% | 50.2% | 48.1% | 53.5% |
| Transport equipment | 1.0% | 12.6% | 1.6% | 9.0% |
| Specialised equipment | 1.3% | 5.5% | 2.3% | 7.9% |
| Misc manufactured articles | 2.5% | 1.3% | 2.5% | 0.9% |

Notes: Table displays the composition of nominal Chinese and U.S. exports by section to the EU10. Sections are mutually exclusive

Source: Author's calculations

6.2. Similarity indices

The measure of the similarity index or overlap in the partners export bundles I use is adapted from Finger and Kreinin's (1979) export similarity index (ESI) For a discussion on the suitability of the various similarity indexes available refer to Liu (2006)

$$ESI^{m,2}_{i,j} = \sum_i \min \{s^{m,t}_{i,j}, s^{2,t}_{i,j}\} \quad (2)$$

This index represented in (2) is the sum of any two countries' m and 2, minimum presence in each good, where presence is the share of the country's export value in non agricultural product i relative to all of their non agricultural exports to region) in year t. this bilateral measure is computed between China and other countries as well as the U.S. and other countries, under the HS six-digit (1992) classification. The index is bounded by zero and unity and equals zero if two countries have no products in common in year t (to region)) and equals unity if their exports are distributed identically across products in year t (to region)).

When reviewing the similarity indexes it is useful to consider who the dominant exporters to the EU10 and AS6 regions are. This is measured by the size of the various partners' market share in the regions, while the members of the regions themselves are considered as additional competitors as well. Given that countries do not import from themselves, there is no double counting in this approach. Figures 3 and 4 above display thus display who the dominant exporters by region are.

Table 10. Competitors with highest export similarity to China, 1994 to 2006

| EU 10 Region | | | | AS6 Region | | | |
|---------------|-------------|---------------|-------------|---------------|-------------|---------------|-------------|
| 1994 | | 2006 | | 1994 | | 2006 | |
| Thailand | 0.39 | Malaysia | 0.39 | India | 0.28 | Korea | 0.42 |
| Indonesia | 0.32 | Thailand | 0.39 | Indonesia | 0.26 | Japan | 0.42 |
| Philippines | 0.30 | Netherlands | 0.35 | Korea | 0.26 | Thailand | 0.39 |
| Korea | 0.29 | Japan | 0.33 | Thailand | 0.25 | Malaysia | 0.36 |
| Malaysia | 0.26 | Korea | 0.31 | Japan | 0.24 | Italy | 0.32 |
| India | 0.25 | Italy | 0.30 | Australia | 0.22 | USA | 0.31 |
| Italy | 0.24 | Philippines | 0.30 | Italy | 0.21 | Germany | 0.31 |
| Great Britain | 0.20 | Indonesia | 0.29 | Great Britain | 0.21 | Philippines | 0.31 |
| Germany | 0.18 | Great Britain | 0.28 | Netherlands | 0.21 | Great Britain | 0.29 |
| Japan | 0.18 | Germany | 0.27 | Germany | 0.20 | Netherlands | 0.26 |
| Denmark | 0.18 | India | 0.27 | USA | 0.20 | France | 0.26 |
| France | 0.18 | Denmark | 0.26 | Malaysia | 0.18 | Austria | 0.26 |
| Netherlands | 0.18 | USA | 0.24 | France | 0.18 | Mexico | 0.24 |
| Ireland | 0.17 | France | 0.23 | Switzerland | 0.16 | Spain | 0.23 |
| Spain | 0.16 | Sweden | 0.23 | Spain | 0.16 | Sweden | 0.22 |
| USA | 0.16 | Ireland | 0.22 | Philippines | 0.16 | India | 0.22 |
| Switzerland | 0.15 | Spain | 0.22 | Austria | 0.15 | Indonesia | 0.21 |
| Austria | 0.15 | Austria | 0.22 | Canada | 0.14 | Denmark | 0.21 |
| Mexico | 0.13 | Mexico | 0.20 | Sweden | 0.14 | Finland | 0.20 |
| Canada | 0.11 | Finland | 0.20 | Mexico | 0.13 | Canada | 0.19 |
| Brazil | 0.11 | Canada | 0.19 | South Africa | 0.13 | Ireland | 0.17 |
| Sweden | 0.11 | Switzerland | 0.19 | Denmark | 0.12 | Australia | 0.15 |
| Finland | 0.10 | Brazil | 0.13 | Brazil | 0.12 | Brazil | 0.14 |
| Australia | 0.06 | Australia | 0.09 | Finland | 0.09 | Switzerland | 0.12 |
| South Africa | 0.05 | South Africa | 0.07 | Ireland | 0.06 | South Africa | 0.08 |
| Chile | 0.02 | Chile | 0.02 | Chile | 0.02 | Chile | 0.02 |

Notes: Table displays the export similarity index (ESI) of Chinese exports with the U.S. and other partner countries into the AS6 and EU10 regions. The developed countries with the top 5 market shares are highlighted in grey.

Similarity with the U.S. is in bold

Source: Author's calculations

Table 10, reports China's ESI with the other selected countries for both the EU10 and AS6 regions, over the twelve-year interval, 1994 to 2006 the competitors other than the U.S present a nice mix of developed and developing countries and represent Asian, Latin American and OECD members. At a glance, it is clear that China's export bundle is more similar to the other Asian countries than any of the other partners. China's ESI with both Thailand and Malaysia is 0.39 in 2006 while only 0.24 with USA. Yet, China does in fact appear to be becoming more similar to the U.S. in its export composition and this overlap appears to be slightly more pronounced in the AS6 region. China's ESI in the EU10 region with the U.S. rises from 0.16 in 1994 to 0.24 in 2006, while in the AS6 region the ESI rises from 0.20 to 0.34. These actual ESI values are very similar to Schott (2008) findings in the ESI between OECD and Chinese exports to the U.S.

I have also highlighted some of the other developed countries which hold significant market shares in the respective regions as displayed in Figures 3 and 4. Interestingly, China seems to display similar advances in similarity with these countries as it does with the U.S. For example Germany and Great Britain display almost the exact same change in their ESI with China as the U.S does. Again, it seems as though China export similarity with developed countries has risen relatively more in the developing AS6 region. However and most importantly Table 10 reveals that other than Japan, China is still most similar to the developing countries of Asia, although there appears to be a definite trend of rising similarity with the U.S. and other developed countries.

In order to get a better sense of how significant China's rising export similarity to the U.S in the various regions is, Table 11 reports the twenty partner countries whose export bundle most resembles the U.S. bundle

Table 11. Top 20 Competitors with highest export similarity to the U.S., 1994 to 2006

| EU 10 Region | | | | AS 6 Region | | | |
|---------------|------|---------------|-------------|---------------|-------------|---------------|-------------|
| 1994 | | 2006 | | 1994 | | 2006 | |
| Great Britain | 0.50 | Canada | 0.48 | Netherlands | 0.47 | Germany | 0.49 |
| Japan | 0.43 | Great Britain | 0.45 | Japan | 0.43 | Japan | 0.47 |
| Germany | 0.41 | France | 0.43 | Great Britain | 0.42 | Great Britain | 0.44 |
| France | 0.39 | Germany | 0.40 | France | 0.41 | France | 0.42 |
| Netherlands | 0.37 | Netherlands | 0.40 | Germany | 0.41 | Ireland | 0.41 |
| Ireland | 0.37 | Japan | 0.39 | Italy | 0.29 | Netherlands | 0.40 |
| Canada | 0.36 | Switzerland | 0.37 | Sweden | 0.27 | Korea | 0.36 |
| Switzerland | 0.32 | Sweden | 0.33 | Ireland | 0.27 | Italy | 0.32 |
| Italy | 0.30 | Ireland | 0.31 | Thailand | 0.26 | Austria | 0.32 |
| Denmark | 0.29 | Italy | 0.31 | Spain | 0.26 | Thailand | 0.31 |
| Sweden | 0.29 | Austria | 0.30 | Denmark | 0.26 | China | 0.31 |
| Austria | 0.27 | Denmark | 0.29 | Korea | 0.25 | Philippines | 0.31 |
| Korea | 0.25 | Mexico | 0.26 | Switzerland | 0.25 | Canada | 0.31 |
| Spain | 0.25 | Spain | 0.26 | Philippines | 0.25 | Malaysia | 0.31 |
| Malaysia | 0.24 | Korea | 0.25 | Canada | 0.23 | Denmark | 0.27 |
| Finland | 0.24 | China | 0.24 | Austria | 0.22 | Sweden | 0.23 |
| Thailand | 0.21 | Malaysia | 0.23 | Malaysia | 0.20 | Spain | 0.22 |
| Philippines | 0.20 | Thailand | 0.23 | China | 0.20 | Mexico | 0.22 |
| Mexico | 0.19 | Finland | 0.20 | Finland | 0.19 | Finland | 0.21 |
| Australia | 0.17 | Philippines | 0.19 | Australia | 0.17 | Switzerland | 0.15 |

Notes: Table displays the export similarity index (ESI) of U.S. exports with the top twenty partner countries most similar to the U.S., into the AS6 and EU10 regions. Similarity with the China is in bold

Source: Author's calculations

The following observations are most noteworthy. First, unsurprisingly Table 11 reveals that U.S. exports are more similar to the developed countries in both regions. Germany and Great Britain's ESI with the U.S. are well over 0.4 in both regions. Second, these results seem to confirm the early observation that China's export bundle has become more similar to the U.S. in the both regions. China's rank increases from 21st to 16th (an ESI of 0.24) in the EU10 region and from 18th to 11th (an ESI of 0.31) in the AS6 region. Nevertheless it is important to note that although China has done well in this regard it does not do better than some of the other developing Asian countries like Malaysia and Korea who both have an ESI value of 0.23 in EU10 region and 0.31 and 0.36 in the AS6 regions respectively.

If China has indeed become relatively more competitive with the U.S. in both regions, it would be interesting to compare how similar China's own export bundles are into the EU10 and AS6 regions. If these two bundles prove to be very dissimilar, then this may suggest that the level of the importing country's development plays a significant role in the interaction between Chinese and U.S. exports. This procedure is repeated for the USA and the results are displayed in Table 12

Table 12. China and the U.S.'s own export similarity between regional exports, 1994 to 2006

| 1994 | | 2006 | |
|-------|------|-------|------|
| China | 0.26 | China | 0.47 |
| USA | 0.48 | USA | 0.48 |

Notes: Table displays the export similarity indexes (ESI) of the U.S. and China's own regional exports.

Source: Author's calculations

Table 12 reveals that if anything China's respective export bundles to the EU10 and ASE regions have become more similar, while similarity in the U.S. bundles have remained relatively the same. If one reviews the export compositions over the sample period in Tables 8 and 9, these results seem to concur with those findings. One plausible reason for convergence in similarity is that China exported significantly more in terms of volume and value to both regions in 2006. There is therefore likely to be more overlap in the respective regional compositions. Finally, Table 12 gives further evidence of China's significant export restructuring over the sample period as China's export bundle converges (in terms of horizontal export product overlap) in both the developed and developing regions.

6.3. What the results imply for the central hypothesis

The results of the analysis of across product variation between China and the US. reveals that although China shows some significant positive trends in increasing horizontal product overlap with the U.S., China does not do significantly better than other developing countries, especially those in Asia. Thus for the central question of this paper it would seem that the results of this analysis can say with little certainty whether U.S. exporters are isolated or not from Chinese competition. This is because irrespective of the two regions considered, there are signs of significant growth in overlap between the US. and Chinese export baskets. But this overlap currently remains relatively low when compared to the horizontal product overlap between the U.S. and other developed countries where overlap is significantly higher as predicted by traditional trade theory. Nevertheless, the trends of China's rising similarity with the U.S. combined with China's rapid restructuring into machinery exports (to both regions) could be some cause for concern if these trends accelerated and persisted. A deeper understanding of the quality of Chinese exports relative to U.S. exports is therefore required, especially given that that exported products shared in common at the horizontal level (such as machinery exports) may possibly grow over time. This paper now turns its attention to the relative within product variation between the U.S. and China.

7. WITHIN-PRODUCT SOPHISTICATION

Thus far changes in across exported product variation between the US. and China have been measured and found to be similar to the findings of Schott (2004) and Zhou (2006) and Kiyota (2008), China's export bundle (to the European Union and developing Asian regions) is becoming more similar to that of the U.S. over time although it still remains relatively dissimilar. Although this paper makes use of fairly disaggregated data, there is still the potential for considerable heterogeneity in the attributes of the products recorded under the same HS six-digit code'. Therefore similarity indexes, although insightful, do not suffice if we are ultimately interested in whether Chinese exports resemble similar levels of quality and sophistication to that of the U.S. and this is of special interest in machinery exports where there seems to be a potential threat. This section therefore analyzes variations in within product prices as an additional measure of product similarity. The calculations of unit values are therefore required and are assumed to capture this heterogeneity partially in the form of varied quality and sophistication.

This section initially motivates why the analysis of within product price variation is a good indicator of products relative quality. Next, the various approaches for the best measurement of unit values are presented and the associated difficulties with the most accurate calculations of unit values as a proxy for relative prices are presented and dealt with. This is followed by the presentation of average relative prices, trends in the relative prices of the most significant manufacturing sections and finally actual disaggregated product prices. Finally based on these results, a conclusion is drawn on whether this analysis provides evidence for or against China's potential threat to the U.S. via increased within product similarity.

7.1. Export prices as a measure of quality

Schott (2004) using detailed product-level U.S. import data finds the relationship between unit values, exporter endowments, and exporter production techniques support the view that capital and skill abundant countries use their endowment advantage to produce vertically superior varieties; i.e., varieties that are relatively capital or skill intensive and possess added features or higher quality, thereby commanding a relatively high price. Thus similar to other literature that uses export unit values; this paper interprets dissimilarities in countries' unit values (export prices) within product categories as evidence of quality gaps."

⁵ There is still the potential for considerable heterogeneity even at the ten-digit level

However it is unlikely that the price differences observed between two given countries are solely a reflection of production costs.

Schott's (2004) findings presents an intuitive understanding of why advanced countries like the U.S. still produce and export in industries like apparel and textiles which are usually associated with developing countries. This is because the U.S utilizes its relatively capital and productive oriented endowments to shift production in these industries into an area of comparative advantage not occupied by developing countries. This shift thus occurs at the vertical level /e.g., analog versus high-definition television).

This implies that it is more descriptive to interpret the predictions of the Heckscher-Ohlin model as predicting specialization within products rather than across products. Simply put the U.S exports in industries associated with developing countries are more superior and sophisticated but relatively more expensive as well. Fundamentally, the counterfactual argument thus holds that if Chinese exports were found to be becoming more similar to the U.S. In terms of export price in industries like machinery and specialized equipment, then this would reflect a threat to the comparative advantage these industries hold for the U.S.

