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The Impact of Trade Liberalisation on Market Concentration

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Abstract

In this empirical study, we use the Difference in Difference estimation to investigate the impact of trade liberalisation on market concentration. We include different measures of market concentration to examine the effect of trade liberalisation on different firm levels (e.g., HHI, CR20, CR4, etc.). We employed the Annual Surveyed Industrial Enterprise (ASIE) firm-industry level dataset to compute the market concentration. Our findings show that output tariff reduction has a significant positive impact on market concentration. This result is robust at all levels of market concentration measures. Then, we found that under trade liberalisation, rising market concentration is mainly driven by the decreasing number of firms.

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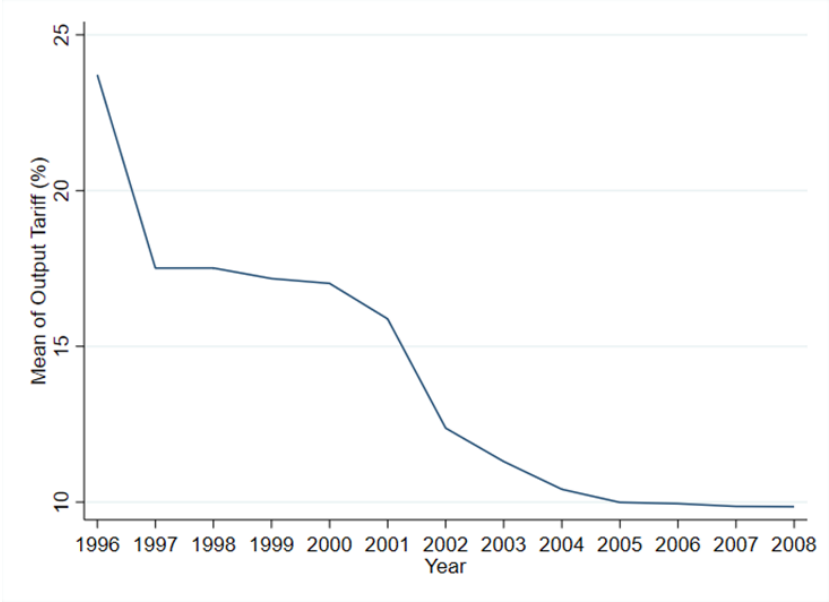
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Section 1. Introduction

In the past few years, market concentration has been widely discussed by many researchers (such as Autor et al., (2020); Bonfiglioli, Crinò and Gancia (2021); CEA (2016); Gutiérrez and Philippon (2017) Amiti and Heise (2021); Freund and Pierola, (2015); Bai, Mao and Zhang (2014)). This is because market concentration is often treated as an indicator of market power. Melitz's model suggests with trade cost reduction, market concentration increases. Rising market concentration is found by researchers Autor et al. (2020), Gutiérrez and Philippon (2017), and falling market concentration found by Amiti and Heise (2021); Freund and Pierola (2015); Bai, Mao and Zhang (2014). However, the impact of trade liberalisation on market concentration remains unclear.

The early 2000s marked a significant period for China as it underwent rapid development, expanded onto the international stage, and progressed towards global integration. The process for China to apply to become a member of the WTO is lengthy. It took 15 years of negotiations after China notified the WTO. Figure 1 shows the output tariff experienced two dramatic cuts in 1997 and 2002, respectively. Additionally, the tariff was barely changed between 1997-2000. Finally, the tariff reached its steady state after 2005, as China was required to complete the tariff reduction by 2004. The first reduction, in 1997, was a condition that China to the WTO, and the second reduction happened after China officially became a WTO member.

Figure 1 Output Tariffs Evolution Between 1996-2008(HS6-products)



In this study, the measure of market concentration constructed at different level. The most common measure of market concentration is Herfindahl-Hirschman Index (HHI) and concentration ratio of top N firms. Our study focus on the impacts of trade liberalization on the market concentration ratio with top 20s (CR20) and supplemented with CR 4 and HHI, and we examine other concentration ratio level at CR1, CR2, CR8, CR10 and CR50 for robustness check, our result remains robust positive. To compute the market concentration, we require to have all firms, and Annual Survey of Industrial Enterprise (ASIE) dataset provide the most comprehensive data for Chinese firms during the period 1998 to 2008 which allowed us to compute the measure of market concentration. However, our measure of market concentration could be underestimated with this dataset, the reason of this is ASIE includes all SOEs, but for non-SOEs, only firms with sale above 5 million RMB are included (Bai, Mao and Zhang, 2014). The graph one illustrates the average lnCR20 before the WTO accession and the percentage changes of lnCR20 after the accession, more than 50 percent of industries market concentration increased higher than 20% after during the post-WTO period. At the same time, there four out of twenty-eight industries have experienced the market concentration decline.

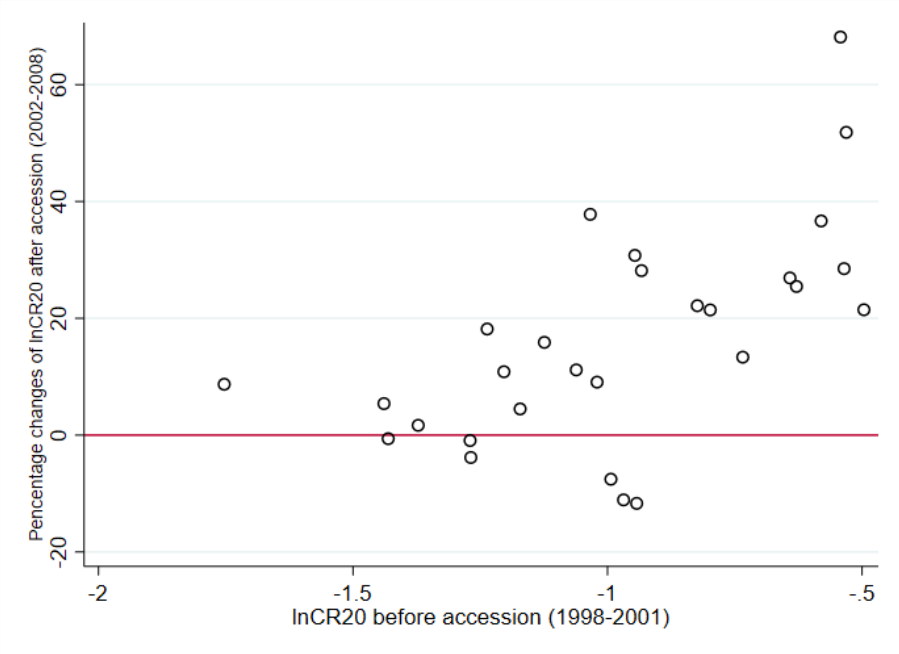


Figure 2 lnCR20 pre-WTO with percentage changes of lnCR20 post-WTO

The main aim of this study is to analyse the impact of trade liberalisation on market concentration. We use the output tariff reduction to indicate trade liberalisation. According to the figure1, output tariff drops dramatically after WTO accession. Both final goods and intermediate goods played an essential role in analysing the trade model (Goldberg et al., 2010). In addition, trade liberalisation not only reflects on the output tariff but also on the input tariffs. Ma, Xu and Zhang (2019) used the input tariff as a regressor of interest to investigate the trade liberalisation impact on China's Manufacturing servitisation. Therefore, we also analyse the impact of input tariff reduction on market concentration in the baseline model. Moreover, China joining the WTO implies a fall in trade uncertainty, and the impacts of TPU reductions on market concentration are one of our interests. Falling in TPU allows domestic market access to foreign markets, increases the variety of goods, and boosts productivity and innovation (Imbruno, 2019; Liu and Ma, 2021).

The Difference-in-difference specification was introduced in our study to investigate the impact of trade liberalisation on market concentration by employing WTO accession as an event. Following the approach of Lu and Yu, 2015, we divided our data into two subsamples upon observing the output tariffs in 2001. The treatment group, also called the high tariff group, is the industries that had higher tariffs in 2001, which means after WTO accession,

these industries experienced higher tariff reduction. The control group are industries with lower tariffs in 2001. In addition, we compare the market concentration for the treatment group and control group for the pre-WTO period and the post-WTO period. Our results show that trade liberalisation effectively mitigates the decrease in market concentration.

