The Effects of Global Competition from China on Taiwanese Labor Market

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Abstract

This paper investigates how intensified global competition from Chinese products affect Taiwanese labor market from 1990 to 2011. We find that intensified Chinese competition is associated with a decrease in manufacturing employment, with the brunt of impacts borne by low- and middle- education level workers. We also find that a lengthier industry quality can shield low-education level workers from more competition, but initially quality advantageous industries are more likely to lower low-education level worker employment when facing increasing Chinese competition. Our wage regressions suggest that among manufacturing industries an increase in Chinese competition does not affect high-education level workers' wages but is associated with a decrease in non-high education level workers' wages. We further find that while workers with less desirable human capital might be forced to leave with intensified competition, those most capable workers are also more likely to leave manufacturing, probably voluntarily doing so in order to avoid future competition.

Keywords: Taiwan, Global Competition, China, Product Quality, Labor Market

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I. Introduction

International trade plays a vital role in the Taiwanese economy. In 2015, the amount of total trade, exports and imports combined, is 117% of the Taiwan's GDP. In fact, excellent export performance has always been an important engine of Taiwan's economic growth in the past few decades, and earnings of Taiwanese workers have increased substantially throughout the period. In the past 20 years, however, although we still see economic and export growth, albeit probably less staggering than in the past, workers' earnings have not increased accordingly. For example, Chen (2012) documents that in Taiwan male workers' real wages stagnated since 1995, while female workers' wages stagnated since 2000. This pattern even holds true for highly-educated workers, as their wages also stagnated after 2000. A natural question is, then, why aren't Taiwanese workers benefitting from rising GDP, or specifically, increasing trade?

One potential answer to this question that receives much public attention is Taiwanese firms' offshoring to China. For example, in recent years over 50% of Taiwanese total export orders are produced in China; in some industries, e.g. the information and communication industry, in 2015 actually over 80% of export orders were produced on the other side of Taiwan Strait. In the academic literature, findings on the labor market effects of offshoring to China have been mixed. While earlier work such as Chen and Ku (2000) do not find such negative effect, a more recent paper by Tsou, Lin, Hammitt and Chang (2013) indeed find that FDI in China decreases domestic employment in Taiwanese parent firms. From a theoretical point of view, offshoring does not necessary imply a decrease in home country employment or home workers' wage. This occurs because while offshoring has a substitution effect that may hurt home country workers, it might also has a positive productivity effect that allow an expansion of sales and therefore benefit the home workers (Grossman and Rossi-Hansberg, 2008). Therefore, a question that one might raise is, why don't we observe a more powerful productivity effect in Taiwan?

One potential reason may be that Taiwanese export products are simply not good enough. Therefore, even if the Taiwanese products become cheaper because of the possibility of offshoring, the quality gaps between Taiwanese and other advanced countries' products are too large to be overcome by lower prices. Furthermore, when Taiwan's manufacturers set their production sites in China or even outsourced to local Chinese manufactures, spillovers may arise and Chinese firms may benefit from these knowledge leakages and became Taiwanese firms' competitors. A combination of failing to achieve high quality and facing more Chinese competition may cause little bargaining power among Taiwanese firms, and hence their profit margins are low and have no room for raising wages. One of the main difficulty in testing the above argument is that data on product quality is very difficult to get, and it is not until recent progress in the literature (for example, Hallak and Schott (2011), Khandelwal (2010), and Feenstra and Romalis (2014)) do economists have a more theoretically sound measurement of quality.

In this paper I will investigate the relationship between international competition, product quality, and labor market outcomes using Taiwanese data between 1990 and 2011. Focusing on the impact of Chinese global competition toward Taiwan, I will ask the following three questions:[1] (a) how does intensified Chinese global competition

[1] In a series of papers, Autor and coauthors study the short and medium run impacts of Chinese competition on the U.S. labor market. This paper complements their studies and further taking into account the role played by export quality.

affects manufacturing employment? (b) Does an industry with a longer quality ladder or a better quality level relative to Chinese manufactures shields its workers from Chinese competition? (c) What are the wage implications of increasing Chinese competition within the manufacturing sector? To study these issues, I will merge Taiwanese worker-level datasets with international trade data to conduct my analyses.

Our empirical results suggest that intensified Chinese competition is associated with a decrease in manufacturing employment, with the brunt of impacts borne by low- and middle- education level workers. We also find that a lengthier industry quality ladder can shield low-education level workers from Chinese competition, i.e. they are less likely to lose their jobs even with increasing Chinese competition. However, we also find that for those initially quality advantageous industries, they are more likely to decrease low-education level worker employment when they find rising Chinese competition. From our wage regression analyses on the manufacturing industries, we find that among manufacturing industries an increase in Chinese competition does not affect high-education level workers' wages but is associated with a decrease in non-high education level workers' wages. Combining our findings from both the employment and wage regressions further suggest very interesting worker dynamics in face of rising Chinese competition: workers, especially those with less desirable human capital, are first to leave the industry with intensified competition. However, for those highly competent workers, they are also more likely to leave manufacturing, potentially to avoid future competition.

This research adds on the existing literature on the effects of international trade on Taiwanese labor market from two important fronts. First, rather than focusing on traditional measures such as import penetration or offshoring, in this study my measurement of Chinese competition will includes Chinese competitions toward Taiwan globally, i.e. I will consider not only competitions in Taiwan and China but also in every Taiwan's main export markets. This type of measurement builds upon Eaton and Kortum (2002) multisectoral model of trade and has been used in empirical work such as Chor (2010) and Autor et al. (2014). As a small open economy, Taiwan trade openness is high (117% of the GDP, where 65% comes from exports and the other 52% comes from imports), so a large portion of competitions Taiwanese industries face are in foreign markets. As will be demonstrated, taking account of the global market is crucial for our analysis. In addition, as in Autor et al. (2014), an IV approach will be used to take into account of potential endogeneity problems.