7.2. Unit value calculations and issues of measurement

Relative unit values are assumed to be a proxy for relative prices. Thus ultimately if the relative prices for two countries are averaged over all products or by sector, then one could determine whether one country's products are selling at a higher or lower price on average (as long as the bundles include the same HS six-digit products). This is the ultimate goal of Vats section and caution must be taken in the use and calculation of unit values as a measure or within product variation.

$$UV_{ji} = \frac{V_{ji}}{Q_{ji}} \quad (3)$$

On a very basic level the unit value of product ; for country) is calculated by dividing the cost in freight import value (V)by import quantity (Q) Some examples of the quantity units employed to classify products are, dozens of shirts in apparel, square meters of carpet in textiles and kilograms of machinery products'

' Later I review which units of measurement are most dominant in the data and fine kilograms and Items 10 all but the only significant units of measurement. The distribution of the quantity units Is crucial should one want to compare multiple countries' unit values

7.2.1. Issues of measurement

There are several of the factors which inhibit the accuracy of unit value calculations that are close to being out of the researcher's hands. These include data recording errors, missing quantity information, tariffs and finally transport costs. Transport costs are slightly problematic. In this paper's calculations given the constraints that were faced in obtaining the data, which resulted in cost in freight (c.i.f.) trade values being used for empirical analysis. According to Hummers and Skiba (2004) c.i.f. trade values are known to increase with transportation. Despite this short coming of the data it is useful to bear in mind **that** each of the two regions are both relatively close and distant to China and the U.S.⁸

There is also a variety of common complexities associated with unit value calculations, for which the researcher does have some control. These complexities mostly involve how the quantity units of HS six-digit products are recoded and distributed over time. Hence, the empirical process followed by this paper to eventually compare and interpret relative unit values between China and the US (with some confidence) is presented in more detail than one would normally encounter in the literature. **This** is in the hope that this will prove useful to future research when similar complexities arise. Bear in mind that in order to track and compare trends in relative U.S. and Chinese average unit values (average prices), one must obtain a consistent basket of products, common over time to both China and the U.S. Once this has been achieved one can measure whether on average U.S. products are selling at a premium or discount relative to a competing country for various levels of aggregation.

(a) Dealing with missing quantity data

Before considering the calculation of unit values one must ascertain whether there is a significant amount of quantity data present. A useful approach is to calculate the share of total rian agricultural trade that is represented by products with missing quantity information. Table 13 displays this information for Chinese and U.S. exports into the two selected regions. Table 13 suggests that there should be adequate quantity data for the unit value calculations with the share of trade that missing quantity data accounts for being consistently under 8% for both the US and China in both regions. However one should be weary of U.S. exports to the EU 10 in 2000 where 13% of this total export value was accounted for by missing quantity data.

There is however a significant benchmark in buying c if trade values as Richardson (1972) recommends the use of cost in freight import values in order to estimate "firmer" import demand functions, which I require for my latter analysis of the cross elasticity of supply between Cluny and the us.

" I perform a similar analysis for the other partner countries and this reveals, which countries may be used as additional competitors

Table 13. Share of trade accounted for by missing quantity information

| | | EU10 | | | | | | | | | | | | |
|--------------|--|------|------|------|------|------|------|------|------|------|------|------|------|------|
| | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
| USA | | 4% | 2% | 2% | 3% | 3% | 3% | 13% | 8% | 6% | 7% | 6% | 6% | 7% |
| China | | 3% | 3% | 3% | 3% | 4% | 3% | 7% | 6% | 6% | 7% | 5% | 5% | 6% |
| | | AS6 | | | | | | | | | | | | |
| USA | | 6% | 5% | 5% | 1% | 2% | 2% | 2% | 6% | 7% | 6% | 8% | 3% | 7% |
| China | | 8% | 6% | 4% | 1% | 1% | 1% | 1% | 6% | 5% | 6% | 7% | 2% | 6% |

Notes: Table displays the shares of U.S. and Chinese total non agricultural exports into the EU10 and AS6 regions accounted for by missing quantity data.

Source: Author's calculations

(b) Dealing with changes in units of measurement

Given there is sufficient quantity data present, the next issue is to review how the quantity variables for each HS-six digit product are recorded (and behave over time in **terms** of their units of measurement). It is the behaviour of these units of measurement that proves most disruptive in achieving accurate relative unit value calculations. This is because in order to compare Chinese prices with U.S. prices; one must make sure "apples are compared with apples". Ironically, whether one really is comparing "apples with apples" is at the centre of this empirical investigation. Table 14 presents three common problems when using relative unit values as a measure of relative prices for a "common" product. These three issues are a direct result from the nature of how quantity units are measured in trade data sets.

First, a particular HS six-digit product code may appear with different quantity units for a given partner and year. This is displayed in the first two rows of Table 14. This will result in very different unit values for each of the two common H5-six digit codes. The problem is now which unit value to select when comparing two countries relative prices? Second, when comparing unit values between two countries any HS six-digit product code may be measured in different quantity units in the respective countries for a given year. Thus trade value per kilogram in China cannot be compared with trade value per item in the U.S., even though the product is classified under the same HS six-digit code. This is displayed in the last two rows of Table 14. Finally, a particular HS six-digit product code may be measured in different quantity units in different years for a given partner. This creates a problem in accurate relative unit values (prices) over time. For example if the EU changes the method in which the units of Chinese TV imports are measured from items in 2000 to kilograms in 2001, while US TV imports are still measured in items in 2001, then the relative price of EU TV imports from the US and China cannot be calculated in 2001. Table 14 displays an example of this final issue in the middle two rows.

Table 14. Common problems with quantity data

| Partner | Year | HS6 | qty_unit | Trade value | Quantity |
|---------|------|--------|----------|-------------|----------|
| China | 1994 | 890310 | Item | 143.966 | 49 |
| China | 1994 | 890310 | Kg | 8653.958 | 2391883 |
| China | 2000 | 900220 | Item | 11.284 | 181 |
| China | 2001 | 900220 | Kg | 326.543 | 55225 |
| USA | 1995 | 890310 | Item | 18.28 | 2 |
| China | 1995 | 890310 | Kg | 10674.85 | 2656564 |

Notes: Table displays the three most common problems resulting from the quantity unit data when comparing unit values between countries

Source: Author's calculations

A number of remedies for these issues have been suggested in the literature. But before reviewing these, one must first determine how rife these issues are in the data. Table 15 below displays the share of total non agricultural exports from the U.S. and China into the regions that HS six-digit product codes with multiple quantity units account for (Refer to the first two rows of Table 14 for an example).

Table 15. Shares of trade accounted for by duplicate HS codes with varying quantity unit information

| | EU10 | | | | | | | | | | | | |
|-------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
| USA | 0% | 0% | 0% | 0% | 18% | 19% | 28% | 32% | 33% | 31% | 29% | 0% | 0% |
| China | 0% | 0% | 0% | 0% | 42% | 42% | 54% | 54% | 57% | 57% | 60% | 0% | 0% |
| | AS6 | | | | | | | | | | | | |
| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
| USA | 55% | 55% | 54% | 36% | 35% | 41% | 44% | 37% | 6% | 6% | 0% | 0% | 0% |
| China | 39% | 35% | 35% | 23% | 23% | 41% | 46% | 44% | 17% | 15% | 0% | 0% | 0% |

Notes: Table displays the shares of total U.S. and Chinese non agricultural exports into the EU10 and AS6 regions accounted for by common HS six-digit products with multiple quantity unit data.

Source: Author's calculations

Table 15 reveals how serious this particular issue is in the data and one of the potential sources could be that some of the members of each region record the quantities of the same imported product differently. Hence when collapsing the data into the respective regions, unique HS six-digit codes appear with multiple entries for a given year and partner. I refer to these products as duplicates. It is also interesting to note that this problem is completely absent in some years and dominant in others. Although this paints a bleak picture for the researcher, it is encouraging to note that the distribution within the respective regions of the duplicates seem similar for both China and the U.S.⁴ This suggests that changes in the classification of traded products were applied equally across different countries. This substantially eases the construction of relative price indices, as will be shown later.

"This means that if China recorded a product in both kilograms and items in year t, the US does the same. In fact when doing a similar calculation for the other partner countries, they all displayed very similar distributions and so there is some evidence of data being recorded differently for specific years consistently.

Table 16. Shares of trade that various quantity units account for

| Year | CHINA | | | | USA | | | |
|------|-------|------|------|-----|------|-----|------|-----|
| | EU10 | | AS6 | | EU10 | | AS6 | |
| | Item | Kg | Item | Kg | Item | Kg | Item | Kg |
| 1994 | 0% | 100% | 8% | 89% | 0% | 99% | 21% | 77% |
| 1995 | 0% | 100% | 7% | 91% | 0% | 99% | 21% | 77% |
| 1996 | 0% | 100% | 8% | 84% | 0% | 99% | 17% | 82% |
| 1997 | 0% | 100% | 7% | 85% | 0% | 99% | 11% | 87% |
| 1998 | 4% | 95% | 9% | 90% | 2% | 96% | 10% | 89% |
| 1999 | 4% | 95% | 10% | 88% | 2% | 97% | 10% | 89% |
| 2000 | 42% | 55% | 13% | 84% | 23% | 76% | 13% | 86% |
| 2001 | 41% | 55% | 32% | 65% | 25% | 74% | 32% | 67% |
| 2002 | 44% | 53% | 36% | 61% | 26% | 73% | 32% | 68% |
| 2003 | 45% | 52% | 35% | 63% | 25% | 74% | 29% | 70% |
| 2004 | 48% | 49% | 31% | 67% | 24% | 75% | 28% | 71% |
| 2005 | 56% | 40% | 35% | 64% | 29% | 70% | 32% | 67% |
| 2006 | 55% | 41% | 32% | 67% | 29% | 70% | 32% | 67% |

Notes: Table displays the shares of non agricultural exports excluding missing quantity data into the EU10 and AS6 regions that the quantity units of items and kilograms account for. These two quantity unit measurements dominate the data and thus the other measurements are not presented here.

Source: Author's calculations

Table 16 displays the shares of Chinese and U.S. non agricultural exports into the two regions accounted for by the most dominate quantity unit measurement types. The calculations of these shares are for only where quantity data is available and the trade totals from which the shares are calculated include all quantity unit types. Although there are roughly nine different units of measurement it is clear that kilograms and Items, as units of measurement, account for well over 90% of Chinese and U.S non agricultural exports to each region. It is encouraging that only two unit types dominate the data, although it is clear from Table 16 that there are some systematic anomalies in the data

This most obvious of these anomalies is in trade flows to the 61110 region where post 1999 both the US and Chinese exports are increasingly measured in terms of *items* rather than *kilograms* while before 1999 almost all goods were measured in kilograms. In short, based on the evidence of Tables 15 and 16 one can conclude that not only are all three issues highlighted in Table 14 an issue, but they are quite rife in the data as well.

Turning to the literature, various suggestions have been put forth to deal with some of these issues. Liu (2006) for example, simply drops those products, which have multiply quantity unit entries in a given year. Clearly in my case, given the large shares of trade that the duplicate products account for, dropping these products is not a feasible solution. Schott (2008) suggests that if one finds products to be recorded consistently with more than one quantity unit measurement in each year, one can then calculate a weighted average in order to get a set of unique products and unit values in each year.

I draw upon Schott's strategy in my later calculations but one must be cautioned in applying this method when comparing two countries' average unit values in levels over time. For example, if in just one year either of the two countries records a specific product in only kilograms, while in all other years a weighted average is calculated over items and kilograms for that product, then these baskets' are essentially not the same and fundamentally the simple or weighted averages of these baskets cannot be compared in levels over time.

One final and fairly straight forward approach is to simply treat common HS six digit product codes, measured in different units as different products, but again the consistency in which these different units are recorded is important for comparability over time. Table 16 suggests that this would be a risky approach, especially for the calculation of average price levels using all the available data. This is because of the drastic distributional changes in the way the quantity information is recorded in the EU10 and to a lesser extent the AS6 regions. However this approach becomes useful in both the calculation of price indices and regression analysis in Section B.

7.2.2. Constructing relative and level prices indicators

The objective is to analyse the level and change in the price of U.S. exports relative to Chinese exports to the EU and Asia. The section does so by first addressing the various concerns relating to the construction of relative price indicators and this is followed by the results. This is in order to address the issues of measurement discussed above. Three indicators are analysed. First, the average U.S. premium relative to other countries, over all products is presented. Second the trends in the U.S. premium (or discount) relative to China for specific manufacturing section exports are presented. Finally at the disaggregated level the U.S. top twenty exports (by trade share) in 1999 are matched with the Chinese export of these same products (defined by the respective HS six-digit code and quantity unit type) and the actual price levels of these products are compared for selected years in the sample.

(a) Aggregate U.S. premium relative to other competitors

The goal of this calculation is to compare the average unit values of as many products as possible between the U.S. and other competitor countries. The major concern when calculating an average relative price over time between two countries is that the basket of goods compared must be identical in all years. Two major concerns are evident from the earlier analysis when performing this calculation. First the same HS six-digit product is sometimes recorded with different quantity units in the same year (duplicates) and secondly identical products are recorded with different quantity units in different years. This is dealt with by constructing a disaggregated relative price variable whereby a weighted average is calculated for the natural log each HS six-digit relative price, using annual U.S export values as the weights such that one creates a variable that is independent of different quantity units and can therefore be aggregated.

A simple two step process is implemented in (4a) and (4b) to achieve this, where the final result is the simple average of all the natural logged relative unit value ratios (for each six-digit product

combination) is calculated between the U.S. and other countries, overtime and in each region. These

calculations have the advantage of incorporating as much of the available data as possible, while the problems associated with the quantity units are negated in (4a) by constructing relative price ratios at the disaggregated level. Once a common basket of relative prices for the U.S. and other countries is constructed the anti log of (4b) allows China and selected competitors aggregate prices (based on the availability of quantity data) to be compared to U.S. aggregate prices. This is on the basis of by what factor U S aggregate prices are more or less on average. I refer to this factor as the U.S. premium (discount) if U.S. products cost more (less) on average.

$$\ln\left(\frac{uv_{US,t,i}}{uv_{j,t,i}}\right) = \sum_{i=1}^k w_i \ln\left(\frac{uv_{US,t,i}}{uv_{j,t,i}}\right) \quad (4a)$$

Where

$$w_i = \frac{TV_{US,t,i}}{\sum_{i=1}^k TV_{US,t,i}}$$

$$\overline{\ln\left(\frac{uv_{US,t}}{uv_{j,t}}\right)} = \frac{\sum_{i=1}^k \ln\left(\frac{uv_{US,t,i}}{uv_{j,t,i}}\right)}{n} \quad (4b)$$

In (4a) a vector of relative prices is calculated containing the weighted average of the logged relative prices between the U. S. and each respective competitor) for the HS six-digit codes, which have multiple quantity units of measurement in each year .

Before (4a) proceeds the U.S. exported products to each region are matched with the respective) competitor's products such that there is a uniform distribution of matching product codes and quantity units in each year for all years. However this only negates the distributional changes over time of single quantity unit measurement types as displayed in Table 16. The problem associated with duplicates remains but now the duplicate entries will appear uniformly in all years for both the U.S. and competitor/.

4a deals with duplicates such that for each region, k represents the total number of duplicate entries for each HS six-digit product's / relative price and in each year t . In each year t I use the U.S. trade value of product i divided by the sum of each U.S. i 's trade value contained in each k for that specific HS six-digit code) as the weights. It should be clear that (4a) does not yield a scalar by a vector of unique HS six-digit codes each with its own natural logged relative price ratio. As long as the duplicate product codes for the U.S and respective competitors are matched such that they share a common quantity unit in each year for all years then the units will be divided out and no longer be an issue. It is this process of matching products and quantity unit combinations in each year (over all years) that avoids the problem associated with the same exported product being recorded with different quantity units in different years.

The sample is initially restricted in this approach given that post 1996 there is the introduction of new exported products for China. I thus only review the sample period 1996 to 2006 in order to fairly reflect China's export bundle over time. Now to track the trends in the logged relative price ratios, (1b) simply sums all the logged relative ratios at the new HS six-digit level (between the U.S and competitor] calculated in 4a) and divides by the number of products in each competitor's j subset, which is common to the U.S.¹² The denominator it will thus be same in all years for each individual competitor.