It is important to check the validity of the DID estimation. First, the pre-exit difference should not exist; the control and treatment groups should have a parallel trend in the pre-WTO period. Additionally, without China's WTO accession, the treatment and control groups should follow the same trend in the post-WTO period. Other ongoing policies should isolate from the impact of the trade liberalisation effect, so we add additional controls to avoid those effects, biasing our results after adding the proportion of SOEs' output share and the FDI to our specification. Our finding remains the same. Moreover, we introduce a placebo test, using the tariff before 2001(pre-WTO period), to confirm no pre-existing difference for the treatment and control groups in the pre-WTO periods, they are comparable.

To understand how trade liberalisation affects market concentration. We check two possible mechanisms in section 5. 1) the number of firms in the market and 2) the market share. Our finding suggests that trade liberalisation significantly negatively impacts the number of firms in the market; this could be one of the channels through which trade liberalisations affect market concentration. In addition, we examine the effect of trade liberalisation on the top 20 firm's concentration to capture the change of market share among the top firms with trade tariffs. The results are positive but insignificant, which implies that trade liberalisation has a little positive effect on market share. With trade liberalisation, it is possible for top firms to obtain more market share by increasing their markup, which leads to a price index increase.

This study is organised into seven parts. This section introduced the background of the WTO accession and the market concentration and briefly explained the research aim of this study. Section 2 presents previous studies and literature on market concentration, markups, and trade policy uncertainty. Followed by a section explaining the specifications. Section four

briefly describes the data and the key variables used in the baseline model. Then, both graphical and empirical results are discussed in section five, supplemented with robustness checks and mechanisms. Section 6 is the conclusion, and References are provided in section 7.

Section 2. Literature Review

To understand and explain the effects of trade liberalisation on market concentration we undertook a literature review. This review has four sub-parts: 1) Related literature on rising market concentration, 2) Relevant literature on falling market concentration, 3) Markups, 4) Trade policy uncertainty (TPU) and trade liberalisation.

1.Related Literature on Rising Market Concentration

We begin with the Melitz model theory. Melitz (2003) suggested that under monopolistic competition, trade cost reduction causes a productivity cutoff for firms, which become exporters and shift to a lower threshold. The firms with lower productivity have an opportunity to export; thus, the number of exporters and the export value increase in the market. Meanwhile, with trade liberalisation, more foreign firms enter the market, bringing more varieties of goods into the domestic market and increasing foreign competition. Due to the higher competition and falling prices in the market, firms will lower their prices to sustain their market share. Moreover, under trader liberalisation, the productivity cutoff for the domestic firms shifts to a higher threshold, and firms with the least efficiency are forced to exit the market; thus, the number of domestic firms in the domestic market decreases, lowering the sale value of the domestic firm. However, the firms with less productivity are the small firms in the market, which only account for a small amount of market share. When small firms exit the market, the market share for the top firms rises. Therefore, the Melitz model predicts that with trade cost reduction, the market concentration rate increases.

The rising market concentration among U.S. firms has been discussed in many recent studies, such as Autor et al. (2020); Bonfiglioli, Crinò, and Gancia (2021); Council of Economic Advisers (CEA) (2016); Gutiérrez and Philippon (2017). The findings of Autor et al. (2020) are in line with the Melitz model prediction that under trade liberalisation, the market concentration rate increased in the United States over the past 10 years while labour shares fell. They argued that the falling labour shares due to the reallocation were triggered by the trade cost reduction. They determined that, with the 'winner takes the most' mechanism triggered under the trade liberalisation, sales increases occurred more often in firms with the largest productivity (e.g., superstar or top firms); thus, market shares for the top firms increased and they dominated the market. The authors also provided evidence for the rising market concentration in other OECD countries, which is consistent with findings of Matej Bajgar et al. (2023).

Bonfiglioli, Crinò, and Gancia (2021) believe the rise in market concentration is mainly driven by the intensive margin, and the falling market concentration mainly arises from the number of exporters in the market (extensive margin). They used the share of seaborne imports to construct the concentration rate by calculating the measure of the top four firms' market shares (CR4) and the Herfindahl–Hirschman Index (HHI) after removing the exporters from China, India, and all Asian and Pacific countries. The authors found that without these countries' exporters, the level of concentration for both the CR4 and HHI in the U.S. is higher. In addition, after they removed China and India alone, the concentration decreased for more than fifty percent of the countries in the sample. This finding is consistent with that of Freund and Sidhu (2017), who found that the falling global concentration is caused by the growing number of firms from China and other emerging markets.

Bajgar et al. (2018a) employed the MultiPod firm-level data with the Orbis dataset to study the industrial concentration ratio for 21 OECD countries, 19 European countries, and 2 North American countries (US and Canada). They used the market share of the top 4, top 8, and top 20 as a measure of concentration and found that during the period from 2001 to 2012, the concentration levels among the European countries at industry-level increase by about 20

percent for the CR4 and CR20 and the concentration ratio increased about 28 percent for North America. Gutiérrez and Philippon (2017) also determined that market concentration increased in the U.S., but they suggested that the dramatically rising market concentration could be driven by the change in institutional ownership. The CEA (2016) reported that in the United States from 1997 to 2012, the market concentration ratio measured by the top 50 firms increased, and this change was driven by the declining number of firm entries.

The aforementioned literature describes a standard monopolistic competition approach. Graziano (2020) developed a hybrid model that introduced an oligopolistic margin to the standard monopolistic competition, and this model allows the study of the industrial concentration related to the CES price index. They used the HHI as a measure of market concentration, and the results suggested that trade liberalisation has negative effect on the CES industry price index and has positive effect on domestic concentration.

2. Relevant Literature on Falling Market Concentration

The rising market concentration in the United States has been the subject of hot debate among researchers. We discussed the finding of a rising market concentration in the previous subsection. We now consider other findings related to a falling market concentration (such as those of Amiti and Heise (2021); Freund and Pierola (2015); and Bai, Mao, and Zhang (2014)).

Amiti and Heise (2021) used confidential U.S. census manufacturing data from 1992 to 2012 to investigate the relationship between the U.S. market concentration and import competition. Their results differed from previous scholars in that when taking foreign firms' sales in the U.S. into account, the market concentration stays constant. They determined that higher import competition leads to a decreasing market share for top firms. In addition, they linked markup with the market share and found a constant aggregated markup, as domestic firms' markups decreased while foreign firms' markups increased.

Freund and Pierola (2015) conducted a panel data analysis of non-oil exports from 32 countries between 2004 and 2008 to investigate the role of superstars in the revealed comparative advantage (RCA). They found that the top firms, or superstars, accounted for a significant share of the variation in sectoral exports, indicating that they play a crucial role in shaping trade patterns. Moreover, their regression analysis shows that superstars had a statistically significant impact on sectoral trade structures in 15 industries. These results imply that the RCA can be explained by a single top firm. The market concentration rate is underestimated in China, and the actual market concentration rate in China should be higher (Bai, Mao, and Zhang, 2014). Many researchers use the HHI as a measure of market concentration, but there could be an existing systematic bias issue when using the CIED data to estimate the HHI directly for China. This is a risk because, for the years before 2007, this dataset includes all state-owned enterprise (SOE) firms, but non-SOE sales values below RMB 5 million are not included. Therefore, Bai, Mao, and Zhang (2014) applied the non-linear least squares estimation to estimate the Zipf distribution to simulate the small firms. Their results for the market concentration indicated a decrease, which is consistent with our estimation for the market concentration.

3. Markup

Recently, there has been a growing amount of research on market power. Some researchers believe that market power can be explained by the market concentration ratio, as the market concentration ratio explains how much market share is held by the top firm. Other researchers (such as De Loecker, Eekhout, and Unger (2020); Autor et al. (2020)) argue that markup can also be a good indicator of market concentration as markup can determine the difference between the firm production cost and the price, which has a direct impact on the consumer. Research can more directly assess the impact of market power by estimating the markups. With a more competitive market, firms often decrease their markup to gain more market shares. Much of the literature indicates that an increase in market concentration is always associated with rising markups (De Loecker, Eekhout, and Unger, 2020).