Secondly, this paper explicitly considers the role played by product quality. Building upon the "contestability" idea proposed by Leamer (2007), Khandelwal (2010) shows that for the United States, industry with a longer quality ladder is less contested, so that its workers fare much better when foreign competition arises.[2] In this paper, we find support to Khandelwal's argument, though interestingly it is the low-education level workers that benefit the most. We furthermore find the quality difference between the competitor (China) and Taiwan matters. We interestingly find that for industries that initially enjoy more quality advantages, they seem to decrease low-education level worker employment to maintain advantage when facing stiffer Chinese competitions.

The organization of this paper is as follows. After this introduction, in the second section we illustrate our data sources and construction; in section 3 we discuss our

[2] In another paper, Weng, Li, and Weng (2015) that uses the data for this paper, we find that types of overseas R&D activities by Taiwanese multinationals also depend on relative quality between Taiwan and the host country. This suggests that taking quality difference across country into account is important for empirical work.

empirical specifications; section 4 presents our results, and we offer a brief conclusion in section 5.

II. Data Description

Employment and Wage Data

Our data on industry employment and individual wages are constructed from 1989-2011 Taiwan Manpower Survey and Taiwan Manpower Utilization Survey, respectively. Taiwan Manpower Survey is conducted monthly on civilian population of ages 15 and above, and the sample size in each survey is around 50,000 to 60,000 individuals. This survey is the main source for understanding the status of Taiwan's labor market, and it consists of detailed demographic information (e.g. gender, age, education, field of major, etc.) on as well as industry affiliations of individuals. These information allows us to construct time-series data on industry-level employment for workers with different characteristics.

One deficiency of the Taiwan Manpower Survey is its lack of wage information on individuals. Therefore, we additionally use the Taiwan Manpower Utilization Survey, which was done concomitantly with the Manpower Survey in May of each year. In terms of contents, the Manpower Utilization Survey supplemented us with important information such as income, number of hours per week usually worked, etc. Since this survey is only conducted in May, each year we only have wage information on approximately 50,000 to 60,000 individuals. In our wage sample, we only consider individuals between 15 and 64 years old who are not students and currently working. We constructed hourly wage information by dividing monthly wage with monthly hours of work. We then transform it to log of real hourly wage by deflating the figure using the Taiwanese CPI. As all of our regressions are done at the industry level, we also construct time-series data on industry average log of wage for workers. Finally, due to data quality concerns, samples in year 2008 are taken out from our analysis.

International Trade Data

In this paper, using international trade data we need to construct two sets of unique information: 1) the global competition presented by Chinese products (hereafter, Chinese global competition) towards Taiwanese products, and 2) indices on Taiwanese and Chinese industry quality.

Chinese global competition

Taiwan is a small open economy in which international trade with all around the globe plays a vital role in its economic development. Therefore, to consider Chinese competition presented towards Taiwanese firms, we need to consider competition situations in Taiwan as well as in every exporting market. Due to data limitation for some smaller countries, we only consider the 63 largest exporting markets for Taiwanese manufactures.[3] Exports to these markets accounts for over 90% of total Taiwanese exports.

Following Autor et al. (2013), I define the (5-year) change in Chinese global competition (GC) faced by Taiwanese manufactures j as:[4]

$$\Delta GC_{wcj,t} = \frac{\Delta M_{wcj,t} + \sum_{o \neq c} \frac{X_{owj,t-5}}{E_{oj,t-5}} \Delta M_{ocj,t} - \Delta X_{cwj,t}}{Y_{wj,t-5}} \qquad (1)$$

In equation (1), the denominator $Y_{wj,t-5}$ represents the 5-year lagged output level of Taiwanese industry, and the first term in the numerator, $\Delta M_{wcj,t}$, represents

[3] We use the UN Comtrade Data for trade flows information.
[4] Autor et al. (2013) setup is based on Eaton and Kortum (2002) model of trade in a multisectoral setting. It attempts to capture the impact of increasing competition due to positive shocks in competitors' export supply.

the change in Taiwanese imports from China between years *t-5* and *t*. Hence, $\Delta M_{wcj,t}/Y_{wj,t-5}$ simply shows the change in import penetration commonly seen in the literature.[5] The third term in numerator, $-\Delta X_{cwj,t}$, represents the (negative) change in Taiwanese exports to China between years *t-5* and *t*. We have a negative sigh here because increasing exports to China implies less competition from Chinese firms. In the literature, some studies might look at the "net" import penetration of a country in order to consider both the import and export effects. In equation (1), this can conveniently be calculated by just considering the first and third terms in the numerator. The main contribution of Autor et al. (2013) specification is the second term in the numerator, $\sum_{o\neq c}\frac{X_{owj,t-5}}{E_{oj,t-5}}\Delta M_{ocj,t}$, which aims to measure the changes in Chinese competition toward Taiwanese industries in third countries' markets. Here, $\Delta M_{ocj,t}$ represents the change in third market *o* imports of Chinese products, $X_{owj,t-5}$ represents the 5-year lagged Taiwan's exports to third market *o*, and $E_{oj,t-5}$ represents the 5-year lagged consumption of industry *j* in third market *o*.[6] To best understand this term, notice that China presents more of a threat to Taiwanese manufacture if a) third market *o* is an important export markets for Taiwanese firms (higher $X_{owj,t-5}$) or b) the increase in Chinese penetration $\frac{\Delta M_{ocj,t}}{E_{oj,t-5}}$ is larger. Summing up all the competition across these other countries constitutes the third market competition effect.

How important is using this new measure of global competition? To understand its importance, in Figures 1, 2, and 3 we look at the measured competition indices for

[5] In most papers, import penetration is calculated by dividing imports with domestic *consumption*. Here we use domestic output rather than consumption because our goal is to see how Chinese competition within an industry affects demand for workers within that industry. Hence, using output as the denominator may be more appropriate.