¹¹ If a product does not have duplicate entries for a given country and year then the weight will simply equal one

One could also calculate a weighted average but when doing so I find similar results for China as In Table 17. although the US premium is relatively higher in all years I purposefully chose the simple mean as the inclusion of additional competitors requires new weights to be calculated to' every competitor . This is because they each overlap with the US in unique ways and so the functionality of the weighting is therefore severely reduced given that the compositional changes could be severe across competitors.

Table 17 displays the average U.S. premium or discount relative to China, India, Brazil, Canada, Germany and Japan by taking the anti logs of (4b). The selection of these competitors provide some context to the U.S.-China relationship. Additional competitors are selected such that various levels of economic development are represented and their selection is constrained by the availability of quantity data. In order to capture a significant share of these competitors exports to the two regions, I review only the period (1996-2006) as this significantly increases the number of common products shared by the U.S and the selected competitors in every year. Finally one cannot directly compare the different U.S. premiums as each competitor shares a different common basket with the U.S., in the subsequent years. Nevertheless Table 17 does provide some insight into the variation of the U.S. premium relative to other exporters.

Table 17. The aggregate U.S. premium by region relative to various competitors

| | China | | India | | Brazil | | Canada | | Germany | | Japan | |
|------|-------------|-------------|-------------|-------------|-------------|-----|-------------|-------------|-------------|-------------|-------------|-------------|
| | EU10 | AS6 | EU10 | AS6 | EU10 | AS6 | EU10 | AS6 | EU10 | AS6 | EU10 | AS6 |
| 1996 | 2.25 | 2.86 | 1.94 | 1.91 | 1.46 | NA | 1.11 | 0.92 | 1.48 | 0.83 | 0.73 | 0.96 |
| | 94% | 70% | 90% | 42% | 80% | NA | 72% | 71% | 88% | 83% | 89% | 84% |
| 1997 | 2.26 | 2.87 | 2.08 | 1.93 | 1.60 | NA | 1.21 | 0.93 | 1.56 | 0.92 | 0.80 | 1.00 |
| | 93% | 75% | 89% | 52% | 82% | NA | 75% | 76% | 87% | 87% | 88% | 89% |
| 1998 | 2.45 | 3.03 | 2.05 | 1.96 | 1.60 | NA | 1.23 | 0.89 | 1.63 | 0.90 | 0.83 | 1.11 |
| | 93% | 81% | 89% | 55% | 78% | NA | 75% | 82% | 88% | 88% | 86% | 91% |
| 1999 | 2.70 | 3.49 | 2.26 | 2.12 | 1.65 | NA | 1.16 | 0.83 | 1.66 | 0.91 | 0.75 | 1.09 |
| | 92% | 85% | 88% | 55% | 77% | NA | 74% | 83% | 87% | 90% | 86% | 93% |
| 2000 | 2.75 | 3.68 | 2.20 | 2.26 | 1.60 | NA | 1.06 | 0.96 | 1.79 | 1.11 | 0.77 | 1.03 |
| | 89% | 83% | 85% | 53% | 79% | NA | 79% | 88% | 86% | 89% | 83% | 92% |
| 2001 | 2.84 | 3.54 | 2.23 | 2.32 | 1.67 | NA | 1.07 | 0.93 | 1.86 | 1.04 | 0.79 | 1.10 |
| | 90% | 81% | 87% | 50% | 81% | NA | 81% | 81% | 86% | 85% | 84% | 89% |
| 2002 | 2.98 | 3.21 | 2.28 | 2.26 | 1.80 | NA | 1.05 | 0.97 | 1.76 | 1.04 | 0.79 | 1.11 |
| | 91% | 83% | 86% | 41% | 82% | NA | 79% | 75% | 88% | 87% | 87% | 89% |
| 2003 | 3.04 | 3.30 | 2.20 | 2.14 | 1.74 | NA | 1.02 | 0.88 | 1.64 | 0.94 | 0.78 | 1.04 |
| | 90% | 82% | 86% | 41% | 82% | NA | 80% | 80% | 86% | 86% | 87% | 87% |
| 2004 | 3.08 | 3.16 | 2.16 | 2.13 | 1.75 | NA | 1.01 | 0.99 | 1.60 | 0.93 | 0.73 | 1.00 |
| | 90% | 80% | 86% | 39% | 80% | NA | 79% | 76% | 86% | 84% | 89% | 84% |
| 2005 | 2.96 | 2.86 | 2.12 | 1.97 | 1.63 | NA | 1.02 | 0.96 | 1.63 | 0.95 | 0.75 | 0.98 |
| | 92% | 84% | 83% | 35% | 79% | NA | 77% | 77% | 85% | 88% | 89% | 91% |
| 2006 | 2.80 | 3.16 | 2.06 | 1.96 | 1.57 | NA | 1.00 | 0.86 | 1.67 | 0.87 | 0.80 | 1.07 |
| | 90% | 83% | 80% | 29% | 76% | NA | 79% | 76% | 84% | 88% | 89% | 87% |

Notes: Table displays the aggregate U.S. premium over all common exported products relative to selected competitors. For each competitor each variety used in the calculation is exported in all 11 years and is common to both the U.S. and the relative competitor in all years. Each Cell displays the antilog of the averaged logged relative prices calculated in (4a) and (4b) by year for each of the selected U.S. competitors. The shares of each competitor's total non agricultural exports to each region are also displayed.

Source: Author's calculations

The results of Table 17 seem quite intuitive and although transport costs and regional member specific factors such as preferential trade agreements and tariffs may bias the results up or down, there seems to be overwhelming evidence that relative to the U.S., China's products differ considerably in terms of price. Canada, Germany and Japan's average aggregate prices are very similar to that of the U.S., with a value of one implying that the U.S. and her respective competitor's export prices do not generally differ. The findings of this paper thus complement Schott (2004) findings, whereby countries with similar endowments and GDP per capita are hypothesized to have a great deal of similarity in quality and price. Of the three developing countries, China concedes the greatest premium to the U.S., with U.S. exports being at a minimum double in price on average in the EU10 region and more than three times in the AS region. One possible explanation for the exaggerated premium in the AS region is outlined in Alchian and Allen's (1964) hypothesis that firms have an incentive to ship their highest quality goods to their furthest customers when facing per unit transport costs.

The most striking feature of Table 17 is that even relative to countries like India and Brazil, the U.S. still has a relatively large premium over Chinese products. Remember both the U.S. and the respective competitors share a common bundle in all years, recorded under the same 115 six-digit codes. Turning to the trends briefly, there seems to be limited year on year changes for China. If anything there seems to be a widening average price gap in the first half of the sample (1996-2000) while in the second half (2000 -2006) this gap seems to be still growing but at a lower rate in the EU 10 region while post 2000 it decreases slightly in the AS6 region. Table 17 also includes the shares of total Asian agricultural trade that the various competitors' common bundles account for. It is evident that over 80% of total non agricultural trade are explained by various common product bundles, with Indian exports to the AS6 region being the exception.

One must ask the question what is behind this large U.S. premium (relative to China) as revealed in Table 17? There are at least two popular theories. First, it is very possible that a difference in the sophistication and quality of products recorded under the same HS six-digit codes are driving these premiums. This argument seems plausible when reviewing other countries relative average price gap with the U.S. as given the prediction of traditional trade theories and general observation, one expects developed countries to export products of similar quality to that of the U.S. Consequently if quality differences are driving price differences, then there should be little divergence in these average export prices. This is exactly what I find in Table 17 with the U.S. seemingly identical in average export prices to Germany, Japan and Canada.

The EU10 results are most conclusive with Chinese prices containing an implicit transport cost bias, yet the U.S. still holds a considerable premium. Second, products may be similar in quality and price differences may be driven by lower input costs which seem plausible when considering China's relative wages to the U.S. This second hypothesis implies that there is scope for a high degree of substitutability between Chinese and U.S. exports based on solely on price and thus the U.S. comparative advantage may still be under threat. This is explicitly tested for in Section 8.

Aggregate U.S. premium by section

Next this paper investigates the trends in the U.S. premium relative to China in selected manufacturing oriented sections of the economy. Assuming that the hypothesis that quality differences are driving price differences is in fact true it would be interesting to review the trends in the relative logged price ratios as well as the price indices for selected manufacturing sections. Earlier in the paper it was found that China had significantly restructured its export bundle into machinery. Therefore an analysis of relative aggregate prices with the US in the machinery section is particularly insightful.

The calculation described in (5) below calculates the weighted average of the logged relative unit values for the chemicals, machinery, specialized equipment and mixed manufacturing sections.

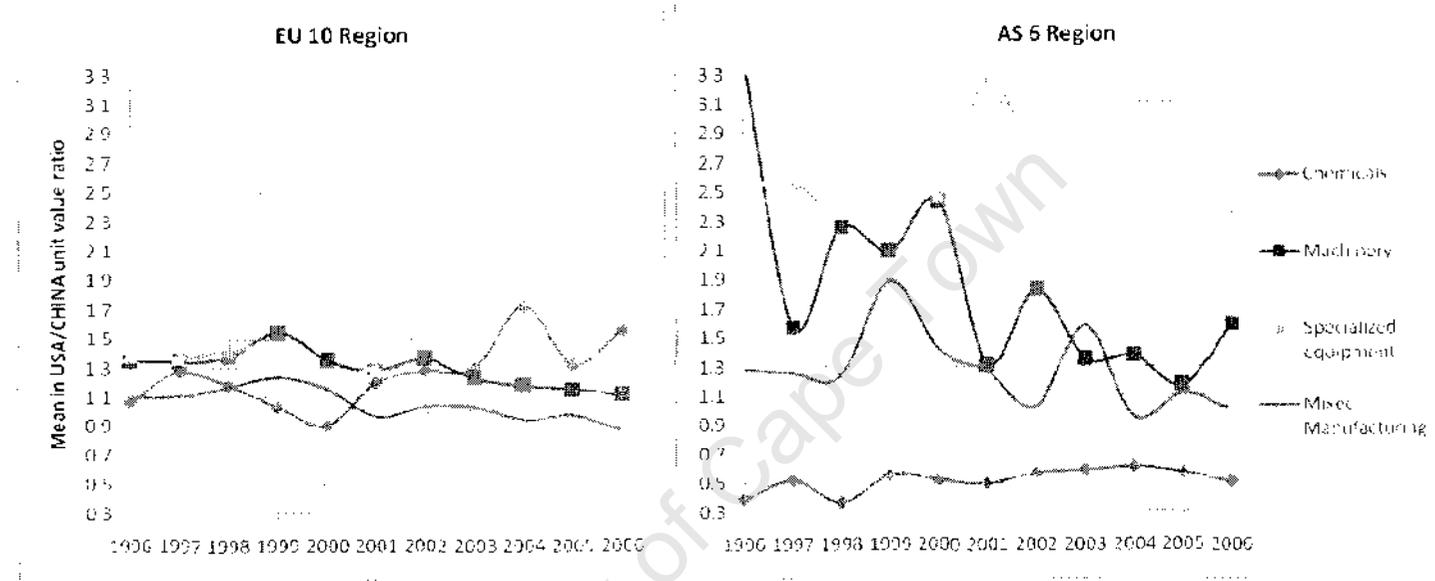
$$\overline{\ln\left(\frac{UV_{US,t}}{UV_{CH,t}}\right)} = \sum_{i=1}^n W_{US99i}^s \cdot \ln\left(\frac{UV_{US,t}}{UV_{CH,t}}\right)^s \quad (5)$$

Where

$$W_{US99i}^s = \frac{TV_{US99i}^s}{\sum_{i=1}^n TV_{US99i}^s}$$

I again only consider a consistent bundle of products over time, common to both the U.S. and China in each of the four manufacturing sections. This is explicitly calculated in (4a). Equation (5) calculates the weighted average over products i and time t , within four sections s , for the U.S. and China. The calculation of the mean prices is weighted by the 1999 U.S. trade shares that each product / accounts for relative to that particular section's total U.S. export value. Therefore I am again assuming China to be similar to the U.S. and also remove the influence of compositional changes in trade over time. Note I do not take the anti log of (5) in Figure 5 as this has no bearing on the nature of the trends and makes for easier display in Figure 5.

Figure 5. USA/China mean unit value ratios by manufacturing sections, 1996 to 2006



Notes: Figure 1 presents the mean log unit value ratios between the USA and China by selected Manufacturing sections between 1996 and 2006.
 Source: Author's calculations

Figure 5 reports the mean log unit value ratios between the USA and China by selected manufacturing sections between 1996 and 2006. When comparing the regional results five features of the data are noteworthy. First, note that the antilog of (5) is not presented in Figure 5 as was the case in Table 19. This is for simple scale and ease of presentation. Second, the fact that all ratios are greater than zero indicates that U.S. exports generally sells for more than Chinese exports. Third, except for chemicals the U.S. premiums are significantly larger (and more volatile) on average in the ASb region. For example the average premiums over time in the EU10 region for machinery, specialized equipment and mixed manufacturing are 3.7 (eA¹³), 3.2 (e[^]) and 2.9 (e⁴⁶⁰¹) respectively versus; 5.4 (e⁸¹), 13.6 (e⁷³) and 3.6 (eis¹³) in the AS6 region. The fact that these premiums are larger in the ASS region is again consistent with Alchian and Allen's (1964) hypothesis described above. the extensive volatility in the ASS regions is driven by the fact that within the four sections only a handful of products denominate the U.S. export share of the total within these sections. Fourth, in the FU10 region the U.S. premium in machinery and even more so in specialized equipment seems to fall post 1999, while the chemical premium begins to rise consistently post 1999. In the ASS region despite the volatility, there is some evidence of the U.S. premium decreasing in machinery post 2000 although it widens again significantly in 2006. Finally it is interesting to note that the premiums across the four manufacturing sections are very similar in the EU10 while there is great deal of variation across these sections in the ASS region, though this is again most likely due to the concentrated nature of the ASS region's data.

Earlier China's staggering compositional shift into machinery was displayed in Tables 8 and 9, while limited evidence was found in favour Chinese across product variation becoming more and more similar to the U.S. in Tables 10 and 11. Figure 5 therefore makes for interesting reading in that the U.S. holds a significant premium over China in machinery and other manufacturing exports to both regions. It is thus plausible that China and the U.S. are in fact exporting very different products when reviewing the within product variation a result that provides further evidence against the hypothesis that China export growth is a threat to the U.S. However it is also plausible that China is closing this price gap since 2000 as evident in the declining premiums over time, although all the manufacturing premiums in both regions are still relatively large in 2006. (Appendix 3 reviews the behaviour of the U.S. and Chinese price indices for machinery exports to the EU10 region only)

A closer inspection of the data reveals that out of 551 U.S. exported machinery products, the top 5 (in terms of trade share) account for 66% of total machinery trade to the AS6 region. Similarly the top 5 U.S. exported Specialized Equipment and Mixed Manufacturing products account for 03% of total exports to the AS6 region for both these sections

(c) Comparison of disaggregated price levels

Table 17 and Figure 5 are insightful in that they reveal that U.S. exports sell for much more relative to China on average. However it is also useful to evaluate the actual price levels of products recorded under the same HS six-digit code, especially those products that are significant in the US export basket. This is the final point of the within product variation analysis.