De Loecker and Warzynski (2012) developed a new empirical framework to investigate the relationship between markups and a firm's export status (exports and non-exports) and the impact of export entry on markup. By analysing Slovenian manufacturing data from 1994 to 2000, they demonstrated that exporters have higher levels of productivity and charge higher markups compared to non-exporting firms. Additionally, their study found that markups increase with the number of firms entering the export markets, suggesting that exporting can enhance firm profitability. Lu and Yu (2015) adopted this methodology to calculate markup when they applied Chinese firm-level data to investigate how the trade liberalisation affect markup dispersion by employing DID estimation. The results indicate that after trade liberalisation, markup dispersion decreased for those industries with high tariffs in 2001. They also used the HHI to determine the industry competition degree, and the results indicated that markups are lower in more concentrated industries. This result is in contrast to the suggestion made by Amiti and Heise (2021), who believe the market concentration increases the markup.

Exporters charge different markups for different export destinations, and the markup's setting depends on trade distance and tariff (Chen and Juvenal, 2022). The authors used Argentinean firm-level customs data from 2002 to 2009 for wine exports and wine rating, which was a proxy for the measure of quality when studying the impact of trade costs on the markup of exports when quality differs. Their finding suggests that exporters' prices discriminate across countries depending on the destination's distance and markup. There is a positive relationship between trade cost and markup. This means the higher the trade cost, the higher the markup, and this finding is in line with that of Lu and Yu (2015), who found with a trade cost decrease, markup decreases more in industries that experienced higher tariff reduction.

Corsetti et al. (2019) developed a new empirical framework to investigate the relationship between a firm's destination-specific export volumes and markup adjustment cause by the shifts in relative market conditions. This new empirical framework contains a newly developed estimator called TPSFE (trade pattern sequential fixed effects) to control endogenous market selection and a newly constructed product classification based on Chinese linguistics to

classify Harmonized System (HS) Codes products as two group of goods, the high differentiation goods and the low differentiation goods, which determine their market power in this study. After applying the China customs data, they suggests markup adjustment varied depends on the degree of market concentration.

Under tariff reduction, a fall in price could be caused by lower markups or a lower input price (Brandt et al., 2017). Brandt et al. studied the impact of trade liberalisation in China on the markup level and productivity. Their finding indicates that input tariff reduction causes a rise in markup, in contrast to the output tariff reduction associated with a lower markup. The same finding was also reported in a later study by Liu and Ma (2021), who investigated the effects of trade liberalisation in China on the markup and markup distribution.

4. TPU

To access the effect of trade liberalisation on China-US export after China joining the WTO in 2001 Handley and Limão (2017) analyse the effects of change in policy uncertainty on trade, prices, and real income in a tractable general equilibrium framework using firm entrance as a reflection .The robust results show that there is a negative relationship between TPU and export growth. Reduction in TPU decreased the tariff and lowered Chinese industry export prices.

While applying the Handley and Limão framework, Graziano (2020) introduced TPU into the hybrid model to characterise its impacts on export flows with oligopolistic behaviour. The results suggest that the impact of TPU on entry depends on the degree of exporter and domestic concentration. This means that exporter concentration enhances the negative effect of TPU on entry. Conversely, domestic concentration weakens the effect of TPU as the anticipation that the increased tariff will be offset by the increased domestic markups. In our analysis, we studied how TPU impacts the market concentration. We found a robust negative relationship between TPU and market concentration. The results implied that market concentration decreased more in industries with higher TPU reduction.

Section 3. Empirical Framework

3.1 Measures of Market Concentration Ratios

The Herfindahl–Hirschman index (HHI_{it}) and concentration ratio for top_N firms are the most common methods used to construct market concentrations, particularly for CR_4, CR_{20} and HHI. According to previous literature, a rise in the market concentration rate has been found for measurements of CR_1 (Freund and Pierola, 2015), HHI and CR_4 (Amiti and Heise, 2021; (Bonfiglioli, Crinò and Gancia, 2021); CEA (2016) (Grullon, Larkin and Michaely, 2019), CR_{20}, (Amiti and Heise, 2021; Autor et al., 2017), and CR_{50} (CEA, 2016).

In this study, I use the CR_{20} as my main outcome variable. The measure is unlike either $CR1$ or CR_2, which are used to analyse superstar or oligopoly firms' behaviour, or CR_{50}, with too many firms. CR_4 and HHI are also included as additional outcome variables in the baseline analysis. HHI is computed by the sum of the square of market share for all firms in an industry. The concentration (CR_N) ratio for the top *N* firms is constructed by the sum of the market shares for those *N* firms in an industry. To construct the market concentration base on the total sale value in the China market, I adopt the approach in Amiti and Heise (2021), using concentration to represent market power. The market share for firm f in industry i at year t is constructed based on all sales in the market. Hence, I first subtract a firm's export values from the total sale value to obtain domestic sales for all domestic firms N^D, then include the total sale for all foreign firms N^F in the market. Thus, a firm's market share can be written as:

$$Share_{fit} = \frac{sale_{fit} - export_{fit}}{\Sigma_{f \in \mathrm{N}} \left(Sale_{fit} - export_{fit}\right)}, \qquad (N^d, N^F) \in \mathrm{N} \qquad (1)$$

After obtaining the market share for firms, the concentration ratio for the top *N* firms can be easily constructed by the sum of the top *N* firms' market shares. Additionally, with *N* number of firms in industry i at year t and letting S_f denote firm f's market share, the standard HHI for can be computed as:

$$HHI_{it} = \Sigma_1^N S_1^2 + S_2^2 + \cdots + S_N^2 \quad (2)$$

The higher the value of HHI, the higher the concentration. The lower the HHI, the higher the competition among the industry. The change of market concentration for pre- WTO and after -WTO reports in the appendix table 1 at 2 digit-industry level for CR20. The results suggested that most of 2-digit industries market concentration rose after WTO accession, only five out of twenty-seven 2-digits industries market concentration decreased. 'Processing of Food from Agricultural Products 'and 'Paper and Paper Products' market concentration decreased less than 1% while 'Manufacture of Beverage' and 'Furniture' reduced more10 percent and 'Artwork and Other Manufacturing Furniture' decreased about 8%.

The question remains how trade liberalisation affects market concentration. To address this question, we start from theory. According to the Melitz (2003) model, under monopolistic competition, trade liberalisation reduces the trade cost and leads to a lower productivity cut-off for a firm to enter the export market. Consequently, the firm with less productivity has an opportunity to export, thus increasing the number of exporters and the exports' value. Meanwhile, with trade liberalisation, more foreign firms enter the market, increasing the variety of goods and causing higher foreign competition. Moreover, the productivity cutoff for domestic firms increases, and firms with the least efficiency are driven out the industry. Thus, the number of domestic firms in the domestic market decreases, lowering the sale value of the domestic firms. Returning to equation 1, with a rising number of firms and exporter values increasing, the theory predicts that the share of manufacturers falls with trade liberalisation. Bonfiglioli, Crinò and Gancia (2021) argued that falling concentrations are mainly driven by a growing number of exporting firms (extensive margin), and a rising concentration comes from the intensive margin. We assessed how the number of firms has been affected by China's accession to WTO in the robustness check section.

Although market concentration accounts for the shares of the biggest firms in the market, it does not clearly reveal the extent of their impact. Some researchers have used markups as a measure of market concentration (such as Autor et al. 2020; De Loecker, Eekhout and Unger, 2020). Markups show the difference between firms' costs and the price; thus, we can observe

more direct impacts on consumers by estimating markups. That is, estimating markups could be another way to estimate the market power of firms while understanding how the firms influence the market price. Rising market power can be explained by the growth of markups towards the top firms. Results shows that firms with no increase in markups lost market share (De Loecker, Eekhout and Unger, 2020). This finding is in line with the superstar firms, trade liberalisation triggers a reallocation, and firms shift towards those products that have a higher productivity to gain more market share. Market concentration increases as superstar firms dominate the industry with high markups. At the same time, the labour share is falling (Autor et al., 2020). Due to time limitations, we mainly focus in this study on the effect of trade liberalisation on market concentration through the extensive margin. In addition, I conduct a test in the robustness check section to observe the impacts on the market concentration rate for the top 20 firms by reducing trade costs.