[6] To calculate the consumption level of industry *j* in a third market *o*, we multiply country *o*'s GDP with the average Taiwanese share of GDP consumed in industry *j*.

three industries: food manufacturing industry, electrical and electronic manufacturing industry, and plastic industry. In each figure, we show three competition indices for each industry, the import penetration index (IM-competition), the net import penetration index (NIM-competition), and the global competition index (G-competition). In Figure 1, we see that for the food manufacturing industry, these three indices follow closely to each other, indicating the changes in Chinese competition are dominated by the changes in import penetration, while changes in Taiwanese exports to China and third market competition play a much smaller role. This might occur because Taiwanese food manufactures mainly focus on the domestic market, and put much less emphasis in the Chinese and other export markets. In Figure 2, on the other hand, we see great divergence among the three competition indices for the electrical and electronic manufacturing industry. Using the traditional import penetration index, we only see a slight increase in Chinese competition pressure throughout our sample years; when consider both imports and exports as in the net import penetration index we actually see a sharp *decrease* in Chinese competition pressure as the increase in Taiwan's exports to China dominates the increase in Taiwan's imports from China. This occurs because the growth in Taiwan's exports to China outpaces the growth in Taiwan's imports from China for this industry; however, when we also consider the third market competition effects using the global competition index, we now see a sharp expected increase in Chinese competition pressure since 2003. This suggests that the real threat from China to Taiwan's electronic firms occurs in third country markets such as the EU, Japan, USA, etc. Finally, in Figure 3 we observe another pattern for the plastic industry. While the import penetration index slightly increase since 2003, implying more Chinese imports in Taiwan's domestic market, the net import penetration and global competition index both suggest that a substantial decrease in Chinese competition pressure. This might come about because a large increase in Taiwan's exports to China, while little has changed in other third country markets. Overall, we find large qualitative differences among the three competition indices, suggesting the need to incorporate the most comprehensive global competition index for a small open economy such as Taiwan.

Industry Quality Indices

My measurement for industry quality are constructed from the export quality indices computed in Feenstra and Romalis (2014). In their paper, they simultaneously consider the demand and supply sides and come up with annual export quality measures at the 4-digit SITC industry level for each country between 1984 and 2011. Based on their indices, for each 4-digit SITC industry k one can identify the country with the highest quality, λ_{kt}^{max}, and the country with the lowest quality, λ_{kt}^{min}. The difference between them, $\lambda_{kt}^{max} - \lambda_{kt}^{min}$, is called the length of quality ladder. A product with longer quality ladder is assumed to have more potential for vertical differentiation, and is usually produced by higher income countries that are technologically advanced.

Since Feenstra and Romalis (2014) have calculated the export quality for every country, including Taiwan and China, we can define the quality difference between Taiwan and China for a particular industry k at time t as $\lambda_{kt}^{TW} - \lambda_{kt}^{CHN}$. The more positive is this difference, the better is Taiwan's product quality relative to that of China's products.

Finally, since the original Feenstra and Romalis quality measure is provided at the 4-digit SITC industry level, we transform them to indices at the Taiwan SIC 2-digit industry level using Taiwanese export weights.

Other Industry-Level Data

In addition to information on international trade, we also consider other industry level data to serve as additional control variables in our analyses. Specifically, one might be worried about how changes in production technologies might affect employment and wage in Taiwanese industries. Unfortunately, such information is difficult to obtain in Taiwan, so we instead employ the NBER U.S. manufacturing productivity database and use the U.S. industry's share of non-production workers as a proxy for skill intensity, and capital-labor ratio as a proxy for capital intensity in the corresponding Taiwan industry.[7]

III. Empirical Specification

This paper first studies how intensified Chinese global competition affects manufacturing employment, and ask the questions of whether a longer industry quality ladders and a more favorable relative quality status can shield workers from Chinese competition. Next, this paper studies whether intensified competition would cause a decrease in industry wages.

To study the employment effects, we use the following long difference (5-year) specification for industry *j* at time *t*:

$$\Delta \text{employment}_{jt} = \alpha \Delta GC_{wcj,t} + \beta X_{j,t-5} + \varepsilon_{jt} \tag{2}$$

In equation (2), $\Delta \text{employment}_{jt}$ denotes the change in employment levels between year t and t-5, $\Delta GC_{wcj,t}$ denotes the change in Chinese global competition between year t and t-5, and $X_{j,t-5}$ denotes a set of industry characteristics at t-5,

[7] Although due to differences in technological level and factor returns there might be substantial difference in production technologies between these two countries, by using 5-year difference in our analysis we only require that the trends in production technologies between corresponding industries in Taiwan and the U.S. be similar.

including lengths of industry quality ladders, skill intensity, capital-labor ratio, and the relative industry quality between Taiwanese and Chinese manufactures. We further distinguish between changes in employment for workers with different levels of education attainment: low-education level (less than 12 years), middle-education level (12-15 years), and high-education level (16 years and above).

One of the main empirical challenge in equation (2) is that the changes in Chinese global competition may not be exogenously determined, but rather due to shocks that impact Taiwanese export supply. Following Autor et al. (2013), we instrument change in Chinese global competition toward Taiwan, $\Delta GC_{wcj,t}$, by a variable, $\Delta GC_{Hcj,t}$, indicating the change in Chinese global competition toward eight high-income countries: Australia, Switzerland, Germany, Denmark, Spain, Finland, New Zealand, and the U.S.[8] The construction of this instrument is similar to that of $\Delta GC_{wcj,t}$.

In order to see whether a longer industry quality ladder or a more favorable relative quality status can shield workers from Chinese competition, we add additional interaction terms in equation (2):

$$\Delta \text{employment}_{jt} = \alpha \Delta GC_{wcj,t} + \gamma \Delta GC_{wcj,t} \times Y_{j,t-5} + \beta X_{j,t-5} + \varepsilon_{jt} \qquad (3)$$

Here, $Y_{j,t-5}$ denotes either length of industry quality ladder or relative industry quality.

In addition to employment effects, we also study the wage effects of Chinese global competition. To do this, we use specifications similar to equations (2) and (3).