A simple approach is taken whereby a subset of Chinese and U.S. exported products is created to be identical in composition for the years 1994, 1999 and 2006, identical in the sense that HS six-digit product codes and quantity unit combinations are matched between the two countries for the three selected years. This is performed independently for each region. The year 1999 is chosen for some midway comparison and its selection is only constrained by the fact that in the year 2000 there is a significant amount of quantity data missing for US. exports to the EU10 region. Once this subset of products is created the U.S. top twenty products by trade share in 1999 are compared in terms of price with the Chinese equivalent of these products in all three years. Therefore the twenty products compared remain the same in each of the three years, while these products are a significant part of the U.S.'s comparative advantage. These twenty products are not necessarily the actual top twenty traded products (in terms of U.S. trade value in 1999), given that some products are excluded in the matching of products between the U.S. and China. Yet as evident from the shares these twenty products account for of total U.S. non agricultural trade in Tables 18 and 19, these products are certainly significant in the U.S. export basket to both regions.

The results appear in Tables 18 and 19 and the EU10 results make for particularly good reading given all twenty products considered have their quantity units measured in kilograms. These tables now provide information on actual relative product prices and in the EU10 case these product prices are interpreted as dollar values per kilogram. In order to bring some focus to this analysis I focus on the machinery products, a common theme throughout this paper. For example, in Table 18 HS 870899 (motor vehicle parts) are exported in 1994 at 15.69 dollars per kilogram by the U.S versus 3.02 dollars per kilogram by China. Thus the U.S. motor vehicle parts were selling for roughly five times more than Chinese exports in this category. Another example is in 2006 HS 847330 (automatic parts and accessories) the U.S. exported this product for 185 dollars per kilogram while China's export price per kilogram was 33 dollars. In short a brief scan of Table 18 reveals that for most of the products under consideration, the U.S. products sell for significantly more, with the exceptions of HS 870829 (Parts and accessories of bodies) which is priced roughly the same for both countries in the three years.

Table 18 also offers some insight into the findings of Figure 5 whereby one can review the change in the relative price of actual products from 1994 to 2006 that are particularly significant to the U.S. Twelve of the twenty products that dominate U.S. total non agricultural exports in 1999 (and even more so in 2006) in Table 18 are machinery products. Of these twelve products, China has significantly closed the price gap in seven, with the most impressive being in HS 841191 (parts of turbo-jets or turbo-propellers) where the relative price has decreased from 3.81 to 1.29 dollars. Thus Table 18 provides some weak evidence in support of China gradually narrowing the price gap in machinery exports with the U.S. Yet none of the machinery exports fall below one in terms relative prices in 2006 and U.S. prices remain well more than double for the majority of the twelve machinery exports in Table 18. An important variable, which should bring further calm to U.S. policy makers, is that relative shares of these twenty products account for the respective countries total non agricultural exports. Accordingly, although China does increase its composition in these products, these products still account for a significantly smaller share of Chinese exports to the EU10 relative to the U.S. (8% for China versus 27% for the U.S. in 2006.). Reviewing the change in the average of the relative price for the twenty products from 1994 to 2006 again reveals some improvement for China but the twenty products are still selling for more than six times per kilogram for the U.S. on average in 2006 (Appendix 4 calculates a weighted average relative price in 1994, 1999 and 2006 using the top 100 U.S. exported products to the EU10 in 1999)

Turning to the AS6 regions disaggregated export prices in Table 19, one finds similar results to the EU10 region, although one cannot average the twenty products level and relative prices given there is a mixture of kilograms and items as the quantity units. Similarly to the U.S. exports to the EU10 region the twenty products exported to the AS6 region that are significant in the U.S. export basket in 1999 contain eleven machinery products. As a point of regional comparison in 2006 exports of HS 847330 (automatic parts and accessories) were priced at roughly 134 and 42 dollars per kilogram for the U.S. and China respectively. This is similar to the price per kilogram for U.S. and Chinese exports of this product to the EU10 region (185 and 33 dollars per kilogram respectively). Thus like the results in Table 18 the majority of U.S. products (especially the machinery exports) are selling for significantly more when compared to their Chinese counterparts. However there are definite signs of China closing this price gap in some products and this is even truer for exports to the AS6 region.

Turning to the relative prices in 1994 three products are revealed to be selling at similar levels (a relative price close to one). These are HS 310530 (Diammonium hydrogenorthophosphate), HS 470329 and HS 470321 (Semi or bleached non-coniferous charcoal), which is not surprising given the relatively homogenous nature of these goods. Yet in 2006 three additional products join this list and significantly they are machinery exports. These are HS 880330 (Aircraft parts), HS 854211 and HS 854219 (both assorted monolithic integrated circuits). This provides further evidence that China is in fact upgrading its exports although this is only to be proven for a handful of products.

Additionally, although the U.S exports are significantly higher in price for the other 14 products, I find China to have made large gains in closing some of the larger price gaps in Table 19. For example U.S. exports of HS 852990 (sole production parts) cost seventeen times more than Chinese exports of this product in 1994 but this premium is reduced to a factor of only five in 2005. The findings of Table 19 thus provide some weak insight in to the trends of the U.S. premium in the machinery section in Figure 5, where this premium was found to be decreasing over time albeit with significant volatility in the AS6 region. The trade shares accounted for by the twenty U.S. exported products (selected in 1999) also echo the finding of high concentration in certain key products something I noted earlier when interpreting Figure 5. In 2005 these twenty products accounted for more than 50% of total U.S. non agricultural exports to the ASS region while this Figure is only 8% for China. This implies that even though China is upgrading and closing the price gap (gradually) in certain key products, its share of exports in these products remains small, while the price gap is still generally quite high.

Table 18. Comparing Chinese and U.S. disaggregated export prices in the EU10 region

| HS six-digit product | quantity unit | uvUSA94 | uvCHN94 | uvUSA94/ uvCHN94 | uvUSA99 | uvCHN99 | uvUSA99/ uvCHN99 | uvUSA06 | uvCHN06 | uvUSA06/ uvCHN06 |
|---|---------------|---------|---------|---------------------|---------|---------|---------------------|---------|---------|---------------------|
| 847330 | Kg | 154.20 | 33.41 | 4.62 | 125.65 | 11.44 | 10.98 | 185.01 | 33.49 | 5.52 |
| 841191 | Kg | 829.90 | 217.86 | 3.81 | 730.96 | 615.02 | 1.19 | 791.44 | 612.41 | 1.29 |
| 880330 | Kg | 309.77 | 268.67 | 1.15 | 422.02 | 202.12 | 2.09 | 214.94 | 160.62 | 1.34 |
| 300490 | Kg | 138.83 | 6.41 | 21.66 | 325.47 | 32.14 | 10.13 | 852.44 | 40.89 | 20.85 |
| 851790 | Kg | 181.67 | 27.30 | 6.65 | 308.15 | 35.78 | 8.61 | 356.52 | 81.10 | 4.40 |
| 382200 | Kg | 91.50 | 86.47 | 1.06 | 83.03 | 60.56 | 1.37 | 63.19 | 17.76 | 3.56 |
| 841199 | Kg | 261.30 | 43.52 | 6.00 | 342.51 | 8.91 | 38.43 | 172.51 | 9.62 | 17.93 |
| 300210 | Kg | 181.31 | 595.44 | 0.30 | 39.06 | 37.08 | 1.05 | 908.15 | 38.44 | 23.63 |
| 870899 | Kg | 15.69 | 3.02 | 5.20 | 13.78 | 2.51 | 5.29 | 11.58 | 3.99 | 2.90 |
| 293490 | Kg | 46.75 | 9.21 | 5.07 | 100.74 | 82.74 | 1.22 | 67.77 | 23.71 | 2.86 |
| 853690 | Kg | 66.70 | 11.83 | 5.64 | 68.98 | 12.22 | 5.65 | 67.86 | 16.99 | 3.99 |
| 392690 | Kg | 16.81 | 2.49 | 6.75 | 14.70 | 2.76 | 5.32 | 18.38 | 3.86 | 4.76 |
| 902790 | Kg | 153.15 | 27.64 | 5.54 | 90.00 | 86.50 | 1.04 | 134.10 | 152.17 | 0.88 |
| 852990 | Kg | 175.97 | 22.71 | 7.75 | 219.33 | 49.97 | 4.39 | 175.94 | 44.40 | 3.96 |
| 870840 | Kg | 16.48 | 6.97 | 2.37 | 14.83 | 9.73 | 1.52 | 15.99 | 5.01 | 3.19 |
| 870829 | Kg | 5.73 | 4.57 | 1.25 | 5.98 | 5.37 | 1.11 | 6.36 | 4.53 | 1.41 |
| 848180 | Kg | 32.77 | 3.83 | 8.57 | 31.95 | 3.84 | 8.31 | 41.30 | 6.49 | 6.36 |
| 293390 | Kg | 56.15 | 10.82 | 5.19 | 58.68 | 9.38 | 6.26 | 66.90 | 11.67 | 5.73 |
| 382390 | Kg | 3.47 | 0.19 | 17.94 | 3.59 | 0.27 | 13.34 | 3.34 | 2.17 | 1.54 |
| 847990 | Kg | 60.46 | 2.25 | 26.83 | 64.14 | 13.41 | 4.78 | 63.34 | 5.15 | 12.31 |
| Average | | 139.93 | 69.23 | 7.17 | 153.15 | 64.09 | 6.60 | 210.85 | 63.72 | 6.42 |
| Share of total non agricultural exports | | 14.83% | 3.06% | | 20.95% | 5.64% | | 26.56% | 7.85% | |

Notes: Table 18 compares disaggregated price levels between the U.S. and Chinese exports to the EU10 region, for twenty of the U.S.'s most significant exported products in 1999. The same products are compared in each of the three years. Relative price levels are shaded in grey, while the share of total non agricultural exports that these twenty products account for is presented for both the U.S and China for each of the three years in the final row.

Source: Authors calculations

Table 19. Comparing Chinese and U.S. disaggregated export prices in the AS6 region

| HS six-digit product | quantity unit | uvUSA94 | uvCHN94 | uvUSA94/ uvCHN94 | uvUSA99 | uvCHN99 | uvUSA99/ uvCHN99 | uvUSA06 | uvCHN06 | uvUSA06/ uvCHN06 |
|---|---------------|---------|---------|---------------------|---------|---------|---------------------|---------|---------|---------------------|
| 854290 | Kg | 3097.19 | 36.15 | 85.68 | 2262.49 | 385.38 | 5.87 | 1334.48 | 39.45 | 33.82 |
| 847330 | Kg | 267.64 | 87.96 | 3.04 | 160.64 | 46.92 | 3.42 | 132.52 | 42.48 | 3.12 |
| 854711 | Item | 1.90 | 0.32 | 5.90 | 1.22 | 0.29 | 4.22 | 1.64 | 1.92 | 0.85 |
| 880330 | Kg | 369.42 | 21.52 | 17.17 | 321.12 | 85.31 | 3.76 | 235.80 | 163.00 | 1.45 |
| 310530 | Kg | 0.23 | 0.24 | 0.96 | 0.21 | 0.31 | 0.68 | 0.31 | 0.31 | 1.01 |
| 852990 | Kg | 133.25 | 7.93 | 16.80 | 109.61 | 18.12 | 6.05 | 91.28 | 19.51 | 4.68 |
| 851790 | Kg | 54.49 | 30.32 | 1.80 | 225.96 | 21.23 | 10.64 | 112.80 | 29.81 | 3.78 |
| 847990 | Kg | 58.19 | 11.08 | 5.25 | 91.36 | 22.11 | 4.13 | 58.57 | 7.36 | 7.96 |
| 903180 | Item | 1064.90 | 4.48 | 237.75 | 1007.97 | 7.99 | 126.12 | 319.86 | 19.58 | 16.34 |
| 732690 | Kg | 22.61 | 1.29 | 17.49 | 6.89 | 2.14 | 3.22 | 10.83 | 2.07 | 5.23 |
| 854219 | Item | 1.84 | 0.41 | 4.47 | 0.68 | 0.37 | 1.83 | 1.19 | 0.92 | 1.30 |
| 848180 | Kg | 31.61 | 1.94 | 16.29 | 22.37 | 1.69 | 13.24 | 30.79 | 4.52 | 6.81 |
| 382390 | Kg | 2.36 | 0.49 | 4.83 | 2.49 | 0.12 | 20.51 | 3.62 | 0.57 | 6.34 |
| 847193 | Item | 302.37 | 146.33 | 2.07 | 125.89 | 55.34 | 2.27 | 122.02 | 35.01 | 3.48 |
| 903190 | Kg | 183.93 | 24.25 | 7.59 | 106.25 | 6.25 | 17.00 | 180.10 | 26.10 | 6.90 |
| 397690 | Kg | 12.66 | 3.63 | 3.48 | 14.49 | 2.92 | 4.97 | 7.99 | 2.65 | 3.02 |
| 470329 | Kg | 0.44 | 0.57 | 0.77 | 0.47 | 0.40 | 1.15 | 0.56 | 0.55 | 1.01 |
| 847199 | Item | 1170.28 | 221.82 | 5.28 | 325.85 | 51.32 | 6.35 | 95.78 | 24.84 | 3.86 |
| 470321 | Kg | 0.48 | 0.51 | 0.93 | 0.52 | 0.39 | 1.32 | 0.65 | 0.83 | 0.79 |
| 930690 | Kg | 137.90 | 5.43 | 25.38 | 164.22 | 11.00 | 14.92 | 276.25 | 10.10 | 27.35 |
| Average | | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Share of total non agricultural exports | | 35.89% | 12.17% | | 49.70% | 16.78% | | 52.55% | 14.78% | |

Notes: Table 19 compares disaggregated price levels between the U.S. and Chinese exports to the AS6 region, for twenty of the U.S.'s most significant exported products in 1999. The same products are compared in each of the three years. Relative price levels are shaded in grey, while the share of total non agricultural exports that these twenty products account for is presented for both the U.S and China for each of the three years in the final row.

Source: Authors calculations

73. What the results Imply for the central hypothesis

This section constructed various export price indicators using unit values and it was argued that price differences are very likely to reflect quality differences in exported products defined under the same HS six-digit code. Before constructing relative and level price variables for the U.S , China and other competitors, various issues of unit value measurement were presented and dealt with

The results for the three core areas of focus total aggregation, trends by manufacturing section and completely disaggregation consolidate the fact that the across product analysis does not capture heterogeneity in terms of vertically differentiated product attributes in trade data. Earlier China was found over time to be improving her across product similarity with the U.S. although China still remains at the bottom of the pile when compared with other middle income and developed countries. This suggested that China may be threatening U.S. welfare via its immense export growth over the last decade

On the whole the within product price analysis reveals a slightly contradictory set of results relative to the across product results in that China's current export basket seems quite different to that of the U.S. The predictions the quality ladder models or traditional trade theory when incorporating vertical differentiation can thus be quite descriptive of U.S. and Chinese trade flows. The aggregated average relative prices revealed U.S. exports to be selling at least double that of Chinese exports on average and this is irrespective of the development of the importing region. The aggregated results also revealed that compared to China other developing countries like India and Brazil's exports have relatively smaller average price gaps with the U.S.

The trends in the manufacturing sections average relative prices revealed a similar story with the U.S. premium being even larger in the individual sections, while the EU10 regions results revealed slightly smaller premiums and less volatility. Despite the overall conclusion of a significant difference in the two countries respective export baskets (a favourable result for the U.S), there is some weak evidence of China closing the price gap in both regions for the most significant section, machinery.