3.2 Econometric Specification

A difference-in-differences estimation is the most popular technique for studying the differential effect of a treatment for a treatment and control group. Hence, I employed a DID estimation to explore the impact of trade liberalisation on market concentration by taking China's accession to the World Trade Organization (WTO) in 2001 as a quasi-natural experiment. After China joined the WTO at the end of 2001, under the WTO accession agreement, China had to reduce its tariffs and meet the requirements by 2004. This timing of reducing tariffs starting from 2002 is the first significant factor for constructing the DID estimation. To carry out the DID analysis, the presence of both a treatment and a control group is essential. Therefore, I followed the approach in Lu and Yu (2015), categorising industries into two groups based on their tariffs in 2001. The treatment group formed by those industries had higher tariff in 2001, which means they experienced a larger tariff reduction after China join the WTO. The control group constituted by those industries had a relatively lower tariff in 2001, meaning they benefitted less from the tariff reduction.

By following Lu and Yu (2015) and Ma, Xu and Zhang (2019), our baseline empirical specification for the DID estimation can be written as the following.

$$Y_{it} = \beta X_{i2001} * Post_{2002_t} + \gamma Z_{it} + \alpha_i + \delta_t + \varepsilon_{it} \quad (3)$$

Where i represents the industry and t indicates the year. The dependent variable Y_{it} is the market concentration measurement in industry i and year t. I use the natural logarithm of the market share of the top 20 firms in an industry, $ln\,CR_{20}$, as my main outcome variable. I also including $lnCR_4$ and $lnHHI$ as additional dependent variables. In the robustness section, concentration ratios for top 1, top 2, top 8, top 10, and top 50 are used. $Post_{2002_t}$ is a dummy variable that is equal to one when the year is after the WTO accession (2002) and zero otherwise**.** β is the coefficient for the interaction term, which captures the differential effect of trade liberalisation on market concentration based on the output import tariff rate in 2001. $X_{i2001} * Post_{2002_t}$ is the interaction term. If β is positive, it means that after 2002, market concentration increased more in industries with a higher tariff in 2001 than industries with lower tariffs in 2001.

I included three interaction variables in the baseline model for the $X_{i2001} * Post_{2002_t}$, which are $tariff_{i2001} * Post_{2002t}$, $intariff_{i2001} * Post_{2002t}$ and $TPU * Post2002$. $tariff_{i2001}$ indicates the average output import tariff rate of industry i in 2001, $intariff_{i2001}$ is the average input import tariff of industry i in year 2001 and TPU is an industry-varying but time-invariant variable that represents the trade policy uncertainty. Both final and intermediate goods played a key role in analysis the trade model (Goldberg et al., 2010). TPU also has a crucial role in analysing the impacts of international trade agreements (Handley and Limão, 2017). Trade liberalisation not only has an effect on the output tariff but also on the input tariff. For example, Ma, Xu and Zhang (2019) used the input tariff as a regressor of interest in their DID estimation, finding that trade liberalisation does have a significantly negative impact on China's manufacturing servitisation.

α_i indicates the industry fixed effects, which captures the effect of time-invariant but industry-specific effects. δ_t is the year fixed effect. The final term, ε_{it}, is the error term. As suggested by Bertrand et al. (2004), standard errors are clustered at the 3-digit CIC industry level to address potential heteroskedasticity and serial autocorrelation.

I also include $TPU * Post2002$ as a control variable. Before the United States granted permanent normal trade relations with China, China's free-trade status had to be reviewed annually. Chinese firms face many threats and uncertainties. Without the normal trade relations tariff (NTR), firms face high tariff rates. Obtaining the PNTR removed the uncertainty around tariffs and rising competition (Gutiérrez and Philippon, 2017). Pierce and Schott (2016) showed that industries with a high TPU rate had a greater increase in Chinese imports. Therefore, I introduce the TPU into the specification to control this effect on market concentration. TPU is an industry-varying but time-constant variable; thus, so I use the interaction term with $Post2002$. Following the approach in Pierce and Schott (2016), the TPU for each industry i can be calculated by:

$$TPU_i = NonNTR_i - NTR_i$$

In the DID estimation, I also included two additional control variables: the output share of SOE's in 2001 interacting with post-WTO dummy and the interaction between export intensity in 2001 and the post-WTO dummy, which was used to omit the potential bias that may be caused by pre-WTO tariffs. As tariffs was not randomly selected, it is important to ensure that the treatment and control groups are not systematically different before the WTO accession.

By the suggestion of Lu and Yu (2015), we checked nine important determinants used to determine the tariff in 2001 at Table (4) in the Appendix. We found that both the output share of SOE's and export intensity are positively statistically significant in 2001, which are susceptions of pre-existing differences between our control and treatment group. We also checked the relationship between our market concentration rate and tariffs in 2001 conditional on the nine tariff determinants. The regression results were negative, but none were statically significant.

The Chinese Industrial Classification (CIC) uses a 4-digit number, but the classification method changed in 2002. Our time span for this study is 1998–2005. To ensure the data classification

is consistent, we must use the same classification. However, problems arise assuring concordance in the data before and after 2002 at the 4-digit level (more details are explained in the data section). Therefore, I employ the 3-digit CIC industry level in the baseline model. The 3-digit CIC industry level is relatively fine, with mostly reliable observations and smaller measurement errors. The 2-digit and 4-digit industry level are taken in the robustness section. The 4-digit CIC level is the finest definition in the dataset and can be used to check for any aggregation bias. As the 2-digit CIC level definition is the same for classifications before and after 2002, it is used to examine the results at a more aggregate level.

Section 4. Data

This study relies on three datasets, namely the Annual Survey of Industrial Enterprise (ASIE), the WTO website and the World Integrated Trade Solution (WITS). ASIE is used to compute the market concentration, and WTO and WITS are both used to obtain the output and input tariff data. The first dataset employed in the study, ASIE, was published by the National Bureau of Statistics of China for the period 1998 to 2008. ASIE is a firm-level panel dataset covering 116,896 firms in 1998 and 299,358 firms in 2008. It is the most comprehensive firm-level dataset in China, including more than 3 million firms for 40 2-digit industries. Moreover, the dataset provides a wide range of information on firms at the 4-digit CIC industry level, including firm type, ownership, sale value, exports, location and employment, which are related to our study interest. This dataset has been widely used in many empirical studies by both national and international researchers, for instance, Bai, Mao and Zhang (2014), Brandt et al. (2017) and Lu and Yu (2015).

Although there are many advantages to using ASIE, the database has many limitations that we cannot ignore. The drawbacks of using the ASIE dataset have been explained in detail by Nie, Jiang and Yang (2012). In particular, three limitations are related to our study. First, ASIE is censored survey data, mainly coming from the quarterly and annual reports that are submitted by the surveyed enterprise to local statistical bureaus. Hence, the data quality may be low for the small firms due to their relatively poor accounting systems.

Second, not all firms in the market are surveyed each year by ASIE, and the sampling standard changed after 2007. Before 2007, ASIE contained all the state-owned enterprises (SOEs) but not all non-SOEs were included. The database only considers non-SOEs if their sales are greater than 5 million RMB. After 2007, ASIE only covers firms with sales no less than 5 million RMB for both SOEs and non-SOEs. Therefore, our market concentration ratio could be overestimated.

The third limitation is related to the classification system for industry codes. The Chinese Industry Code (CIC) for years 1998 to 2002 in the ASIE is the old classification version (GB/T4754-1994). From 2003 to 2008, ASIE adopted a new classification (GB/T 4754-2002) version. To make the CIC consistent throughout our entire dataset, I used a concordance table to covert the old classification version in 1998 to 2002 to the new classification. Therefore, the industry code in my study is the GB/T 4754-2002 version.

The finest level for CIC is the 4-digit level. However, many problems occur when converting the old version to the new classification standard at 4-digits. For example, some industries are divided into two different subindustries, and the definitions of some industries changed. Therefore, I followed the method of Brandt, Van Biesebroeck and Zhang (2012) to covert the 4-digit industry to the new classification standard.

After converting the code, we have 394 four-digit industries in the sample data. Only a small difference is seen between the old and new industry classification standard at the 3-digit industry level. Therefore, I used the 3-digit industry level in the baseline analysis, yielding a total of 128 industries in our study. As the CIC at the 2-digit level is same for both classification standards, it was applied in the robustness check section. A total of 27 two-digit industries were used in the sample data. I excluded three industries, namely 12, 16 and 43, because industry 12 only appears before 2003, industry 16 only has few observations and industry 43

was only available after 2003. I also dropped firms with fewer than eight employees, as mentioned in Yu (2014).