[8] We choose the same 8 countries as in Autor et al. paper, with the sole difference been the U.S. in our paper but Japan in Autor et al. We favored the U.S. over Japan there are much cooperation and interaction between Taiwan and Japan, so part of Japan's demand for Chinese exports might arise from changes in Taiwan's productivity and/or export supply.

Specifically, the industry level wage regression takes the form:

$$\Delta\log(\text{industry wage})_{jt} = \alpha\Delta GC_{wcj,t} + \beta X_{j,t-5} + \delta\Delta Z_{jt} + \varepsilon_{jt} \quad (4)$$

Here, $\Delta\log(\text{industry wage})_{jt}$ denotes the change in (log of) average wages between year *t* and *t-5* for industry *j*; $\Delta GC_{wcj,t}$ and $X_{j,t-5}$ are defined similarly as before; ΔZ_{jt} is the new term in equation (4), and it denotes a vector of 5-year difference in means of workers' characteristics for industry j. These personal characteristics are used to characterize the human capital composition within industry j, and they include education levels, ages and their squares, tenures and their squares, marital status, gender, and whether work in public sectors. As in the employment regression, we will estimate equation (4) using an instrumental variable approach. Finally, in order to see whether product quality impacts the wage effects of Chinese global competition, we conduct the following analysis similar to equation (3):

$$\Delta\log(\text{industry wage})_{jt} = \alpha\Delta GC_{wcj,t} + \gamma\Delta GC_{wcj,t} \times Y_{j,t-5} + \beta X_{j,t-5} + \delta\Delta Z_{jt} + \varepsilon_{jt} \quad (5)$$

Since all of our analysis are conducted at the industry level, we cluster our errors at the industry level. Furthermore, we use 5-year lag industry employment levels as weights, so all of our analyses could be viewed as estimating the mean effects of Chinese competition on Taiwanese manufacturing industries.

IV. Empirical Findings

A. Employment impacts of global competition from Chinese products

In Table 2, we present our results showing how global competition from Chinese products affects employment in Taiwan manufacturing industries based on equation

(2).[9] As we have weighted our industry samples based on industry employment levels, the regression results could be viewed as the average effects of Chinese competition on the entire Taiwanese manufacturing sector. Furthermore, as we are concerned the observed changes in Chinese competition may in part reflect domestic shocks to Taiwanese industries, the results shown are specifications where we use changes in Chinese competition toward other high income countries as instruments for changes in Chinese competition faced by Taiwanese industries.

In the first four columns, we simply regress 5-year changes in industry employment on 5-year changes in Chinese competition, lagged 5-year industry employment levels, and year dummies.[10] As we can see, intensified Chinese competition is associated with a decrease in industry employment level, although the brunt of impacts appears to be borne by low-education level workers. In columns 5 through 8 we add additional industry controls as one might be concerned about omitted variable bias. As we can see in these columns, once we add these additional industry level variables, as a whole the impact of Chinese competition on manufacturing employment rises, and now the negative impacts affect both the medium- and low-education levels workers, and the magnitude among these two groups of workers are also similar. However, we find that Chinese competition still does not affect employment of high-education level workers, as both the coefficient's magnitude and significance seem to be small.

What is the quantitative importance of Chinese competition on manufacturing

[9] Here we ignore trade in services due to data limitations. Hence, we could only look at the impact on the manufacturing sector.
[10] To further ease the concern about simultaneity bias, we lagged the 5-year changes in Chinese competition by one year, so we actually look at the difference in Chinese competition between year t-1 and t-6.

employment? To answer this question, notice that from the summary statistics (Table 1), during the sample period the average 5-year change in Chinese competition is approximately 5.84%, so the average effects (based on column 5-7) on 5-year change in total employment, low education level employment, and middle education level employment are -4927, -2615, and -2302 person per industry.[11] From the summary statistics we also see that on average there is employment growth in both total and middle education level employment, but a decline in low education level employment of -17,422 people every five years. Hence, intensified Chinese global competition can explain 15% (=-2,615/-17,422) of the decrease in manufacturing low education level employment.

In columns 5 through 8 we also see how other industry level variables affect employment of different educational level workers. The results are mostly consistent with our expectations. For industries with more room for vertical differentiation (as proxied by the ladder length of the industry), we find the employment growth in both medium and high education level workers. In a similar vein, for industries that are more skill intensive (as proxied by the share of nonproduction workers in corresponding U.S. industries), employment growth appears for all three types of workers. In addition, we find that for industries with larger initial employment levels, they significantly increase high-education level employment but significantly decrease low-education level employment. These three findings suggest that Taiwan has been more focused on these skill-intensive high-tech industries during the past 20 years. Interestingly, we find that while capital intensity (as proxied by capital-labor ration in corresponding U.S. industries) has a positive impact on employment of high

[11] There are 21 industries in total, so the total decrease in manufacturing employment during the 5-year period are 103,467 people as a whole, 54,915 people for low education level employment, and 48,342 people for middle education level employment.

education level workers, it has no impact on low education workers and a negative impact on middle education level workers. This result fits well with Autor et al. (2003) claim that computerization and automation replace routine tasks, which have previously mostly been undertaken by middle skill workers.

In column 9 of Table 2, we show our OLS result to demonstrate the importance of instrumenting our main explanatory variable. Comparing columns 5 and 9, we see that without using instrumental variable (column 9), the effect of changes in Chinese competition becomes smaller in magnitude and insignificant (although the p-value is 0.101). This suggests that without using an instrumental approach we might confound the actual impact of Chinese competition with domestic shocks to Taiwanese industries.

Khandelwel (2010) argues that the effects of international competition on labor will be more pronounced in short quality ladder industries, since shorter quality ladders imply fewer opportunities for vertical differentiation, which is essential for survival when facing competition from low-income countries. To test this hypothesis, in the first four columns in Table 3 we interact the industry quality ladder length with changes in Chinese competition and see if lengthier quality ladder can successfully shield workers from competition. From column 1 we that longer quality ladder has positive but insignificant impact on the employment effect of changes in Chinese competition. However, from columns 2 to 4, we see that the insignificant impact stems from its ineffectiveness in protecting middle- and high- education level workers, but it significantly lessens the negative effect of Chinese competition on low-education level worker employment. This result supports Khandelwel's claim, though my result further suggest that it is the low education level workers that benefit the most.