The disaggregated results gave further insight into the inability to reject the hypothesis that U.S. and Chinese exports are dissimilar as although China reduces the relative price gap in some machinery exports which are contained in the U.S. comparative advantage, the majority of the U.S. products in the top twenty that is considered are still priced at a significant premium on average, while China's share of trade in these products to both regions remains relatively small. I do however regard some of the trends in the actual product prices to be a warning at the least to those U.S. producers who export these products and further analysis of the disaggregated data is likely to be most fruitful from a strategic policy perspective. This is especially true if some sectors are regarded as more significant than others by U.S. policy makers.

However for the central question of this paper this analysis reveals most U.S. exporters are likely to be fairly insulated from China's export growth at least in the short run and assuming the price differences found in this Section mostly translate into quality differences an assumption that is relaxed in the next Section.

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8. COMPETITIVE IN DEMAND

Thus far the across product analysis revealed rising similarity in Chinese and U.S. exports to both regions over time, while the within price product analysis revealed vast difference in the quality and attributes of U.S., and Chinese exports (despite some weak evidence of China closing this gap). Thus there is slight discrepancy in the findings of these two sections. One plausible scenario for these findings, especially given China's low input costs such as cheap labour, is it may be the case that the rising similarity reflects the price difference as EU and Asian consumers substitute Chinese for US goods. If the Chinese and U.S. export bundles are highly substitutable, then price differences will lead to an erosion of the U.S. comparative advantage (export competitiveness) and result in the welfare losses discussed in Section 2. If not, then US exports will only be affected indirectly. For example price declines in conventional televisions may influence the demand of plasma displays. This chapter therefore estimates the elasticity of substitution directly and relaxes the assumption that solely based on price differences Chinese and U.S. exports are significantly different. The price elasticity of substitution assesses the ease of substituting between two products (by importers) with respect to a change in their relative price and is used to reconcile the marginally divergent findings in Sections 6 and 7

This section begins by presenting the theoretical grounds for estimating the price elasticity of substitution. Similarly to the implementation and interpretation of unit values, estimating the elasticity of substitution is not without its controversies. Thus before presenting the results of the empirical models, the requirements for the best estimate of the elasticity of substitution are discussed and potential sources of bias are dealt with as best as possible. It should be noted from the outset that we wish to estimate a model that separates the impact of price from non price preferences on the demand for exports.

Interpreting the elasticity of substitution itself can be tricky, yet its estimation allows one to determine how significant factors other than price are, in explaining the demand for either countries exports. These factors include quality, regional income effects and other prices. If these non price driven preferences are significant both practically and statistically, then we have further evidence favouring the hypothesis that Chinese and U.S exports are in fact quite dissimilar. On the other hand if the necessary theoretical conditions are not satisfied for the estimation of the elasticity of substitution, then based on theoretical grounds one may infer that the relationship between Chinese and U.S export demand cannot be teased out with respect to price differences. These theoretical requirements are tested for explicitly, something that has been overlooked in previous work in this area. Next, where the estimation for the elasticity of substitution is theoretically valid, a two-way fixed effect model is used to estimate the elasticity of substitution by the relevant HS two-digit chapters.

The elasticities for the various chapters are then ranked from most substitutability to least and what is of most interest is where the machinery chapters lie in this ranking. Finally the elasticity of substitution is estimated between the US and other competitor countries for the machinery chapters as simply ranking the chapters is implicitly biased by some chapters containing more homogenous products than others. The overall results provide further evidence against the hypothesis that Chinese export growth is detrimental to U.S. welfare. Initially it is evident that based on the test for theoretical validity most chapters do not contain U.S. products that are similar enough to their Chinese counterparts. This is particularly true for exports to the AS6 region. Where the estimation is valid, I initially find that U.S. and Chinese machinery exports to the EU10 are least substitutable (an unsurprising result), while when comparing U.S. substitutability with other competitors in the machinery chapters (both developed and developing) China stills bottoms the list. This final point of analysis thus illuminates the within product price results and confirms that Chinese and U.S. exports are dissimilar enough for the postulated erosion of U.S. welfare via China's export growth to be unlikely.

8.1. Theoretical foundation

Lerner and Stern (1970) present the theoretical foundation for estimating the elasticity of substitution. The elasticity itself can simply be defined as the percentage change in relative quantities demanded divided by the percentage change in relative prices:

$$e = \frac{d(q^1/q^2)}{q^1/q^2} \div \frac{d(p^1/p^2)}{p^1/p^2} = \frac{d \log(q^1/q^2)}{d \log(p^1/p^2)} \quad (6)$$

where q_1 and q_2 are exports from two competing supply sources to some third market (in our case the EU10 and ASS regions) and p_1 and p_2 are their respective prices. It is evident that if q_1 and q_2 are absolute complements then e will be zero. However if q_1 and q_2 are perfect substitutes, consumers will only purchase the lower priced item, in which case e will be $-\infty$ at $p_1 = p_2$ and zero elsewhere.

Lerner and Stern (1970) initially draw upon utility analysis to explain the theory behind the elasticity of substitution. Though there is some difficulty in the use and concept of community indifference maps required for this approach. Therefore the examination of conventional demand analysis seems more fruitful, especially when the application of empirical estimation is to be considered later.

Initially we have a basic export demand function for countries 1 and 2 from a common country (or region) j , defined respectively as:

$$q_1 = f(p_1, p_2, y, p_j) \text{ and } q_2 = g(p_1, p_2, y, p_j)$$

y is money income in the importing country (region) and p_j is the general price level in this country (or region) other than commodities one and two, including perhaps competing imports. Now we assume log-linear demand or constant price elasticity approximations of the simple demand equations above:

$$q_1 = ap_1^{\alpha_1} p_2^{\alpha_2} y^{\alpha_3} p_j^{\alpha_4} \quad \text{and} \quad q_2 = bp_1^{\beta_1} p_2^{\beta_2} y^{\beta_3} p_j^{\beta_4}$$

Now the α 's and β 's refer to the elasticity's of the respective variables, while 1 and 2 stand for the U.S. and China respectively. q is the regional import demand for a commodity class of the given country (U.S. or China) and p , the calculated price level of the corresponding goods. y denotes money income of the region. p_j instead of a general price level now represents an array of export prices, an approximation using the average regional export price seems appropriate.

We can then write (7) by dividing q_2 into q_1 as

$$\frac{q_1}{q_2} = \frac{a}{b} \frac{p_1^{\alpha_1 - \beta_1}}{p_2^{\alpha_2 - \beta_2}} y^{\alpha_3 - \beta_3} p_j^{\alpha_4 - \beta_4} \quad (7)$$

The elasticity of substitution may now be conveniently defined holding money income (y) and other prices (p_j) constant. However it is crucial to note that q_1/q_2 will only be functionally related to p_1/p_2 if the exponents of the price variables are equal.

This fundamental condition is

$$e = \alpha_1 - \beta_1 = \alpha_2 - \beta_2 \quad (8)$$

If equation (8) does not hold then the elasticity of substitution is not defined. Intuitively this condition imposes the condition that commodities q_1 and q_2 to be quite similar but not too similar. Leamer and Stern (1970) go further in that two additional conditions are put forth for the elasticity of substitution to be defined, namely $\sum_{j=1}^n \epsilon_{ij} = 1$, that is, when the income elasticities of each commodity are comparable and when the cross price elasticities with respect to other goods are also comparable. Nonetheless, as will be shown later these income and cross price effects can be explicitly controlled for in our regression models and we can test these additional conditions by inferring whether the income and cross price coefficients differ significantly from zero. If these conditions are not satisfied (or income and other prices are not controlled for) then the elasticity of substitution is likely to be dependent on the paths taken by the individual prices. That is to say the paths of these prices will most likely depend on other economic variables and thus we are not getting a ceteris paribus effect of relative prices on relative quantities. It is therefore best to try and control for these other economic relationships in order to make the elasticity of substitution unique".

8.2. Empirical modelling

What can be concluded from the theoretical discussion is that the elasticity of substitution can initially be thought of in the following basic specification, where y_j , p_j , $\frac{q_1}{q_2}$ and $\frac{p_1}{p_2}$ are defined above.

$$\ln \frac{q_1}{q_2} = a + b \ln \frac{p_1}{p_2} + c \ln y_j + d \ln p_j \quad (9)$$

This regression requires two assumptions to be theoretically valid. First, the algebraic sum of the cross and direct elasticities of demand for the two commodities must be equal as in (8). Second, the income and any other price elasticities of demand for the two commodities must be equal. Leamer and Stern (1970) suggest one can explicitly test these conditions by running the model in (10) and conducting various hypothesis tests.

$$\ln \frac{q_1}{q_2} = a + b_1 \ln p_1 + b_2 \ln p_2 + c \ln y_j + d \ln p_j \quad (10)$$

¹⁴Leamer and Stern (1970) additionally discuss the underlying effects of supply functions, with the example of constant inflation rates between two countries driving the estimate for the elasticity of substitution. Polak (1950) introduces supply functions for q_1 and q_2 to calculate the observed elasticity of substitution in terms of demand and supply elasticities.

If one cannot reject the hypothesis that $b_1 = \sigma_{22}$, then estimates of the elasticity of substitution are likely to be robust as condition (8) is now likely to be satisfied. One can also test whether the coefficients c and d are statistically insignificant and if this is found to be the case then one can interpret the estimate for the elasticity of substitution with more confidence. Though, according to Ginsburg and Stern (1965), the coefficients on the income and other price variables are often found to be quite small or insignificant. This paper therefore does not explicitly test whether c and d differ statistically from zero, while these variables are explicitly controlled for in the final specification.

Assuming that the conditions discussed thus far hold one must consider issues of measurement when estimating (9). The first major concern is the lack of independence between relative prices and random shocks that affect the import demand for q_1 or q_2 (Orcutt 1950). These shocks will most likely have their sources either in the supply or demand functions, which we have not controlled for. Similar to standard price elasticities, this endogeneity will result in the estimate of the elasticity of substitution to be biased towards zero.

The size of the bias will be large when the disturbances on the equation are large relative to the disturbances to the supply function. Yet there is some value gained in dividing the two respective demand equations. Leorner and Stern (1970), emphasize that disturbances to one of the demand functions are likely to have their counterparts in disturbances to the other demand function. Hence, when one divides these demand functions, the one disturbance will tend to cancel out the other and the elasticity of substitution relation may be quite stable on the demand side. On the supply side however, disturbances are unique to each of the two countries and therefore less likely to cancel out. Yet Learner and Stern (1970) suggest, because of the simultaneous interaction between demand and supply the bias may still be reduced significantly.

Although dividing one demand equation by the other reduces the influence of simultaneity bias, it has an ambiguous effect on another bias induced by measurement error. Estimating the price elasticity of demand requires price data and the only proxy for prices, under such circumstances, are unit values. One of the issues identified earlier, regarding unit value calculations is the fact there is most likely to be a degree of measurement error in the quantity data. This has dire consequences for the regression estimate, resulting in a spurious correlation between the endogenous variable, the quantity and the exogenous variable, the price calculated as the quotient of value by quantity Zhou (2006)¹⁵. This will result in the coefficient being biased towards minus one (proof follows from Zhou (2006) and can be found in Appendix 5).

"This problem, commonly referred to as ratio or division bias, is well documented in labour studies see for example Borjas (1980).

ibis result holds in the specification above where double division bias is present i.e. ratio bias both in the numerator in denominator. The severity of the bias may be mitigated or magnified depending on the relationship of the measurement errors of the two countries. Given the source of data collection is common to both the U.S. and China it may be appealing to assume both countries are likely to experience similar errors in measurement and these may divide out. However this is not satisfactory and a standard way to solve this problem is via instrumental variables. If one assumes that the measurement errors on the quantities are independent of the quantities and the equation error, one can use the previous year's calculated price ratios as valid instruments. This technique is found to be appropriate as the test for overidentification reveals the instruments (lagged prices) to be orthogonal to the equation error in (9); accordingly lagged prices are used as instruments in the final regression model.

Another important consideration with respect to measurement error is whether free on board (f.o.b.) or cost in freight (c.i.f.) trade values are used in the calculation of price proxies (unit values). Richardson (1972) presents a set of theoretical and empirical arguments for why the use of f.o.b. unit values in estimating the elasticity of substitution is inappropriate. Unit values calculated using f. o.b. trade values do not include transportation costs and tariffs. Yet these factors can be expected to have a significant effect on the demand for a particular product given these missing attributes directly affect the prices the importer must pay. Richardson (1972) thus concludes that using c.i.f. unit values reduces the problem of measurement error associated with the price proxies because c. i. f. prices are assumed to more closely approximate the price to the buyer.

This paper makes use of cot unit values in the hope that the underlying bias induced by measurement error (discussed above) is minimized further. However there will still be other sources of measurement error such as data recording errors, which may still induce bias, see Goldstein and Khan (198b). The application of instrumental variables therefore remains relevant ¹⁰.

One issue that is not explicitly addressed in this paper is the influence of tariff structures on the demand for the respective countries exports and further work is needed in this area. Despite this oversight, given the coordination in EH trade policy and the fact that the data is averaged in the final specification it is likely that the influence of tariffs on the EU10's relative demand functions will be minimised. This is not the case however for the 056 region.

Richardson (1972) suggests another remedy with respect to the data for making estimations of the elasticity of substitution more robust. This involves restricting the sample such that only relative prices between U.S and 2 are included in the estimation. This is clearly not suitable for this analysis. First, in econometric terms there is the obvious problem of sample selection bias. Second, finding the elasticity of substitution not to be valid for certain chapters is a revealing result in itself in that one has further evidence that U.S. and Chinese products are in fact very different (for those chapters).

The final area of consideration in selecting the best specification is the nature of the variation in the data. Previous studies have either relied on time series or cross section estimates for the elasticity of substitution, but given that the data under consideration has significant variation in cross sectional and time units, a pooled estimator seems most appropriate. Learner and Stern (1970) as well as Ginsburg (1969) suggest that pooled or panel estimations of the elasticity of substitution are more efficient than there cross sectional and time series variations

Based on our discussion the estimation strategy adopted can be described in two equations.

$$\ln \left(\frac{q_{US}}{q_{CHN}} \right)_{i,t}^R = (\delta + \delta_i) + b_1 \ln (p_{US})_{i,t} + b_2 \ln (p_{CHN})_{i,t} + b_3 \ln (p_j)_{i,t} + b_3 \ln (Y_j)_{i,t} + \epsilon_{i,t} \quad (11)$$

$$\ln \left(\frac{q_{US}}{q_{CHN}} \right)_{i,t}^R = (\alpha + \alpha_i + \beta_t) + b \ln \left(\frac{p_{US}}{p_{CHN}} \right)_{i,t} + c \ln p_j + \epsilon_{i,t} \quad (12)$$

Each equation is estimated by the relevant HS two-digit chapters, which consists of unique H5 six-digit product combinations for Chinese and U.S. exports to the AS6 and FU10 regions. These unique products within each chapter represent the cross sectional units i , while t is the time variation measured in years from 1994 to 2006. The first equation (11) is estimated for each chapter (given there are sufficient data observations and the overidentification test is satisfied) and is a simple one way fixed effect estimator, whereby the differential intercepts of the various products are assumed to vary. Equation (11) includes competing prices (p_j), calculated by taking the average of each region's members export prices to the region itself and regional income (Y_j), which is simply total regional exports to the region itself. These variables are only calculated for matching U.S. Chinese products and where the members of each region do not have missing quantity data (11) is used to test whether condition (8) is likely to be satisfied by testing the null hypotheses $b_1 = -$

The actual values of coefficient b_1 and b_2 bear no reflection to the theoretical concept underlying the elasticity of substitution and thus should not be interpreted as such.