Both the WTO website and WITS were used to obtain the output tariff data. The output import tariff data are available at the HS-6-digit product level where can be download from the WTO website for year between 2001 and 2008. The output tariffs data for years 1998–2000 are available in WITS, which is operated by The World Bank. The data provide information for the average, minimum and maximum ad valorem tariff duties as well as information on the number of tariff lines. We used the average ad valorem tariff duties aggregated to the industry level in our study. Before aggregating to the industry level, we had to covert the HS codes as the HS code classification standard has changed from 2002. Tariffs in 1997–2001 were used the 1996 HS codes (HS-96), and tariffs in 2002–2006 used the 2002 HS codes (HS-02). Using the HS concordance table, which is available on WITS, we matched the HS-96 code to the HS-02 code. Therefore, the output import tariff data in my study are in the HS-02 standard.

After obtaining the output tariff data, the input tariff data can be constructed by using China's 1997 IO matrix table. Following the approach in Goldberg et al. (2010), the input tariff can be calculated by the sum of the cost share for each input times its tariff. The input tariff used in this analysis come from Lu and Yu (2015).

Table 1 Descriptive Statistics

Variable	Obs	Mean	Std. dev.	Min	Max
lnCR20	1,469	-1.091	0.517	-2.591	-0.010
lnCR4	1,495	-1.912	0.679	-3.796	0
lnHHI	1,496	-4.429	1.126	-7.145	0
Input tariff 2001	1,402	0.147	0.057	0.055	0.338
Output tariff 2001	1,402	0.167	0.098	0	0.559
Export intensity 2001	1,467	0.143	0.190	0	0.805
The Output share of SOEs 2001	1,467	0.259	0.248	0	0.974
TPU	1,496	0.288	0.140	0	0.717

Tabel 1 shows the descriptive statistic for variables used in the baseline model. There are total of 1496 observation for TPU and lnHHI. Both variables lnCR20 and lnCR 4 with observation less than 1496, a there may exit an industries less than 4 or 20 firms within an industry. The concentration ratio measures are in log term, they are negative because there many firms with an industry, so the market concentration rate is very small. In addition, the standard deviation for all three concentration ratio measures is big. In appendix Table 2 shows the number of firms for each year. There are 116896 firms in 1998 and more than 29900 firms in 2008. The variable for output tariffs, input tariffs and output share of SOEs and export intensity are only included in year 2001. The minimum tariff for output tariff is zero but for input tariff is 0.055. The highest output tariff rate in 2001 is 55.9%.

Section 5. Empirical findings

5.1 Graphical Results:

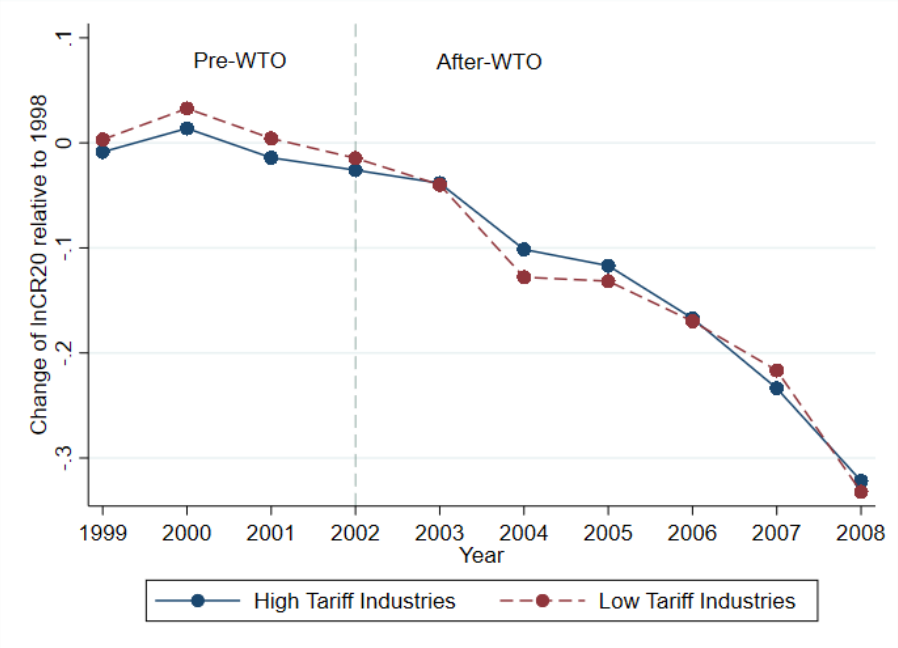


Figure 3 Change of lnCR20 relative to 1998 for treatment and control group (based on tariff reduction).

We divide industries in two subgroups based on the output import tariff in 2001. The high-tariff group represents industries with a tariff greater than the median in 2001. The low-tariff

group includes industries with a tariff below the median tariff in 2001. Figure (2) illustrates the change in $lnCR_{20}$ relative to 1998 by year for both subgroups. While observing the trend in the change of $lnCR_{20}$ for high- and low-tariff industries, a clear parallel trend is evident in the pre-WTO period. Meanwhile, a distinct difference is seen between the two groups after WTO accession. The market concentration ratio $lnCR_{20}$ in industries in the low-tariff group drops dramatically from 2002 to 2004, while the high-tariff group slightly decreases from 2002 to 2003 and drops sharply from 2003 to 2004, but the drop is still less than the low-tariff group. This result suggests that the market concentration rate increased more after WTO accession in industries with higher tariff rates in 2001 than in firms in industries with lower tariff rates. Given that the higher-tariff industries in 2001 had a higher output tariff reduction after WTO accession, this means that the output tariff reduction mitigated the decline in the market concentration. Alternatively, we can say that without trade liberalisation, the market concentration rate in the high-tariff group would have had the same declining trend as the low-tariff group.

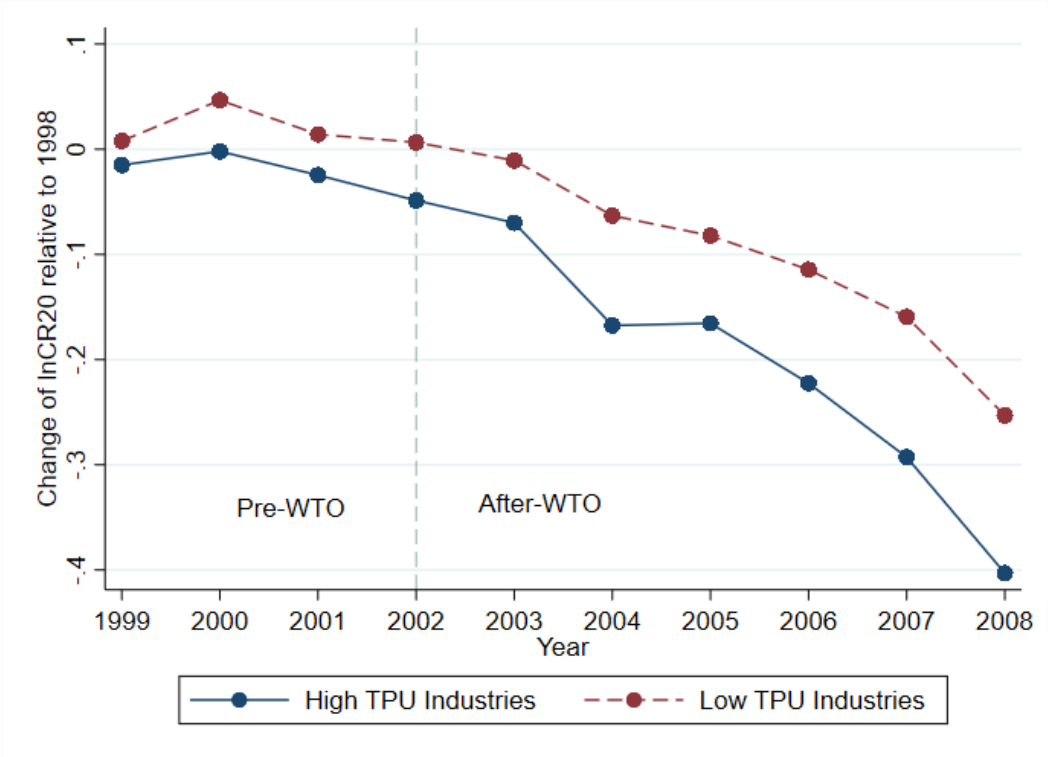


Figure 4 Change of lnCR20 relative to 1998 for treatment and control group (based on TPU reduction)

We use the same method as above to divide industries in two subgroups based on the TPU. As mentioned, TPU is an industry-varying but time-constant variable. The same definition is used for output tariffs, where high TPU industries means industries with a TPU greater than the median TPU. The low TPU group includes industries with a TPU below the median. Figure (3) shows the change in $lnCR_{20}$ relative to 1998 for high- and low-TPU industries from 1999 to 2008. A clear parallel trend is seen in the pre-WTO period and the years between 2002 and 2003. After 2003, $lnCR_{20}$ in industries with high TPU drop sharply until 2004, and slightly increased from 2004 to 2005. Meanwhile, the low TPU industries decreased relative constantly from 2002 to 2008. This result suggests that the market concentration rate declined more after WTO accession in industries with higher TPU than in firms in industries with TPU, which means that under trade liberalisation, market concentration decreased and the market became more competitive.