While longer quality ladder might help the employment situation for low education level workers when facing Chinese competition, we do not know how workers of different education levels fare when China's product quality is catching up with Taiwan's product quality. In columns 5 through 8 in Table 3 we attempt to answer this question by adding a variable which interacts the industry quality difference (between Taiwan and China) with changes in Chinese global competition. We also add the industry quality difference as an additional control covariate. From the Table, we see that for industries that initially enjoy larger quality advantage over China, they also has a larger increase in total employment, with the beneficiaries mainly been middle and high education level workers (the increase in employment among low education level workers is small and insignificant). Furthermore, we find that for these initially advantageous industries, when they face more Chinese competition, they are more likely to decrease employing low education level workers (they also tend to decrease employing middle- and high- education level workers, but the coefficients are far from significant.) This result is to some extent counterintuitive, but this might suggest that for these quality advantageous industries the first step to maintain competitiveness is to upgrade their industry skill levels. In sum, our results suggest that for industries with more quality advantage over China, they are more likely to employ middle- and high- education level workers, and when they face increasing Chinese competition, they are also more likely to decrease their hiring of low-education level workers.

B. Wage impacts of global competition from Chinese products

In the previous subsection we show that increasing Chinese competition is associated with decreasing employment in manufacturing industries. However, how does it affect workers' wages?

To answer this question, in Table 4 we present our results showing how changes in global competition from Chinese products affects changes in wage levels among Taiwan manufacturing industries based on equation (4). Again, we have weighted our industry samples based on their employment weights, so the regression results also represent the average effect on wage changes in the entire Taiwanese manufacturing sector. The results shown are also based on the instrumental variable approach, with the same set of instruments used in the employment regressions.

In the first 3 columns of Table 4 we simply regress 5-year changes in industry average log of hourly wages on 5-year changes in Chinese competition, lagged 5-year industry average log of hourly wages, and year dummies. While the first column looks at the average wage effect on all workers, the second and third columns presents results when we focus on high education level workers and non-high (middle-and low-) education level workers, respectively. From the first 3 columns, we surprisingly find that while as a whole more Chinese global competition does not significantly affect industry wages (column 1), it significantly decrease industry average wages among high education workers (column 2) but has no significant impact on non-high education workers (column 3).

Looking only at changes in industry average wages may be insufficient, as one should also take into account the human capital embodied in workers. In columns 4 through 6, we further controlled in our wage regressions for changes in industry average workers' characteristics, e.g. changes in workers' educational attainment and ages, that are often considered to affect a person's wage in a Mincer equation. We find that adding these personal characteristics substantially alter our findings. First, we find that now intensified Chinese global competition is associated with a decrease in industry average wages among all workers and among non-high education workers. However, its effect on industry average wages among high education workers becomes insignificant. What are the implications? Notice that we can learn about the changes in the quality of workers stayed within the manufacturing industries if we compared the results between controlling and not controlling for the composition of workers. For example, finding a more negative wage effect of Chinese competition on workers as a whole and on non-high education workers with personal characteristic controls suggests that with more competition the worker quality (at least the observed part) within manufacturing has increased for these two types of workers. However, finding a less negative wage effect on high education workers suggests that more Chinese global competition is associated with a *decrease* in observed worker quality among this type of workers.

One can further learn about the worker dynamics if we look at the results in Table 2 and 4 together. Recall that in Table 2 we learn that more Chinese competition is associated with a decrease in total employment, of which mainly from non-high education employment. When we combine this with our wage findings suggests that during the rise in Chinese competition, workers, especially those with less desirable human capital, are first to let go. On the contrary, we see in Table 2 that increasing Chinese competition does not significantly decrease high-education workers' employment level. However, the results in Table 4 that this masks the changing composition of high-education workers. Specifically, we learn that while employment level among high-skilled workers do not change, it is the more abled ones that leave while the less abled ones stay. This might suggest that the more competent workers, envisioning the threat of Chinese competition, will be the first to leave manufacturing in order to avoid competition.

In columns 7-9, we also include additional industry-level variables to our regressions. Our results suggest that adding these industry variables does not affect much our findings, with the biggest difference been that for high-education workers the wage effect changes from insignificantly negative to insignificantly positive.

In Table 5, we interact industry-quality related variables with changes in Chinese competition to see product quality also plays a role in wage determination. From the first three columns in Table 5, we see that a longer ladder will alleviate part of the negative wage effect of Chinese global competition, and this is especially relevant for non-high education workers. Again, if we combine this result with those in Table 3, we see that a longer ladder will shield low education workers as they are less likely to lose their jobs (Table 3 column 2) and also suffer less wage loss (Table 5 column 3). In columns 4-6, we do not see quality difference between Taiwan and China important in determining the wage effect of Chinese global competition.

V. Conclusion

In this paper, we merge Taiwanese worker-level dataset with international trade data to study how intensified Chinese global competition affects the Taiwanese labor market. Compared with previous studies, we extend the literature by considering the competitions put forth by Chinese firms in all main exporting markets of Taiwanese manufactures. This extension is especially crucial to our understanding of the Taiwanese case as international trade plays a vital role in Taiwan’s economic development. We further consider the role played by product quality in determining the labor market effects bring about by Chinese competition.

Our results suggest that intensified Chinese competition is associated with a decrease in manufacturing employment, where most of the negative impacts fall on low- and middle- education level workers. We also find that, in accordance with Khandelwal (2010) argument that a lengthier industry quality can shield low-education level workers from Chinese competition. However, we find that for those initially quality advantageous industries, they are more likely to decrease low-education level worker employment when facing increasing Chinese competition. Based on our wage regression results, we find that among manufacturing industries an increase in Chinese competition does not affect high-education level workers' wages but is associated with a decrease in non-high education level workers' wages. Combining our findings from both the employment and wage regressions suggest that while workers with less desirable human capital might be forced to leave the industry with intensified competition, those most capable workers are also more likely to leave manufacturing, probably voluntarily doing so in order to avoid further competition.