If this hypothesis is not rejected when estimating (11) for a given chapter at the 5% level of significance, it is assumed that specification (12) is a valid theoretical estimation of the elasticity of substitution for that particular chapter. This is because there is now evidence these products within such chapters may be considered similar but not too similar on average.

The level of specification (12) is defined by the term $(\alpha + \alpha_i + \beta)$ and is assumed to vary among commodities and over time. Specification (12) is essentially a two-way fixed effect model and used to estimate the actual elasticities. The constant term α measures the average preference of the importing region for all the commodities in a given chapter in all time periods covered by the sample. The variable α_i determines whether the preference for a particular commodity differs from the average preference α for all commodities in a given chapter. These variations are driven by transport costs, quality differences and the demand characteristics (unrelated to price) of the importing region. In short this variable captures time invariant product specific effects and the omission of this variable may lead to omitted variable bias, particularly if they are correlated with some of the exogenous variables.

The variable β_t , represented by year dummies, measures how relative preferences vary with the time periods due to such factors as changes in world or regional incomes or changes in commercial policy. This is why the income variable (1a) is not included in specifications (12). The variable (p_i) is defined exactly as in (11) and again represents other prices that may affect the relative quantities as motivated by theory.

ρ in specification (12) measures the price elasticity of substitution. This elasticity is constrained by the form of this equation to be constant over time and for each commodity with a given chapter. However, given estimations are performed by chapter the assumption of constant elasticities across products is not overly restrictive. As a point of comparison additional estimations of the elasticity of substitution between the U.S and Great Britain, Brazil, India and Japan are presented for the machinery chapters as well. These estimations follow the same process as the China-U.S estimates. Finally, (12) is estimated by instrumentation on lagged logged relative prices, only where the over identification test is satisfied and sufficient observations are present¹⁴

Before reviewing the results, it must be made explicit how the data is used in the two specifications above. As with the comparison of unit values, unique combinations of products are required for U.S. and Chinese exports to the respective regions and over time. The distributional implications of the quantity values discussed in Section 7 remain an issue but are easier to overcome given that panel data estimates are robust for unbalanced panels i.e. certain products relative quantities (and quantity units) are absent in some years. The relative price and quantity variables were formed by creating a new variable which combined the HS six digit code and quantity unit type in each year. Therefore two products with the same HS-six digit code but different quantity units are now regarded as unique products. Relative prices and quantities for the U.S and China are simply calculated by matching these new variables in each year where both China and the U.S exported that particular HS6 unit combination. The fact that some of these combinations are absent in certain years does not affect the results. A final note regarding the data is that some chapters are not considered for estimation in order to narrow the analysis to the more relevant sections. These include mineral products, raw hides, non- and precious stones and metals.

¹⁴ Using instrumental variables results in the loss of efficiency relative to the pooled OLS results given endogeneity is not found to be present using the Hausman test. However in this case IV estimation is necessary for unbiased results. There is also some loss of information when using lagged prices as instruments. This does not induce bias but decreases the efficiency of the IV estimates further. This is because the sampling distribution for the variance of Mills is inversely related to the sample size.

$\text{Var}(in)$

for $i = 1, 2, \dots, k$ and where $SST = Ch_{i,i} \cdot T^{-1}$ is the total sample variation in α_i . It is clear that the greater the total variation in α_i the greater the sample size, the smaller the Cur LCD will be. See Wooldridge PO081 for more on the sampling properties of these estimators.

8.3. Results

Table 20. Description of the EU10 chapters for which estimating the elasticity of substitution is valid

| Section | Chapter | Chapter Description | No. obs. |
|-----------------------|---------|---|----------|
| Chemicals | 32 | Tanning, dyeing extracts | 515 |
| Plastic products | 39 | Plastic articles | 1421 |
| | 40 | Rubber articles | 799 |
| Wood products | 44 | Wood articles | 645 |
| Paper products | 48 | Paper and board articles, | 1047 |
| Footwear | 64 | Footwear articles | 514 |
| Base metals | 72 | Iron and Steel | 1173 |
| | 74 | Copper and articles | 569 |
| | 82 | Tools, spoons and forks | 866 |
| Machinery | 84 | Reactors, boilers, machinery & computers | 5850 |
| | 85 | Electrical machinery & equip. & parts | 4028 |
| Transport equipment | 86 | Railway or tramway locomotives | 114 |
| | 87 | Vehicles other than railway or tramway | 845 |
| | 89 | Ships, boats, & floating structures | 102 |
| Specialized equipment | 90 | Cinematographic, measuring, checking, & precision accessories | 2251 |
| | 91 | Clocks, watches and parts | 328 |
| | 92 | Musical instruments | 353 |
| Mixed manufacturing | 95 | Toys, games and sports equipment | 665 |
| | 96 | Miscellaneous products | 720 |

Notes: Table displays the details of the chapters in the EU10 regions for which the estimation of the elasticity of substitution is theoretically valid based on not being able to reject the null that $\sigma_1 = -b_2$ in (11). Mineral products, raw hides, non-metallic minerals and precious stones and metals are not considered.

Source: Authors calculations

Table 20 presents the details of the chapters for the EU10 region's imports from the U.S and China, such that the null hypothesis $b_1 = -b_2$ (11) could not be rejected at the 5% level of significance. Table A6.1 in Appendix 5 presents a description of the various chapters for which this hypothesis is tested and assigns the associated p-values as well as the number of observations to all the chapters that were tested. Chapters describing the EU10 region's imports are present in Table 20, conditional on the associated p-values in Table A5.1 in Appendix 6 being greater than 5%.

A similar analysis is performed for the AS6 region in Appendix 6 but given the volatility in the price data of U.S. and Chinese exports to this region as evident in Figure 5) focus is given to the EU10 region's results. The elasticity of substitution in the AS5 region is thus only estimated for chapters where the null hypothesis $b_1 = b_2$ cannot be rejected in both Regions. Table 21 presents these chapters for the AS6 region. Table 21 also reveals where some informal comparisons are allowed between the regional results

Table 21. Description of AS6 chapters to be compared to EU10 estimations

| Section | Chapter | Chapter Description | No. obs. |
|-----------------------|---------|--|----------|
| Chemicals | 32 | Tanning, dyeing extracts | 579 |
| Plastic products | 39 | Plastic articles | 1518 |
| | 40 | Rubber articles | 897 |
| Wood products | 44 | Wood articles | 658 |
| Base metals | 72 | Iron and Steel | 1817 |
| | 74 | Copper and articles | 665 |
| | 82 | Tools, spoons and forks | 1038 |
| Transport equipment | 87 | Vehicles other than railway or tramway | 819 |
| | 89 | Ships, boats, & floating structures | 115 |
| Specialized equipment | 91 | Clocks, watches and parts | 223 |

Notes: Table displays the details of the chapters in the AS6 region for which the estimation of the elasticity of substitution is theoretically valid based on not being able to reject the null that $b_1 = b_2$ in {11} for these chapters in BOTH regions.

Source: Authors calculations

The most striking feature of this initial analysis is the limited number of chapters in the AS6 results for which estimating the elasticity of substitution is theoretically valid. The hypothesis $b_1 = b_2$, essentially tests whether the respective exported products can be considered similar at all. Thus it would seem that Chinese and U.S. exports to the AS6 region are less substitutable relative to exports to the EU10 region. This seems to compliment the results of the within product variation analysis where U.S exports to AS6 region were priced significantly higher than Chinese exports.

Some general observations in Appendix 6 are that in the EU10 region the Textiles and Clothing section are the least conducive to the theoretical assumption in (S), with all chapters within this section returning a p-value very close to zero.

This may reveal a significant difference in the quality of these products as discussed with reference to relationship between vertical differentiation and developed countries in international trade above. Interestingly, estimating the elasticity of substitution for the machinery chapters are valid for the EU10 region but not for the AS6 region. A formal estimation of the substitutability in the AS6 region's machinery imports from the U.S and China is thus not possible. One may conclude that machinery exports to the AS6 region from the U.S. and China are thus in fact very different while they are relatively more similar in the EU10 region. Although this not a sufficient condition for this conclusion, Figure 5 echoes this finding given the average U.S. premium over the sample period for machinery exports to the AS6 region is 63 versus 3.4 for the EU10 region. Focus in the estimation results is given to the EU10 region's imports of machinery as it has been revealed throughout this paper that the most plausible area of significant competition between China and the U.S. (irrespective of region) is in machinery exports.

Table 22. Estimation results for constant elasticity of substitution between China and the U.S.

| HS2 | EU10 | | | | | AS6 | | | | |
|-----|---------------|-----------------|-----------------|-----------------|-----------------------|---------------|-----------------|-----------------|----------------|-----------------------|
| | <i>b</i> | <i>Std Err.</i> | <i>No. Obs.</i> | <i># groups</i> | <i>R</i> ² | <i>b</i> | <i>Std Err.</i> | <i>No. Obs.</i> | <i>#groups</i> | <i>R</i> ² |
| 44 | -6.241 | 9.623 | 505 | 77 | 0.28 | -2.447 | 1.072 | 529 | 78 | 0.48 |
| 74 | -2.376 | 0.747 | 473 | 54 | 0.37 | -0.774 | 0.068 | 665 | 58 | 0.36 |
| 89 | -1.923 | 0.927 | 66 | 14 | 0.32 | -0.213 | 1.037 | 84 | 17 | 0.10 |
| 40 | -1.830 | 0.911 | 667 | 75 | 0.33 | -1.740 | 0.536 | 761 | 87 | 0.30 |
| 39 | -1.570 | 0.269 | 1236 | 123 | 0.36 | -1.338 | 0.246 | 1365 | 124 | 0.51 |
| 72 | -1.450 | 0.071 | 1173 | 165 | 0.26 | -4.529 | 8.450 | 1516 | 183 | 0.32 |
| 32 | -1.320 | 0.195 | 446 | 45 | 0.45 | -0.671 | 0.200 | 512 | 49 | 0.31 |
| 96 | -1.266 | 0.285 | 634 | 68 | 0.17 | NA | NA | NA | NA | NA |
| 64 | -1.212 | 0.941 | 452 | 54 | 0.09 | NA | NA | NA | NA | NA |
| 86 | -1.147 | 0.61 | 93 | 12 | 0.32 | NA | NA | NA | NA | NA |
| 92 | -1.026 | 0.605 | 302 | 36 | 0.16 | NA | NA | NA | NA | NA |
| 90 | -0.967 | 0.197 | 1928 | 240 | 0.13 | NA | NA | NA | NA | NA |
| 48 | -0.957 | 0.42 | 868 | 101 | 0.29 | NA | NA | NA | NA | NA |
| 85 | -0.866 | 0.115 | 4670 | 409 | 0.18 | NA | NA | NA | NA | NA |
| 84 | -0.847 | 0.227 | 3502 | 667 | 0.32 | NA | NA | NA | NA | NA |
| 95 | -0.838 | 0.241 | 591 | 66 | 0.41 | NA | NA | NA | NA | NA |
| 82 | -0.639 | 0.198 | 794 | 70 | 0.1 | -1.661 | 0.500 | 862 | 116 | 0.33 |
| 87 | -0.498 | 0.803 | 692 | 94 | 0.17 | -1.613 | 6.320 | 637 | 96 | 0.25 |
| 91 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

Notes: Table reports IV regression results for the elasticity of substitution by chapter between U.S. and Chinese exports to the AS6 and EU10 regions from 1994 to 2006. Explanatory variables include product fixed effects, year dummies and average EU10 export prices. Relative prices are instrumented on lagged prices. Elasticities are sorted from highest to lowest substitutability. Machinery chapters are shaded in grey. Coefficients in bold are not significant at the 5% level, while all other coefficients are at least significant at the 5% level. Not applicable (NA) is assigned to those chapters where the estimate is either not theoretically valid or there are insufficient observations

Table 22 presents the estimates for the elasticity of substitution by chapter and four observations are most noteworthy. First, the AS6 results again suggest that U.S. and Chinese exports to this region are very different. This is motivated by the fact that the elasticity of substitution is mostly not theoretically valid for this region (i.e. we often reject that the products are reasonably similar based on price) and when it is theoretically valid the estimates are either insignificant or very low. For example for vehicles (chapter 87), ships, boats (chapter 89) and Iron and steel products (chapter 72) one cannot reject the null hypothesis that the elasticity of substitution is zero for these products, while chemical and copper products have relatively low estimated values of 0.77 and 0.67 respectively. Second, at first glance there seems to be relatively more scope for substitution in the EU10. Copper and rubber articles are two of the chapters with the largest estimated values of 2.4 and 1.8 respectively. Thus for U.S. and Chinese copper exports to the EU10, a 1% increase in U.S. prices would result in the ratio of U.S. to Chinese exports decreasing by 2.4%. It is not surprising that the larger estimates are found for copper, rubber, plastic and Iron products as these products are more homogenous relative to vehicles, electrical machinery and computers. This introduces the third and most important point, which is the relatively small estimates of 0.847 and -0.866 for chapters 84 and 85 (shaded in grey). It would thus seem that there is less scope for competition based on price in the machinery chapters relative to some of the other chapters.

This reaffirms the earlier finding that although machinery products account for roughly 50% of both Chinese and U.S.'s export composition to the EU10 and AS6, the actual products within these bundles are quite different. Finally a note is needed on the interpretation of the elasticities in Table 22. The elasticity of substitution consists of two elements, the demand elasticities with regard to a country's own price (α_1 or α_2) as in equation (8) and to the other country's price (α_2 or α_1) or the cross price elasticity. It is very close to impossible to isolate one from the other with some confidence based on the specification in (12)¹⁹. Another issue is the problem in interpreting these results is that a comparison of the elasticities across sectors is less meaningful as they are driven by the characteristics of the actual sectors. The chapters with more homogenous goods will therefore have higher elasticities of substitution. Still, with the knowledge of the elasticities of substitution between the U.S. and other competitors, one can get a better insight into where China stands relative to other countries in its substitutability with U.S. exports. This strategy is specifically invoked for some of the chapters of interest. These include the machinery chapters (84 and 85) and chapter 90 under specialized equipment (for a description of these see Appendix 6).

See Learner and Stern (1970) for a theoretical discussion on the difficulties in isolating these variables

Therefore although the exact effect of a Chinese price change on U.S. export demand cannot directly be inferred, what can be inferred is whether Chinese machinery and specialized equipment exports are relatively more or less similar to the U.S. when reviewing the substitutability between the U.S. and Great Britain, Brazil, India and Japan. Table 23 and 24 below presents these results.