5.2 Baseline results

In this section, I examine the impacts of trade liberalisation on various market concentration ratios, including $lnCR_{20}$, *ln*HHI and $lnCR_4$, by using output tariffs, input tariffs and TPU separately as an independent variable. The baseline regression results for our DID specification are reported in three panels in Table 2. Column (1) to (3) in all three panels only included our independent variables, which show the basic relationships between different measures of market concentration rates and our three interested regressors separately with controls for both year and industry fixed effects.

Examining columns (1)–(3) in panel (2a), we note the coefficients for $Output\ Tariff_{2001} * Post_{2002}$ are positively and statically significant at the 1% significance level, meaning that market concentration rates as measured by $lnCR_{20}$, $lnCR_4$ and *ln*HHI increased more after WTO accession for industries with higher tariff rates in 2001 than industries with lower tariff rates in 2001. That is, given that higher-tariff industries in 2001 had higher output tariff reductions after WTO accession, these results suggest that output tariff reduction increases market concentration.

Columns (1) to (3) in panel (2b) show that $Input\ Tariff_{2001} * Post_{2002}$ has a positive relationship with all three market concentration measurements but is only statistically significant for *lnCR*$_{20}$. Moving down to panel (2c), the regression results in columns (1)–(3) reported a statistically negative relationship between our regressor of interest $TPU * Post_{2002}$ and all three market concentration measures, which means that high-tariff firms in industries with a higher TPU experienced a larger decrease in market concentration after 2002 than firms in industries with a lower TPU. These results imply that a fall in TPU decreases the market concentration. Columns (4)–(6) in panel (2c) only include the tariff determination. Moreover, after adding controls in panel (2c), the coefficient for our regressor of interest became positive, while the coefficient for *lnCR*$_{20}$ and *lnCR*$_4$ was no longer significant. The correlation results are shown in the Appendix table 3. In addition, the correlations between variables used in panel (2c) are less than 0.7. Therefore, collinearity issues do not exist.

In addition, the regression results shown in Table 2 at columns (4)–(6) replicate column (1) to (3) separately for panels (2a) and (2b) by incorporating the control variable TPU*Post_2002 and two additional tariff determinations. The coefficient results remain positive and significant for all three market concentration ratio measures with slight changes of magnitude in panel (2a). In panel (2b), the coefficients are remained positive and significant for *lnCR*$_{20}$. However, the coefficient magnitude decreased for *lnCR*$_4$ after adding the control variables, which may be because the market concentration ratio among the top 4 firms has more effects from the TPU and tariff determinants. Comparing columns (3) and (4) in panel (2b), the coefficient increased dramatically and became significant at the 10% significance level after adding controls. While the regression results report a significant negative relationship between the market concentration rate and TPU when we regress without other variables in panel (2c), TPU has positive relationship with the market concentration rate when TPU is included as a control in panels (2a) and (2b).

The regression results in Table 2 show that the output tariff is the most significant. Therefore, we use the interaction term between the output tariff in 2001 and the post-WTO dummy as our core explanatory variable in the following regression.

Table 2 Baseline Results

Panel(2a)	Output Import Tariff					
	lnCR20	lnCR4	lnHHI	lnCR20	lnCR4	lnHHI
	(1)	(2)	(3)	(4)	(5)	(6)
$Output\ Tariff_{2001} * Post_{2002}$	0.438***	0.417***	0.651***	0.502***	0.468***	0.778***
	(-0.081)	(-0.141)	(-0.215)	(-0.081)	（-0.141）	-0.216
$TPU * Post_{2002}$				0.064	0.234**	0.215
				（-0.064）	（-0.109）	（-0.167）
$SOE's\ Output\ Shares_{2001} * Post_{02}$				0.169**	0.142	0.339**
				（-0.066）	（-0.112）	（-0.172）
$Export\ Intensity_{2001} * Post_{2002}$				-0.217***	-0.493***	-0.652***
				（-0.062）	（-0.108）	（-0.165）
Year FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Observations	1,380	1,402	1,402	1,380	1,402	1,402
R-squared	0.933	0.88	0.896	0.937	0.886	0.901
Number of Industries	126	127	127	126	127	127
Panel(2b)	Input Import Tariff					
	(1)	(2)	(3)	(4)	(5)	(6)
$Input\ Tariff_{2001} * Post_{2002}$	0.434***	0.406	0.052	0.574***	0.232	0.697*
	（-0.139）	（-0.369）	（-0.241）	（-0.141）	（-0.244）	（-0.373）
$TPU * Post_{2002}$				0.129*	0.274**	0.310*
				（-0.066）	（-0.112）	（-0.171）
$SOE's\ Output\ Shares_{2001} * Post_{02}$				0.137**	0.086	0.273
				（-0.066）	（-0.113）	（-0.172）
$Export\ Intensity_{2001} * Post_{2002}$				-0.257***	-0.540***	-0.722***
				（-0.062）	（-0.107）	（-0.164）
Year FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Observations	1,380	1,402	1,402	1,380	1,402	1,402
R-squared	0.932	0.895	0.879	0.936	0.885	0.901
Number of Industries	126	127	127	126	127	127
Panel(2c)	TPU					
	(1)	(2)	(3)	(4)	(5)	(6)
$TPU * Post_{2002}$	-0.195***	-0.390***	-0.169*	0.041	0.195	0.207*
	（-0.057）	（-0.146）	（-0.095）	（-0.064）	（-0.163）	（-0.107）
$SOE's\ Output\ Shares_{2001} * Post_{02}$				0.129**	0.239	0.102
				（-0.062）	（-0.161）	（-0.105）
$Export\ Intensity_{2001} * Post_{2002}$				-0.247***	-0.705***	-0.502***
				（-0.061）	（-0.158）	（-0.103）
Year FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Observations	1,380	1,402	1,402	1,380	1,402	1,402
R-squared	0.931	0.895	0.879	0.934	0.900	0.884
Number of Industries	126	127	127	126	127	127

*** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level.

Notes: Standard errors in parentheses.

5.3 Robustness Checks:

The robustness checks for the validity of our DID estimation are reported in Table 3. After 15 years of negotiations, China officially became a member of WTO in the end of 2001 (December 2001). Therefore, it is necessary to check whether the accession was expected. I introduced an additional interaction term between $Output\ Tariff_{2001}$ and $Year_{2001}$ – the year before China's accession – to our DID estimation to check if firms had any anticipation regarding whether China would successfully join the WTO. The regression results in columns (1)–(3) show that with the additional variable, the relationship between market concentration and $Output\ Tariff_{2001} * Post_{2002}$ remains positive and statistically significant. Additionally, the coefficient of the additional variable is positive but statistically insignificant. This result suggests that some expectation effect might exist, but the effect is negligible.

Under trade liberalisation, firms more easily access the foreign market. Previous literature has mentioned that with import tariff reductions, domestic firms are increasing their imports of intermediate inputs to meet rising firm productivity (Amiti and Heise, 2021) or promote innovation (Liu and Ma, 2020). Therefore, I included a new interaction term between input tariffs in 2001 and post-2002 in the regression to capture the effect of importing foreign intermediate inputs.