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Figure 1: Comparison of Changes in 3 Competition Indices (Food Manufacturing Industry)

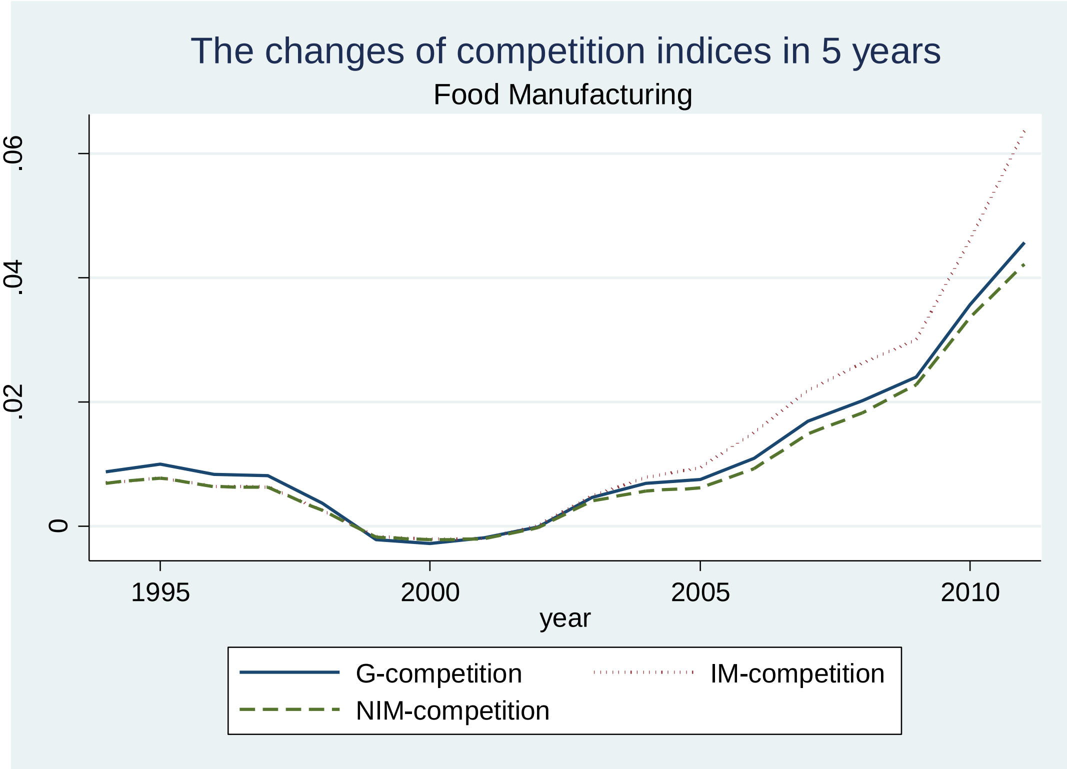

Figure 2: Comparison of Changes in 3 Competition Indices (Electrical and Electronic Manufacturing Industry)

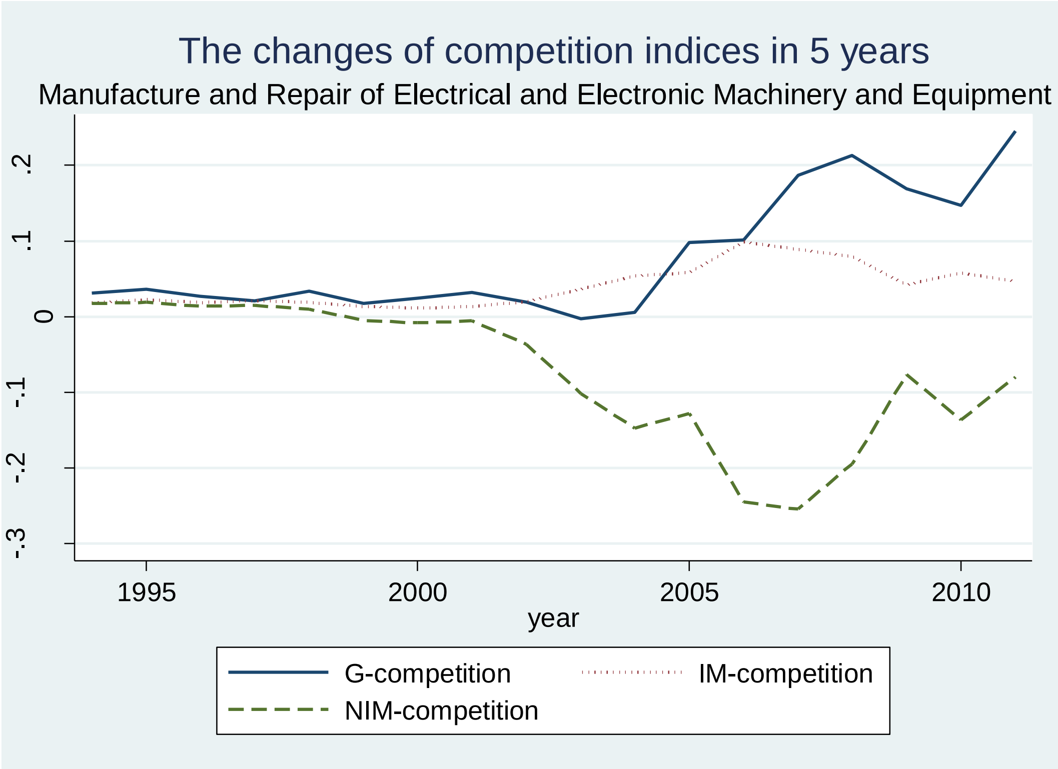

Figure 3: Comparison of Changes in 3 Competition Indices (Plastic Industry)