Table 23. The elasticity of substitution between the U.S. and competitors for chapters 84 and 85

| Partner | HS | <i>b</i> | Std Err. | No. Obs. | # groups | R ² |
|------------------|----|----------|-------------|-------------|-------------|----------------|
| Great Britain | 84 | -2.06 | 0.803 | 6071 | 747 | 0.2 |
| | 85 | NA | NA | NA | NA | NA |
| Brazil | 84 | -1.406 | 0.404 | 3045 | 535 | 0.21 |
| | 85 | -1.531 | 0.2957 | 2204 | 328 | 0.21 |
| India | 84 | -1.289 | 0.362 | 2675 | 476 | 0.24 |
| | 85 | -1.876 | 0.327 | 2304 | 343 | 0.27 |
| Japan | 84 | -1.02 | 0.023 | 6063 | 753 | 0.15 |
| | 85 | 0.982 | 0.167 | 3554 | 407 | 0.16 |
| China | 84 | -0.847 | 0.115 | 4670 | 667 | 0.32 |
| | 85 | -0.866 | 0.227 | 3502 | 409 | 0.18 |

Notes: Table reports IV regression results for the elasticity of substitution by chapter between U.S. and Great Britain, Brazil, India and Japan exports to EU10 region from 1994 to 2006. This is for chapter 84 (Nuclear reactors, boilers, machinery & computers) and 85 (Electrical machinery & equip. & parts). Explanatory variables include product fixed effects, year dummies and average EU10 export prices. Relative prices are instrumented on lagged prices. All Coefficients presented are at least significant at the 5% level. Not applicable (NA) is assigned to those chapters where the estimate is either not theoretically valid or there are insufficient observations

Source: Authors calculations

Table 24. The elasticity of substitution between the U.S. and other competitors for chapter 90

| Partner | HS | <i>b</i> | Std Err. | No. Obs. | # groups | R ² |
|------------------|----|---------------|-------------|-------------|-------------|----------------|
| Great Britain | 90 | -1.18 | 0.166 | 2031 | 244 | 0.24 |
| Brazil | 90 | -1.16 | 0.298 | 1122 | 182 | 0.17 |
| Japan | 90 | -1.05 | 0.151 | 2043 | 243 | 0.15 |
| India | 90 | -0.864 | 0.288 | 1761 | 203 | 0.1 |
| China | 90 | -0.967 | 0.115 | 4670 | 667 | 0.32 |

Notes: Table reports IV regression results for the elasticity of substitution by chapter between U.S. and Great Britain, Brazil, India and Japan exports to EU10 region from 1994 to 2006. This is for chapter 90 (Cinematographic, measuring, checking, & precision accessories computers). Explanatory variables include product fixed effects, year dummies and average EU10 export prices. Relative prices are instrumented on lagged prices. All Coefficients presented not in bold are at least significant at the 5% level.

Source: Authors calculations

Tables 23 and 24 convey a simple yet powerful result. When selecting a few random export competitors for the U.S., with varied levels of development, all are more competitive with U.S relative to China. Only chapters 84 (nuclear reactors, boilers, machinery & computers), 85 (Electrical machinery, equipment and parts) and 90 (cinematographic, measuring, checking, and precision accessories) are considered for this analyses of relative performance. The selection of these chapters are based on the fact that they all represent sectors of significance to both the U.S. and China, while also containing a large number of actual products and thus data observations for the estimation. It is not surprising that Great Britain is found to have the highest estimate for the elasticity of substitution in these chapters (excluding 85), while it is perhaps surprising that Japan does not do a little better in her substitutability with the U.S. machinery exports. This could be driven by Japan's weak exchange rate and the general lack of purchasing power parity in international markets. What is most striking in Table 23, is compared to China even India's machinery exports seem significantly more substitutable with the U.S.

In Tables 23 and 24 the quantification of actual affect that say a one percent price reduction in any of the competitors exports (for a given chapter) will have on the quantity demand for U.S. exports, is not made explicit. What can be concluded from Tables 23 and 24 however is that relative to other competitors China is likely to have the most muted effect on the quantity demand for U.S. machinery and specialized equipment exports into the EU10 region, should China decrease the price of her exports in these chapters

8.4. What the results imply for the central hypothesis

This section applied the theory and estimation of the elasticity of substitution to consolidate the divergent findings of increasing across product similarity but significant differences in within product similarity between the U.S and China. The hypothesis that the increased similarity reflects importers in Asia and Europe substituting U.S. products for Chinese products based on the relatively lower Chinese prices is very unlikely to be true based on the results in this Section. There are three main reasons for this conclusion. Firstly, most of the respective export baskets for various HS two-digit chapters cannot be considered to be substitutes based on theoretical grounds. Secondly, where the estimation is theoretically valid, China has the lowest elasticities for the chapters of interest when these elasticities are ranked. Finally, China has significantly lower estimated values for the chapters of interest relative to other developing and developed competitors' elasticities of substitution with U.S.

The findings of this section thus reveal that the Chinese and U.S. export demand functions are fairly independent of one another. In other words Chinese export price changes in various product categories, defined by the same HS six-digit codes and quantity combinations for the U.S., have a relatively muted effect on the demand by importers for these U.S. products on average.

Based on the combination of findings here and in Section 7, U.S. policy makers seem to have little to fear from China's export growth given that there is little evidence for the potential of importers substituting U.S. for Chinese products. Additionally, this section gives further weight to the argument that although China seems to be becoming more similar to the U.S. over time at the aggregated level, a closer analysis of the disaggregated data reveals that actual products being exported by these two countries differ considerably in terms of quality and other vertically differentiated attributes

9. CONCLUDING REMARKS

This paper performs a comprehensive analysis of the similarity of U.S. and Chinese exports to European and Asian markets in order to determine whether China's staggering export growth over the last decade is detrimental to U.S. welfare. At glance it seems that China is a potential threat to the U.S. with considerable market share and product penetration growth as well as significant restructuring into machinery exports, an area that is dominant in the U.S. export composition to both Asia and Europe. There are early indications however that China's export growth may not threaten the U.S. given that this paper finds almost all of China's export growth is fuelled by the increased production of existing broadly defined HS six-digit product lines (intensive margin).

Overall the empirical results of the three measures of similarity result in the inability to reject the hypothesis that Chinese and U.S. exports to both regions are very different in sophistication and quality, especially when benchmarked against the similarity between the U.S. and other developed and even some developing countries. This is particularly true of the other developing Asian countries whose performances are at least equal to that of China. This paper does find that China and U.S. do overlap more, over time, in terms of export mix, but are very different in terms of export prices. Before concluding that developed economies compete with developing economies like China by raising the quality of their exports as postulated by Grossman and Helpman (1991), the elasticity of substitution is estimated to test whether the increased across product overlap between the U.S. and China is being driven by Chinese export discounts

The estimation results give further weight to U.S. and Chinese exports being dissimilar as there is little evidence that relative to other competitors (both developed and developing) importers are significantly substituting U.S. for Chinese products based on price differences and in key sectors of the U.S. economy. The results of this paper therefore provides further evidence in favour of the predictions of models Grossman and Helpman (1991) quality ladder driving U.S. comparative advantage overtime as well as the Heckscher-Ohlin model, if products are assumed to differ vertically and not horizontally.

This paper does provide a cautionary note though, in that unlike previous work in this area, I do find some empirical evidence of China's price gap with U.S. decreasing marginally. This is particularly true when reviewing the disaggregated data of actual exported products, while the average relative price trends by manufacturing section where less conclusive for both the Asian and European region.

Overall, the results of this paper should bring considerable optimism to U.S. producers, policymakers and most of all consumers as based on the findings of this paper intense medium run competition from China with U.S., in manufacturing exports seem very unlikely.

This overall finding seems independent of the development of the importing region. The only significant observations when comparing the regional results is that the U.S. seems to export a more concentrated and higher quality export basket to the Asian region in order to negate the negative effect of transport costs, while China seems to be exporting a more diverse basket over time to the EU 10 region which becomes more similar to its export Asian export basket. It is not clear however whether competition between the U.S. and China is stronger in the Asian or European region but given the overarching finding of significant dissimilarity in the respective export baskets, this question becomes ancillary.

This paper also dealt with some important methodical and theoretical issues relating to the calculation and interpretation of unit values as a proxy for price. The identification and rectification of quantity data issues affecting accurate unit value calculations using raw trade data are particularly insightful

The results in this paper provide a fairly comprehensive insight into how China and the U.S. compete in two different regional export markets but it also raises a number of questions requiring further research. First, understanding the dynamics of the quality ladder in which the U.S. "escapes" competition from low wage countries like China would be most useful. Schott (2008) refers to research by Khandelwal (2006), whereby different industries are described to have varying lengths in their quality ladders. In other words it is easier for some producers versus others to diversify and improve their products and thus outperform their competitors, while on the other hand some producers invest in the process of lengthening the actual length of the quality ladder. Understanding these processes would be most useful. Second, quality variation in production across Chinese provinces cannot be discerned in the international trade data used in this paper; it merely reflects the value-weighted average unit value of exports from all regions of the country. Thus from a Chinese policy perspective research on the relative endowments and production performance of the various Chinese provinces would be most fruitful. Finally this paper does not deal with the amount of foreign value added in the Chinese export basket; this is because the welfare implications discussed in this paper remain relevant for the U.S. as long as the foreign value added is not from the U.S. itself. However for the long run implications of possible future improvements in China's exports it would be insightful to get a meaningful measure of the amount of foreign value added in key sectors such as machinery and more fundamentally who the major contributors of this foreign value are.

Appendix 1

Table A1. The Top 25 Trading Partners of the U.S. and China in 1994 and 2006

| CHINA EXPORTS | | | US EXPORTS | | |
|---------------|------------|------------|---------------|------------|------------|
| Destination | 1994 | 2006 | Destination | 1994 | 2006 |
| Japan | 17.65% | 12.63% | Canada | 22.49% | 20.11% |
| Germany | 7.06% | 7.09% | Mexico | 10.88% | 13.60% |
| Rep. of Korea | 3.45% | 5.31% | Germany | 5.71% | 6.67% |
| Great Britain | 1.87% | 4.21% | Japan | 11.24% | 6.18% |
| Canada | 2.12% | 3.44% | Great Britain | 5.15% | 5.15% |
| France | 3.06% | 3.43% | Rep. of Korea | 4.81% | 3.53% |
| Netherlands | 1.19% | 3.26% | France | 4.52% | 3.51% |
| Mexico | 0.38% | 2.73% | Netherlands | 2.10% | 3.19% |
| Italy | 2.35% | 2.56% | Australia | 2.50% | 2.01% |
| Australia | 1.88% | 2.14% | Malaysia | 2.31% | 1.79% |
| Spain | 1.36% | 2.03% | Brazil | 1.85% | 1.68% |
| India | 0.42% | 1.95% | Italy | 1.74% | 1.44% |
| Malaysia | 0.71% | 1.71% | India | 0.61% | 1.26% |
| Thailand | 1.00% | 1.53% | Spain | 1.29% | 1.09% |
| Brazil | 0.13% | 0.92% | Ireland | 1.05% | 0.93% |
| South Africa | 0.27% | 0.78% | Switzerland | 0.99% | 0.92% |
| Indonesia | 0.75% | 0.71% | Philippines* | 0.97% | 0.90% |
| Ireland | 0.22% | 0.64% | Thailand | 1.45% | 0.89% |
| Finland | 0.27% | 0.59% | Chile | 0.62% | 0.60% |
| Austria | 0.66% | 0.53% | South Africa | 0.54% | 0.56% |
| Denmark | 0.49% | 0.50% | Austria | 0.56% | 0.50% |
| Sweden | 0.84% | 0.45% | Sweden | 1.00% | 0.47% |
| Philippines* | 0.62% | 0.47% | Indonesia | 0.81% | 0.37% |
| Chile | 0.22% | 0.40% | Finland | 0.40% | 0.29% |
| Switzerland | 0.64% | 0.36% | Denmark | 0.35% | 0.28% |
| Total | 50% | 60% | | 86% | 78% |

Notes: Market shares are sorted by 2006. China and the U.S. are not considered as destination countries. Each cell displays the market share each destination country holds of Chinese and U.S. total exports. Chinese and U.S. total exports exclude bilateral trade between each other and are for non agricultural products only.
 Source: UN Comtrade; Author's calculations

Table A1 reveals 25 of the major export destinations of both the US and China, for the years 1994 and 2006 and used to select the members of the two regions. It displays the market shares that the majority of both China and the US's most significant export destinations account for relative to total Chinese and U.S. exports. All bilateral trade between China and the U.S. is excluded in the calculations of the trade shares. This is both reflected in the absence of China and the U.S. as export destinations, while the respective export totals are adjusted to exclude trade between these countries.

The fact that these 25 destinations account for a relatively smaller share of Chinese total exports is a result of the exclusion of bilateral trade between Hong Kong and China. Although the share of Chinese exports, Hong Kong holds is significant, the origins of these goods are ambiguous (Feenstra and Hanson 20001

Appendix 2

Table A2.1. Partner Market Shares in the EU10 Region, 1994 to 2006

| Partner | Market share 1994 | Partner | Market share 2006 |
|---------------|----------------------|---------------|----------------------|
| Germany | 14.40% | Germany | 12.81% |
| France | 7.90% | China | 6.70% |
| Great Britain | 7.72% | France | 6.15% |
| USA | 7.65% | Great Britain | 5.96% |
| Italy | 6.82% | USA | 5.93% |
| Japan | 4.97% | Italy | 4.96% |
| Netherlands | 3.99% | Netherlands | 4.22% |
| Switzerland | 3.45% | Japan | 2.76% |
| Spain | 2.73% | Spain | 2.74% |
| Austria | 2.57% | Switzerland | 2.56% |
| Sweden | 2.47% | Sweden | 2.02% |
| China | 2.16% | Austria | 1.96% |
| Finland | 1.34% | Ireland | 1.55% |
| Denmark | 1.15% | Korea | 1.38% |
| Korea | 0.89% | Finland | 1.20% |
| Ireland | 0.89% | Denmark | 1.14% |
| Canada | 0.68% | India | 0.62% |
| Malaysia | 0.55% | Brazil | 0.59% |
| Brazil | 0.50% | Malaysia | 0.58% |
| India | 0.47% | Canada | 0.47% |
| South Africa | 0.44% | South Africa | 0.45% |
| Indonesia | 0.42% | Thailand | 0.44% |
| Thailand | 0.42% | Chile | 0.41% |
| Australia | 0.24% | Indonesia | 0.37% |
| Mexico | 0.21% | Mexico | 0.35% |
| Chile | 0.17% | Australia | 0.27% |
| Philippines | 0.15% | Philippines | 0.21% |
| Average | 2.79% | | 2.55% |
| Partner Total | 75.36% | | 68.82% |

Notes: Table presents the market shares held by selected partners of the EU10 region's total non agricultural imports. Market shares do not add to 1 as not all of the EU10 trading partners are presented.

Source: Author's calculations

Table A2.2. Partner Market Shares in the AS6 Region, 1994 to 2006

| Partner | Market share 1994 | Partner | Market share 2006 |
|----------------------|----------------------|---------------|----------------------|
| Japan | 26.59% | Japan | 13.59% |
| USA | 15.86% | China | 12.24% |
| Germany | 5.90% | USA | 9.24% |
| China | 3.02% | Germany | 3.66% |
| Australia | 2.71% | Malaysia | 3.10% |
| Korea | 2.55% | Australia | 2.80% |
| Great Britain | 2.55% | Korea | 2.79% |
| Malaysia | 2.07% | Indonesia | 2.37% |
| France | 2.03% | Thailand | 1.91% |
| Italy | 1.90% | Switzerland | 1.64% |
| Indonesia | 1.60% | France | 1.41% |
| Switzerland | 1.43% | Great Britain | 1.29% |
| Canada | 1.06% | Italy | 1.06% |
| Netherlands | 0.89% | India | 0.87% |
| Sweden | 0.82% | Philippines | 0.86% |
| Brazil | 0.74% | Netherlands | 0.74% |
| Thailand | 0.74% | Chile | 0.73% |
| India | 0.51% | Canada | 0.68% |
| Spain | 0.50% | South Africa | 0.58% |
| Finland | 0.45% | Sweden | 0.57% |
| Chile | 0.43% | Brazil | 0.51% |
| South Africa | 0.42% | Ireland | 0.37% |
| Philippines | 0.39% | Finland | 0.26% |
| Denmark | 0.30% | Spain | 0.25% |
| Austria | 0.28% | Mexico | 0.25% |
| Ireland | 0.19% | Austria | 0.20% |
| Mexico | 0.14% | Denmark | 0.14% |
| Partner Total | 76.08% | | 64.10% |

Notes: Table presents the market shares held by selected partners of the AS6 region's total non agricultural imports. Market shares do not add to 1 as not all of the EU10 trading partners are presented.