The regression results displayed in columns (4)–(6) in Table 3, panel (3a) show that after adding the additional variable to our specification, the relationship between output tariffs and market concentration measurements remain positive and statistically significant at the 1% significance level. The coefficient for the input tariff interaction term is negative with all concentration measurements, but only statistically significant at the 90% confidence interval for $lnCR_4$. These results indicate that with trade liberation, an input tariff reduction decreases market concentration, and market competition increases. This result is in line with Amiti and Konings (2007), who found that with falling input tariffs, competition rises in the product market. However, when the input tariff was employed as an explanatory variable in our baseline model, the coefficient was positive.

Table3. Robustness Checks

	One Year Before Accession			Control for Input Tariff		
Panel(3a)	(1)	(2)	(3)	(4)	(5)	(6)
	lnCR20	lnHHI	lnCR4	lnCR20	lnHHI	lnCR4
$Output\ Tariff_{2001} * Post_{2002}$	0.550***	0.862***	0.524***	0.512***	0.935***	0.699***
	(0.089)	(0.236)	(0.154)	(0.110)	(0.294)	(0.192)
$Output\ Tariff_{2001} * Year_{2001}$	0.192	0.338	0.222			
	(0.145)	(0.386)	(0.253)			
$Input\ Tariff_{2001} * Post_{2002}$				-0.025	-0.398	-0.586*
				(0.191)	(0.506)	(0.331)
Controls	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Observations	1,380	1,402	1,402	1,380	1,402	1,402
R-squared	0.937	0.901	0.886	0.937	0.901	0.886
	Control for Other Policy			Pre-WTO		
	(7)	(8)	(9)	(10)	(11)	(12)
Panel(3b)	lnCR20	lnHHI	lnCR4	lnCR20	lnHHI	lnCR4
$Output\ Tariff_{2001} * Post_{2002}$	0.397***	0.607***	0.384***			
	(0.073)	(0.202)	(0.136)			
SOE	-0.020	-0.453***	-0.215**			
	(0.069)	(0.154)	(0.104)			
Log (FDI)	-0.271***	-0.588***	-0.295***			
	(0.016)	(0.043)	(0.029)			
				0.002	0.004	0.002
Tariffs				(0.002)	(0.005)	(0.003)
Controls	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Observations	1,380	1,402	1,402	496	508	508
R-squared	0.949	0.915	0.895	0.981	0.963	0.953

*** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level.
Notes: Robust standard errors in parentheses. Controls include interactions between TPU and Post 2002 and another two interactions terms between Post 02 and significant determinants which are the output shares of SOEs and the exports intensity, separately.

Two ongoing policy reforms might bias the effect of trade liberalisation during the time of China's WTO accession, namely SOE reform and the encouragement of foreign direct investment (FDI) (Lu and Yu, 2015). I added two additional variables, SOEs and FDI, to control the potential effects caused by those reforms. FDI is represented by the number of foreign invested firms (in log terms). As shown in columns (7)– (9) at panel 3b, after adding an additional control variable into our regression, the coefficients for our core explanatory

variable remain positive and statistically significant at a 99% confidence level for all three market concentration measurements.

To further check the validity of our DID specification, I adopted the approach from Topalova (2010) that only used the tariffs from the pre-WTO period as a placebo. Figure 1 shows that the mean tariff evolution from 1998–2001 was flat, meaning the output tariff before the WTO accession period should not have any significant effect. The regression results in panel (3b) indicate that the coefficient of tariffs in the pre-WTO period for all three market concentration rates are close to zero.

Furthermore, market concentration can be measured in a different way. I used another four alternative measures of market concentration for additional robustness checks, which include the natural logarithm of CR_1, CR_2, CR_8 and CR_{50} at the 3-digit industry level. The regression results reported in Table 3 show that our coefficients for output tariff are positive and significant for all types of measurements.

Table 4. Additional Robustness Checks

Panel(4a)	4-digit Industry			2-digit industry		
	(1)	(2)	(3)	(4)	(5)	(6)
	lnCR20	lnHHI	lnCR4	lnCR20	lnHHI	lnCR4
$Output\ Tariff_{2001} * Post_{2002}$	0.261***	0.482*	0.278*	1.067**	2.014***	1.038*
	(0.081)	(0.256)	(0.144)	(0.488)	(0.671)	(0.534)
Control Variables	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Observations	4,215	4,374	4,363	308	308	308
R-squared	0.933	0.881	0.878	0.961	0.943	0.907
Number of industries	394	394	394	28	28	28
Panel(4b)	Additional Interaction with Number of Products			Aggregated Long Run Effect		
	(7)	(8)	(9)	(10)	(11)	(12)
	lnCR20	lnHHI	lnCR4	lnCR20	lnHHI	lnCR4
$Output\ Tariff_{2001} * Post_{2002}$	0.500***	0.918**	0.534**	0.491***	0.746**	0.450**
	(0.136)	(0.382)	(0.206)	(0.133)	(0.360)	(0.204)

$Output\ Tariff_{2001} * Post_{2002} * Number\ of\ Products_{2001}$	0.000	-0.007	-0.003			
	(0.002)	(0.007)	(0.004)			
Control Variables	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Observations	1,380	1,402	1,402	252	256	256
R-squared	0.937	0.902	0.886	0.488	0.346	0.299
Number of industries	127	127	127	126	127	127

*** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level. Notes: Robust standard errors in parentheses. Controls include interactions between TPU and Post 2002 and another two interactions terms between Post 02 and significant determinants which are the output shares of SOEs and the exports intensity, separately.

Table 4, panel (4a) reports the regression results for various industry levels. Our baseline regressions use the 3-digit industry level; however, the original dataset uses the 4-digit industry CIC level. To address the concern of aggregation issues, I first conducted the regression at the 4-digit industry level, where a total of 394 four-digit industry level firms were included in our analysis, which is more than double the number of firms at the 3-digit industry level. We found that the coefficients for the $Output\ Tariff_{2001} * Post_{2002}$ remain positive and statistically significant at the 4-digit-industry level. Some limitations occur when using the 4 digit-industry level: (1) fewer industries are under each industry code, and (2) the classification standard has changed since 2002. Therefore, some remaining data-matching issues could bias our results.

In the same panel at columns (4) to (6), we find that our results remain positive and statistically significant for all measures of market concentration. The advantage of using the 2-digit industry level is first, although there are only 27 industries, the number of observations for each industry is larger. Second, in the real world, firms do not produce or import only one type of goods. Using the 2-digit industry level can address the problems of multiple products.

Our tariff data is at the HS-6 product level, yet our dependent variables are industry-level. Consequently, we use the concordance table to match the data from the HS-6 product level

to the industry CIC level. Next, we aggregated the tariff data to the mean average tariff at various industry levels for each year. Thus, some variations across different products might be missing after aggregation. We employed a triple interaction term into our regression, which was suggested by Lu and Yu (2015). After adding the interaction term $Output\ Tariff_{2001} * Post_{2002} * Number\ of\ products_{2001}$ into our DID specification, we found this interaction term to have nearly zero impact on market concentration. Moreover, the coefficient for $Output\ Tariff_{2001} * Post_{2002}$ remained robust. These results suggest that the variations between those products do not have any significant impacts on market concentration.

Moreover, we divided our data to two periods – the post-WTO period for 2002–2008 and the pre-WTO period for 1998-2001 – to analyse the long-run aggregate effects of tariff reductions on market concentration. The regression results are reported in Table 4, panel (4b) at column (10)–column (12). Our results remain positive and statistically significant for all three market concentration measures.

We further checked our data with an additional fixed effect for the interaction between the 1-digit industry level with year fixed effects and also included the 3-digit industry fixed effects. This method allowed us to capture the variation of the specific 1-digit industry level characteristics changing over time while controlling the 3-digit specific industry level characteristics. The results are reported in Table 5, and our findings remain robust with this additional fixed effect.

Table 5. Additional Robustness Checks with 1-digit industry -Year Fixed Effect

	(1) lnCR20	(2) lnCR4	(3) lnHHI
$Output\ Tariff_{2001}$ $* Post_{2002}$	0.476***	0.538**	0.799*
	(0.151)	(0.271)	(0.461)
Control Variables	YES	YES	YES
1-digit industry #Year	YES	YES	YES
Industry FE	YES	YES	YES
Observations	1,380	1,402	1,402
R-squared	0.914	0.871	0.884
Number of Industries	127	127	127

*** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level. Notes: Robust standard errors in parentheses. Controls include interactions between TPU and Post 2002 and another two interactions terms between Post 02 and significant determinants which are the output shares of SOEs and the exports intensity, separately.

Section 6. The mechanisms

After analysing the impact of liberalisation on the market concentration, the results suggested that falling in trade cost leads to an increase in market concentration. However, how this impact was achieved was not clear. The basic idea of this section is to examine the possible mechanisms by which trade liberalisation affects market concentration, back to the definition of market concentration, which is the sum of the square of the market share for all firms within the industry. Therefore, a change in the number of firms in the market and a change in the market share of the firm would directly affect the market concentration. Furthermore, according to the trade theory, with trade cost reduction, domestic firms' productivity cutoff increases, and the least productive firms in the domestic market are forced to exit the market (Melitz, 2003). This theory suggests that a trade cost decrease leads to a decline in the number of firms in the market. Bonfiglioli, Crinò and Gancia (2021) believe that the extensive margin is the main force that leads to falling market concentration. Their finding shows that the rising number of exporters in the domestic market negatively impacts the market concentration.

Table 6, column 1 reported the regression results with the natural log term of the number of firms as a dependent variable with all control variables and industry and year fixed effect. The coefficient for output tariff is negative and significant at a one percent significant level. These

results suggest that trade liberalisation significantly negatively affects the number of firms in the market. It confirmed that trade liberalisation raised the market concentration by reducing the number of firms in the market. Then, we further checked the impact of trade cost reduction on the number of exporters, regression result reported in table 6 in column 2, where use the log term of the number of exporters to our DID estimation, this result shows there is a negative insignificant relationship between the number of the exporter and the tariff reduction. We can say that trade liberalisation decreases the number of exporters and increases the market concentration. Overall, the two exercises suggest that both the number of firms and the number of exporters channels work for the trade liberalisation effect on the market concentration.

Table 6. Mechanisms

	(1)	(2)	(3)
	ln (number of firms)	ln (number of exporter)	lnHHI for top20 firms
$Output\ Tariff_{2001}$	-0.606***	-0.107	0.021
$* Post_{2002}$	(0.224)	(0.341)	(0.403)
Control Variables	YES	YES	YES
Year FE	YES	YES	YES
Industry FE	YES	YES	YES
Observations	1,408	1,397	447
R-squared	0.971	0.958	0.607
Number of Industries	128	128	66

*** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level. Notes: Robust standard errors in parentheses. Controls include interactions between TPU and Post 2002 and another two interactions terms between Post 02 and significant determinants which are the output shares of SOEs and the exports intensity, separately.

The trade theory also suggested that falling trade cost allows more foreign firms to enter the market, bring more varieties of products, increase foreign competition, and reduce the price index (Melitz, 2003). With trade liberalisation, firms reducing their markup has been suggested by many recent literatures, (such as (Lu and Yu (2015) and Bonfiglioli, Crinò and Gancia (2021)). With more firms entering the market, they reduce their markup to obtain

higher market share. Graziano (2020) suggested that trade liberalisation decreases the CES industry price index and increases domestic concentration. Hence, another channel of trade liberalisation that could potentially affect the market concentration is market share, markup, and price index. Therefore, we included an additional exercise to see how market share changed among the top 20 firms with trade liberalisation. The dependent variable used to generate the regression result for column (3) is the natural logarithm of HHI for the top 20 firms. It is measured by using only the top 20 firms' market share to compute the HHI. The regression results show the coefficient for the output tariff is positive but insignificant, which suggests that trade liberalisation has a weekly positive impact on the market concentration among the top 20 firms. This result shows when trade costs decrease, firms are reducing their markup to obtain more market share, hence the price index drop. Many methods could used to measure the markup. Hence, in order to confirm that trade liberalisation affects market concentration by reducing markup or decreasing the price index, we could have additional exercises in future studies.

Section 7. Conclusion:

Market concentration is an important indicator; if the market has a higher market concentration rate, top firms dominate the market and tend to charge higher markups, and consumers are worse off from higher prices. In this study, we use WTO accession as an event to analyse the impact of trade liberalisation on market concentration.

From our empirical analysis, we first found that the output tariff reduction could effectively alleviate the decrease in the market concentration. Then, we found that the input tariff reduction has positive effects on market concentration. However, when we included input tariff as a control variable to capture the impact of firms using foreign intermediate goods, this relationship became negative. Finally, I study the effects of TPU reduction on market concentration. The results show that with TPU reduction, the market concentration decreased more in industries with higher TPU in 2001 than in industries with lower TPU in 2001.

Our finding suggests that trade liberalisation increases market concentration by decreasing the number of firms in the market. Also, trade liberalisation could potentially increase market concentration by increasing the markup, as we found trade liberalisation increases the market share among the top 20 firms, but the results were insignificant.

There are many gaps still waiting to be filled for this study. First, the channel of trade liberalisation's impact on the market concentration by changing the firm's markup was unclear; we could include two additional exercises to confirm this. First, we can compute the markup and regress as a dependent variable. It should be positive if it is a channel of trade liberalisation. Second, we can check how price is affected by trade liberalisation. The product's price is not directly available in the dataset, but ASIE has the firm's revenues and output quantity, which allows us to get the price. If price is the channel of trade liberalisation's effect on market concentration, it should also be positive.

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Appendix

Appendix. Table 1 Average 2-Digit Industry CR20(in log term)

2-digit Industry Names	Pre-WTO	Post-WTO	Change
Processing of Food from Agricultural Products	-1.422	-1.431	-0.60
Manufacture of Foods	-0.969	-0.798	21.44
Manufacture of Beverages	-0.833	-0.943	-11.68
Textiles	-1.517	-1.439	5.40
Garment, Foot Ware, and Caps	-1.196	-0.933	28.16
Leather, Fur, Feathers, and Related Products	-1.238	-0.946	30.77
Timber, Manufacture of Wood, Bamboo, Rattan, Palm, and Straw Products	-1.425	-1.034	37.80
Furniture	-0.861	-0.969	-11.09
Paper and Paper Products	-1.258	-1.270	-0.92
Printing, Reproduction of Recording Media	-1.395	-1.372	1.68
Articles for Culture, Education, and Sport Activities	-0.806	-0.531	51.84
Petroleum, Coking, and Processing of Nuclear Fue	-0.912	-0.542	68.16
Raw Chemical Materials and Chemical Products	-1.224	-1.172	4.48
Manufacture of Medicines	-1.113	-1.021	9.08
Chemical Fibers	-0.603	-0.496	21.46
Rubber	-0.832	-0.734	13.35
Plastics	-1.461	-1.236	18.17
Non-Metallic Mineral Products	-1.906	-1.753	8.71
Smelting and Pressing of Ferrous Metals	-1.006	-0.824	22.15
Smelting and Pressing of Non-Ferrous Metals	-0.814	-0.642	26.91
Metal Products	-1.303	-1.124	15.88
General Purpose Machinery	-1.334	-1.204	10.86
Special Purpose Machinery	-1.180	-1.061	11.16
Transport Equipment	-0.789	-0.629	25.46
Communication Equipment, Computers, and Other Electronic Equipment	-0.688	-0.535	28.50
Measuring Instruments and Machinery for Cultural Activities and Office Work	-0.793	-0.580	36.67
Artwork and Other Manufacturing	-0.918	-0.993	-7.55

Appendix. Table 2 correlation for baseline model

	TPU	lnCR4	lnCR20	lnHHI	Input Import Tariff	Tariff	Export intensity	SOE' s Output Shares
TPU	1.000							
lnCR4	-0.068	1.000						
lnCR20	-0.121	0.958	1.000					
lnHHI	-0.100	0.983	0.968	1.000				
Input Import Tariff	0.614	-0.098	-0.124	-0.112	1.000			
Tariff_2001	0.597	-0.083	-0.116	-0.097	0.856	1.000		
Export intensity	0.676	-0.004	-0.031	-0.025	0.497	-0.433	1.000	
SOE' s Output Shares	0.470	-0.077	-0.095	-0.080	0.621	-0.498	0.081	1.000

Appendix. Table 3 Number of firms for each year

Year	Number of firms
1998	116896
1999	117324
2000	116594
2001	126387
2002	135012
2003	148140
2004	199630
2005	202529
2006	224498
2007	251518
2008	299358