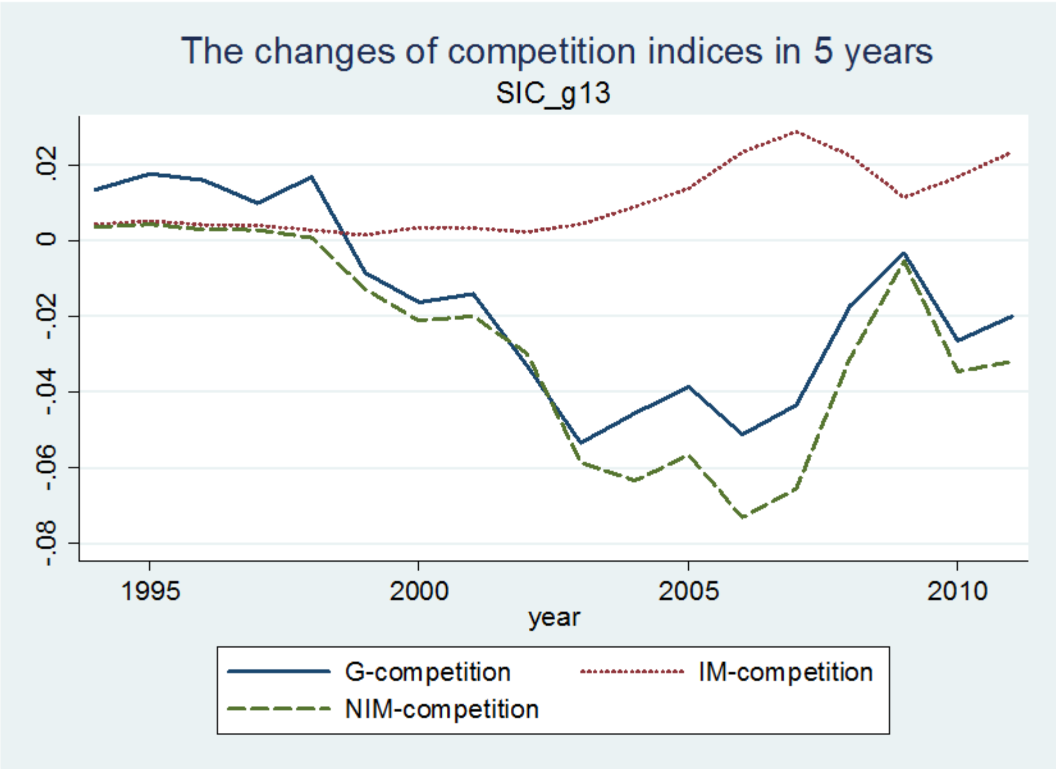

Table 1: Summary Statistics (weighted)

Variable	Obs	Mean	Std. Dev.	Min	Max
Δ Industry Employment	357	35452.56	72280.53	-59158.16	210515.40
Δ Industry Employment (low-education)	357	-17421.82	15533.98	-53972.07	15482.25
Δ Industry Employment (middle-education)	357	9574.15	24772.61	-35253.41	78566.09
Δ Industry Employment (high-education)	357	43300.22	64440.95	-3946.83	197024.50
Δ Industry Chinese global competition (%)	357	5.84	15.92	-144.86	187.70
Length of industry quality ladders	357	5.48	1.78	0.95	17.26
Skill intensity (share of nonproduction workers, %)	306	0.43	0.12	0.24	0.61
Capital labor ratio	306	94.40	75.71	11.50	808.97
Quality difference	357	0.22	0.16	-1.15	1.15
Log of hourly real wage	592,826	5.03	0.64	-6.02	9.16

Table 2: Employment effect of China's global competition

Dependent Variable: Δ Industry Employment$_t$	Total (1)	Low Education (2)	Medium Education (3)	High Education (4)	Total (5)	Low Education (6)	Medium Education (7)	High Education (8)
Δ China global competition $_t$	-563.37**	-448.84***	-125.92	11.40	-843.70***	-447.69***	-394.15***	-1.86
	(227.47)	(84.30)	(114.00)	(125.14)	(238.83)	(87.84)	(125.00)	(126.81)
Ladder$_{t-5}$					6,435***	706.1	2,876**	2,853**
					(2,137)	(564.6)	(1,264)	(1,154)
Skill intensity $_{t-5}$					1,989.40***	205.22*	738.38***	1045.80***
					(475.51)	(104.99)	(236.84)	(257.41)
Capital/labor ratio $_{t-5}$					4.277	11.15	-45.35***	38.47***
					(26.69)	(6.936)	(16.06)	(13.84)
Employment level $_{t-5}$	0.230***	-0.0422***	0.0330**	0.239***	0.139***	-0.0517***	-0.0010	0.191***
	(0.0224)	(0.00352)	(0.0132)	(0.0127)	(0.0236)	(0.00559)	(0.0137)	(0.0138)
Constant	-52,068**	3,555	-16,203	-39,420***	-146,428***	-8,009	-46,428***	-91,991***
	(20,375)	(2,660)	(11,184)	(11,987)	(27,066)	(5,617)	(13,232)	(17,123)
Observations	357	357	357	357	306	306	306	306
R-squared	0.676	0.471	0.301	0.884	0.730	0.498	0.385	0.907
Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Note: *** p<0.01, ** p<0.05, * p<0.1

Table 3: Industry quality and the employment effect of China's global competition