Source: Author's calculations

Appendix 3

Chinese and U.S. price indices for manufacturing exports to the EU10 region

The EU10 results in Figure 5 of the main text were found to be significantly less volatile than the A56 results and revealed marginally declining U.S. premiums in machinery and specialized equipment post 1999. However, given China's relatively small share of exports in specialized equipment to the EU10 (roughly 4 percent over the sample period) and the fact that the U.S. and China overlap considerably in machinery exports at the aggregated level, only the trend in the machinery premium is compared with the behaviour of the U.S. and Chinese price index for this section. The index drawn upon is the import price index (MPI) described by the Tornqvist formula in (A1)".

$$MPI_{CHN,t}^{Section} = \prod_{i,r} \left(\frac{w_{t,i}}{w_{t-1,i}} \right)^{w_{r,i}}, \text{ where } w_{t,i} = 0.5 * (share_{t,i} + share_{t-1,i}) \quad (A1)$$

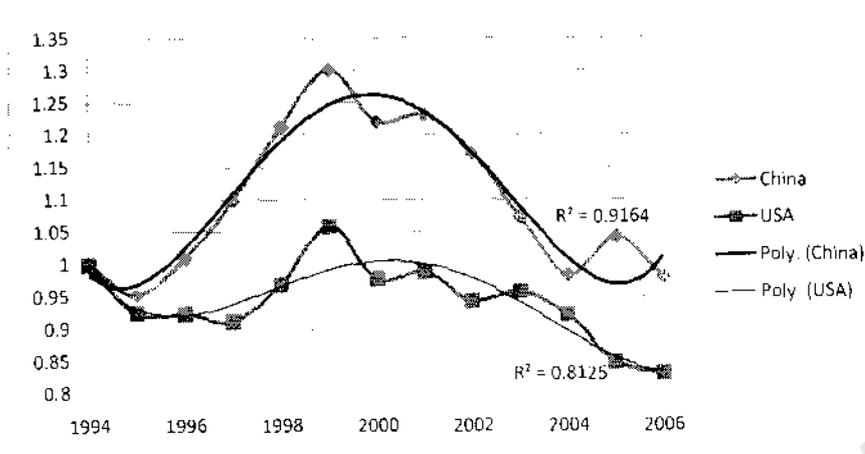
In the calculation of (A1) duplicate products in each year are treated as unique as long as that product is measured with same quantity unit in the previous year. For product r to be included in the construction of the index and in period t, the product must be imported in both period t and t-1. Each HS six-digit product code is weighted $w_{e,r}$ by taking the average share of the particular section's imports of product i in period t ($share_{t,i}$) and period t-1 ($share_{t-1,i}$). Thus here the basket of goods is allowed to change as do the weights. The distribution of the quantity data is not addressed explicitly but given this index calculates relative prices the various units do not have a significant impact.

The formula gives the changes in import prices from period to period. Thus to calculate the series of the index I accumulate these changes starting with a base value of 100 in 1994. Therefore if the price index in 1995 and 1996 is 96 and 108 respectively. Then the 1996 import price index relative to 1994 is 104. Figure 2 displays the machinery price indices' series for EU imports from the U.S and China. Before reviewing the trends one must not that there is an implicit bias in using this approach. In particular, the approach does not adequately take into account the effect of new products and old products on the price index and often the year on year trends are slightly exaggerated yet there is very little churning in the product data post 1996 for the machinery section. For more on the effect of new products on price indices see Feenstra (1994).

²⁰ The calculation of the *tornqvist price index* is not appropriate for the specialized equipment section, given the considerable product churning which exaggerates upward and downward trends.

²¹ This index appears in the Federal Reserve Bank of New York's monthly publication "Current Issues in Finance and Economics" (2009). For a description of the various types of indexes, refer to Diewert (1993).

Figure A1. Tornqvist index for machinery imports by the EU10 region



Notes: Figure displays the trends in the EU10 region's machinery import prices from China and the U.S.
 Source: Author's calculations

The trends in the machinery section are of most interest given that China's composition of trade has shifted significantly into this section see Tables 8 and 9). The results of Figure A1 above are not easily consolidated with results for Figure 5 in the main body of this paper. This could be due to the fact that that the data has been treated differently in the calculations of the U.S premiums in Figure 5, relative to the tornqvist index in Figure A1. However what is most revealing is when one considers that that the index in Figure A1 assumes 1994 as the base year for both China and the U.S. Thus it seems that China should be closing the machinery price gap between 1994 and 2000 in Figure A1 but one must consider that U.S. machinery imports into the EU10 region are 3.7 times more on average. Hence, U.S. machinery exports are priced much higher than China in 1994 and so the individual trends in Figure A1 may be misleading when drawing comparisons with the U.S. premium over China, using the tornqvist index.

Despite these issues it is interesting to note that Chinese machinery import prices grew mostly pre 1999, and then began to fall mostly up until 2006. This does seem to contradict any evidence of China closing the machinery export price gap with U.S. post 1999, although one should note that post 2000 there is a declining trend in the U.S machinery import price thus making the findings of figure A1 less ambiguous. Additionally, Figure A1 offers some insight into the evidence of China's "price catch up" over time for certain machinery products when the disaggregated data was evaluated in Tables 18 and 19.

Appendix 4

For the years 1994, 1999 and 2006 the weighted average of one hundred product prices is compared between U.S and Chinese exports into the EU 10 regions calculated for the U.S top 100 exports. When comparing average prices, one must ensure that one compares the same set of products over time. Otherwise changes in average prices may reflect changes in the composition of the bundle and not changes in the price of the bundle. First I select largest 100 goods by U.S trade value in 1999 that are available for both countries in 1994, 1999 and 2006. Then, I weight these using US export values in 1999, using a fixed weight avoids changes in the average prices being driven by changes in the composition of either countries trade (note that you can only weight upwards if the units are all the same which is the case here). This weighted average is described below for each of the three years whereby I use the U.S. top 100 products' trade shares in 1999 as the weights.

$$\bar{uv} = \sum_{i=1}^{100} W_{1999,i} \cdot uv_{j,t,i}$$

Where

$$W_{1999,i} = \frac{TV_{1999,i}}{\sum_{i=1}^{100} TV_{1999,i}}$$

For the each selected year t I sum the product of country's unit values for each unique product i in the top 100 with the trade value that product represented for the US. in 1999 I his is then divided by sum of the trade values these 100 products represented in the U.S in 1999. I therefore am comparing the average prices in a world where China's composition of trade is assumed to be similar to that of the U.S. Table 4A below presents both the weighted average prices for China and the U.S , as well as the shares of total non agricultural trade the U.S. 1999 top 100 goods account for in each country.

Table A4. Weighted average of U.S. 1999 top 100 products unit values and trade shares

| Year | EU10 | | Rel(uv) | Share USA | Share China |
|------|---------|-----------|---------|-----------|-------------|
| | Wuv USA | Wuv China | | | |
| 1994 | 230 | 97 | 2.4 | 27% | 5% |
| 1999 | 261 | 115 | 2.3 | 32% | 20% |
| 2006 | 408 | 160 | 2.6 | 40% | 13% |

Notes: Table displays the weighted average unit values for China and the USA, whereby a consistent bundle of goods based on U.S.'s top 100 exports in 1999. The shares represents China and the U.S.'s shares of total non agricultural exports that the U.S. 1999 top 100 bundle accounts for in each year

Source: Author's calculations

Although Table A4 focuses only on a handful of products it certainly makes for interesting reading. Remember, the exact same products in terms of the HS six-digit classification are being compared. The EU10 region reveals the U.S. average unit values to be more than double than that of China in the beginning, middle and end of the sample. By chance all products in U.S. top 100 in 1999 that are exported to the EU10, are measured in kilograms. Therefore the U.S. products' average price per kilogram of the common 100 product basket is 261 dollars per kilogram in 1999, while only 115 dollars per kilogram for China. It is interesting to note that when considering these 100 products China does not close the average price over time, while when individual products were considered in the "top" twenty China closed the price gap on majority of the products. Despite this slight discrepancy it is not surprising (based on table 17 and Figure 5 in the body) that Table A4 provides further evidence that at least for now the U.S and Chinese export baskets are different in quality assuming a higher relative price reflects greater product sophistication.

It is also useful to note how the trade shares represented by the U.S. 1999 top 100 bundle behave. The results in Table A4, although in a hand waving way, echo the earlier findings that China's composition across products is becoming more similar to that of the U.S. over time. The base bundle represents 100 products that are fairly dominant in the U.S export bundle accounting on average for 33% of U.S. total non agricultural exports to the EU10²² over time, these goods are accounting for more of China's export composition in terms of value although the data suggests China still lags the U.S. in 2006. Essential Table A4 reveals there is no convergence in relative average price levels and this is a less meaningful result given the mixture of industries in the top100. Nevertheless, the average unit values displayed in Table A4 suggests that in reality Chinese and U.S. goods are in fact very different as predicted by traditional trade theories.

²² Note that this top 100 products in 1999 do not represent the top 100 of all U.S. products' market share given I have restricted the data to a subset of products with common quantity units for both the U.S. and China. The actual top 100 U.S products account for an average over time of roughly 05% in both regions.

Appendix 5

Assume β is the true population parameter for the elasticity of substitution

The unbiased estimate of the coefficient is thus

$$\hat{\beta} = \frac{\text{cov}(v - q, q)}{\text{var}(v - q)}$$

Where $v = \ln V_1 - \ln V_2$ and $q = \ln Q_1 - \ln Q_2$.

V_1 and V_2 are the exports of the two countries and Q_1 and Q_2 are the export quantities.

If the quantity (Q) is mismeasured, the estimate becomes:

$$\bar{\beta} = \frac{\text{cov}(v - q - u, q + u)}{\text{var}(v - q - u)}$$

Where u is the log difference of the measurement errors on Q_1 and Q_2 . The relationship between $\hat{\beta}$ and $\bar{\beta}$ can be derived using simple algebra:

$$\bar{\beta} = \hat{\beta} \frac{\text{var}(v - q)}{\text{var}(v - q) + \text{var}(u)} - \frac{\text{var}(u)}{\text{var}(v - q) + \text{var}(u)}$$

Therefore $\bar{\beta}$ is the weighted value of the true estimate of β and 1. Hence, it will be biased towards minus one.

Appendix 6

Table A6.1. Testing the theoretical validity of the elasticity of substitution ($b_1 = -b_2$)

| Section | Chapter | Chapter Description | No. obs. | | P-value | | Elasticity of substitution valid | |
|-----------------------|---------|--------------------------------|----------|------|---------|-------|----------------------------------|-----|
| | | | EU10 | AS6 | EU10 | AS6 | EU10 | AS6 |
| Chemicals | 28 | Organic chemicals | 1637 | 1763 | 0.015 | 0.113 | NO | YES |
| | 29 | Inorganic chemicals | 2942 | 3244 | 0.007 | 0.905 | NO | NO |
| | 32 | Tanning, dyeing extracts | 515 | 579 | 0.397 | 0.119 | YES | YES |
| | 38 | Miscellaneous products | 519 | 628 | 0.000 | 0.693 | NO | YES |
| Plastic products | 39 | Plastic articles | 1421 | 1518 | 0.210 | 0.080 | YES | YES |
| | 40 | Rubber articles | 799 | 897 | 0.234 | 0.958 | YES | YES |
| Wood products | 44 | Wood articles | 645 | 658 | 0.367 | 0.996 | YES | YES |
| Paper products | 48 | Paper and board articles, | 1047 | 1259 | 0.874 | 0.039 | YES | NO |
| Textiles and clothing | 52 | Cotton | 910 | 1236 | 0.006 | 0.009 | NO | NO |
| | 54 | Manmade filaments | 768 | 912 | 0.000 | 0.158 | NO | YES |
| | 55 | Manmade staple fibres | 973 | 1352 | 0.000 | 0.010 | NO | NO |
| | 58 | Special woven, tapestry etc | 476 | 562 | 0.000 | 0.469 | NO | YES |
| | 61 | Articles of apparel (knit) | 1897 | 1283 | 0.000 | 0.103 | NO | YES |
| | 62 | Articles of apparel (not knit) | 2087 | 1790 | 0.000 | 0.193 | NO | YES |
| | 63 | Other textiles | 767 | 649 | 0.000 | 0.662 | NO | YES |
| Footwear | 64 | Footwear articles | 514 | 472 | 0.256 | 0.011 | YES | NO |

Table A6.1. Continued

| Section | Chapter | Chapter Description | No. obs. | | P-value | | Elasticity of substitution valid | |
|-----------------------|---------|---|----------|------|---------|-------|----------------------------------|-----|
| | | | EU10 | AS6 | EU10 | AS6 | EU10 | AS6 |
| Base metals | 72 | Iron and Steel | 1173 | 1817 | 0.834 | 0.532 | YES | YES |
| | 73 | Articles of iron and steel | 1377 | 1472 | 0.023 | 0.041 | NO | NO |
| | 74 | Copper and articles | 569 | 665 | 0.949 | 0.179 | YES | YES |
| | 82 | Tools, spoons and forks | 866 | 1038 | 0.063 | 0.122 | YES | YES |
| | 83 | Miscellaneous articles | 465 | 478 | 0.032 | 0.012 | NO | NO |
| Machinery | 84 | Nuclear reactors, boilers, machinery & computers | 5850 | 7362 | 0.298 | 0.000 | YES | NO |
| | 85 | Electrical machinery & equip. & parts | 4028 | 4439 | 0.195 | 0.000 | YES | NO |
| Transport equipment | 86 | Railway or tramway locomotives | 114 | 112 | 0.829 | 0.019 | YES | NO |
| | 87 | Vehicles other than railway or tramway | 845 | 819 | 0.609 | 0.707 | YES | YES |
| | 89 | Ships, boats, & floating structures | 102 | 115 | 0.807 | 0.200 | YES | YES |
| Specialized equipment | 90 | Cinematographic, measuring, checking, & precision accessories | 2251 | 2218 | 0.191 | 0.000 | YES | NO |
| | 91 | Clocks, watches and parts | 328 | 223 | 0.972 | 0.510 | YES | YES |
| | 97 | Musical instruments | 353 | 316 | 0.753 | 0.011 | YES | NO |
| Mixed manufacturing | 94 | Furniture, bedding etc | 563 | 623 | 0.000 | 0.000 | NO | NO |
| | 95 | Toys, games and sports equipment | 665 | 707 | 0.091 | 0.020 | YES | NO |
| | 96 | Miscellaneous products | 720 | 671 | 0.265 | 0.000 | YES | NO |

Notes: Table displays the p values by chapter testing the null hypothesis ($b_1 = -b_2$) for the equation

$$\ln \left(\frac{q_{US}}{q_{Chn}} \right)_{i,t}^R = (\delta + \delta_2) + b_1 \ln(p_{US})_{i,t} + b_2 \ln(p_{Chn})_{i,t} + b_3 \ln(p_j)_{i,t} + b_4 \ln(Y_j)_{i,t}$$

If one cannot reject the null at the five percent level of significance then it is assumed that the products under consideration satisfy the necessary theoretical requirement for the estimation of the elasticity of substitution to be valid. Chapters that are theoretically valid for both the AS6 and EU10 regions are highlighted in grey.

Source: Authors calculations

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