Dependent Variable:	Total	Low Education	Medium Education	High Education	Total	Low Education	Medium Education	High Education
Δ Industry Employment $_{t}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ China global competition $_{t}$	-1,926.14	-1,527.64***	-318.59	-79.91	-85.42	-25.32	-218.17	158.07
	(1,236.98)	(345.27)	(572.14)	(693.56)	(225.18)	(88.51)	(134.88)	(174.02)
Ladder $_{t-5}$*	180.09	179.67***	-12.57	12.98				
Δ China global competition $_{t}$	(198.18)	(55.29)	(91.58)	(112.32)				
Quality difference $_{t-5}$*					-3,571.29**	-1,564.23***	-308.56	-1,698.50
Δ China global competition $_{t}$					(1,743.57)	(362.70)	(581.54)	(1,766.27)
Ladder $_{t-5}$	5,838**	110.2	2,918**	2,810**	4,524**	481.7	2,065*	1,978*
	(2,316)	(590.7)	(1,307)	(1,270)	(1,917)	(584.3)	(1,099)	(1,067)
Quality difference $_{t-5}$					94,440***	1,670	44,216***	48,554***
					(18,540)	(5,104)	(10,119)	(10,684)
Skill intensity $_{t-5}$	1,895.26***	111.29	744.95***	1,039.02***	2,079.40***	241.74**	765.22***	1,072.43***
	(527.23)	(112.91)	(254.55)	(283.87)	(452.11)	(104.72)	(226.68)	(245.34)
Capital/labor ratio $_{t-5}$	-1.387	5.498	-44.95***	38.07***	65.79**	23.47***	-21.46	63.79***
	(26.62)	(7.228)	(15.54)	(13.48)	(28.37)	(7.484)	(16.74)	(15.11)
Employment level $_{t-5}$	0.143***	-0.0479***	-0.00122	0.192***	0.136***	-0.0520***	-0.00221	0.190***
	(0.0259)	(0.00538)	(0.0143)	(0.0146)	(0.0226)	(0.00516)	(0.0132)	(0.0132)
Constant	-139,908***	-1,503	-46,883***	-91,521***	-173,689***	-9,864*	-58,590***	-105,235***
	(30,604)	(5,947)	(14,278)	(18,986)	(25,228)	(5,806)	(12,513)	(16,291)
Observations	306	306	306	306	306	306	306	306
R-squared	0.724	0.523	0.387	0.907	0.757	0.521	0.430	0.914
Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Table 4: Wage effect of China's global competition

Dependent Variable: Δ Industry Average Wage $_t$	Total (1)	High Education (2)	Non-high Education (3)	Total (4)	High Education (5)	Non-high Education (6)	Total (7)	High Education (8)	Non-high Education (9)
Δ China global competition $_t$	-0.0493	-0.256*	-0.0792	-0.118**	-0.121	-0.182***	-0.147**	0.0402	-0.178**
	(0.0739)	(0.139)	(0.0540)	(0.0593)	(0.128)	(0.0633)	(0.0712)	(0.107)	(0.0747)
Ladder $_{t-5}$							0.00175	-0.00981**	0.00482*
							(0.00242)	(0.00451)	(0.00255)
Skill intensity $_{t-5}$							0.0551	0.148***	-0.0573
							(0.0414)	(0.0500)	(0.0397)
Capital/labor ratio $_{t-5}$							0.000311***	0.000528***	0.000283***
							(5.63e-05)	(7.89e-05)	(4.69e-05)
Industry Average Wage $_{t-5}$	-0.164***	-0.371***	-0.189***	-0.147***	-0.284***	-0.208***	-0.294***	-0.716***	-0.276***
	(0.0586)	(0.120)	(0.0455)	(0.0444)	(0.0967)	(0.0396)	(0.0426)	(0.0922)	(0.0417)
Constant	0.810***	1.907***	0.901***	0.670***	1.416***	0.971***	1.340***	3.573***	1.257***
	(0.308)	(0.633)	(0.233)	(0.238)	(0.509)	(0.202)	(0.231)	(0.474)	(0.221)
Observations	336	331	336	336	331	336	288	288	288
R-squared	0.663	0.400	0.679	0.761	0.551	0.712	0.794	0.698	0.752
Personal Controls	NO	NO	NO	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: *** p<0.01, ** p<0.05, * p<0.1

Table 5: Industry quality and the wage effect of China's global competition

Dependent Variable:	Total	High Education	Non-high Education	Total	High Education	Non-high Education
Δ Industry Average Wage $_{t}$	(1)	(2)	(3)	(4)	(5)	(6)
Δ China global competition $_{t}$	-0.484***	-0.195	-0.614***	-0.0492	0.0610	-0.0649
	(0.169)	(0.548)	(0.222)	(0.0565)	(0.0714)	(0.0704)
Ladder $_{t-5}$*	0.0542**	0.0404	0.0693**			
Δ China global competition $_{t}$	(0.0226)	(0.0843)	(0.0343)			
Quality difference $_{t-5}$*				-0.458	0.0719	-0.547
Δ China global competition $_{t}$				(0.430)	(0.443)	(0.452)
Ladder $_{t-5}$	0.000346	-0.0106**	0.00284	0.00139	-0.0109**	0.00473*
	(0.00276)	(0.00449)	(0.00364)	(0.00251)	(0.00503)	(0.00268)
Quality difference $_{t-5}$				0.0152	0.0697	0.00348
				(0.0271)	(0.0431)	(0.0296)
Skill intensity $_{t-5}$	0.0374	0.140***	-0.0871*	0.0767*	0.138**	-0.0526
	(0.0508)	(0.0537)	(0.0517)	(0.0465)	(0.0542)	(0.0398)
Capital/labor ratio $_{t-5}$	0.000313***	0.000524***	0.000278***	0.000347***	0.000593***	0.000320***
	(5.56e-05)	(7.30e-05)	(5.84e-05)	(8.09e-05)	(8.09e-05)	(6.98e-05)
Industry Average Wage $_{t-5}$	-0.322***	-0.726***	-0.314***	-0.291***	-0.734***	-0.272***
	(0.0431)	(0.101)	(0.0564)	(0.0477)	(0.0838)	(0.0460)
Constant	1.493***	3.632***	1.470***	1.317***	3.650***	1.235***
	(0.235)	(0.525)	(0.304)	(0.254)	(0.439)	(0.240)
Observations	288	288	288	288	288	288
R-squared	0.787	0.694	0.744	0.794	0.701	0.748
Personal Controls	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES