Trade liberalization and Domestic Vertical Integration: Evidence from China

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Abstract

This paper examines the impacts of trade liberalization on domestic vertical integration activities. We particularly focus on domestic backward vertical integrations through downstream firms acquiring upstream firms, with both the acquirer and target being domestic firms. Trade liberalization affects vertical integration incentives because it changes the profitability of the targets, the acquirers or both. Our empirical analysis is based on data of China's trade liberalization and mergers and acquisitions from 1998 to 2007. Using China's accession to the WTO as a quasi-natural experiment for trade liberalization, we find that reduction of output (the target firm's product) tariffs reduces the number of backward vertical integrations, but reduction of input (the target firm's inputs) tariffs increases backward vertical integration. The result is obtained using the difference-in-differences technique and robust to various specifications checks of the model.

JEL: F13 F15 L14 L22

1 Introduction

How do firms organize their production, through market or within firms? This is a classic question in economics. This question has been extended to the field of international trade and foreign direct investment (FDI): How do firms organize their production *in different countries*, through market (offshoring) or within firms (FDI)? On one hand, the advancement of information and commu-

nication technology changes the incentive for vertical integration (production within firms). On the other hand, the falling of transportation costs and reduction of trade barriers alters firms decision of allocating their production across countries' boundaries. Theories of firm boundaries (including the transaction cost theory and property right theory) have been introduced to the field of international trade and FDI to address these issues. Most studies in this literature focus on the impacts of globalization (e.g., trade and cross-border investment liberalization) on multinational corporations' (MNCs) decisions on offshoring and global vertical integration.[1] In contrast to this focus, the present paper explores how globalization affects outsourcing (organizing some production through market) and vertical integration *within* a country's boundary. We examine such decisions by domestic firms, as opposed to MNCs.

Our analysis is based on China's experiences. There are two advantages of the China focus. First, China had implemented drastic trade liberalization when it was accepted to be a WTO member in 2001. The timing of China's accession to the WTO is commonly viewed as a shock. Thus, we can use China's WTO accession as a quasi-natural experiment to identify the causal relationship between trade liberalization and domestic vertical integrations. Second, firms' reorganization or restructuring in China have become very active and important since the end of last century. During 1998-2014, there were totally 18220 completed mergers and acquisitions (M&As) involving Chinese firms, including foreign firms acquiring Chinese domestic firms, Chinese domestic firms acquiring foreign firms, and Chinese domestic firms acquiring Chinese domestic firms, which we call pure domestic M&As. Among those M&As, 12371 are pure domestic ones, accounting for 67.9% of the total activities. The total value of all reported transactions is USD741.2 billion while those of pure domestic M&As is USD411.4, accounting for 55.5% of the total value.[2]

We conduct our empirical analysis based on data from 1998 to 2007, with China's WTO entry (year 2001) around the middle of the period. We observe a vary large variation of tariff reductions across industries due to the WTO accession. This allows us to employ the difference-in-difference (DID) method to identify the causal relationship between trade liberalization and domestic vertical integration. Any vertical integration has an upstream firm and a downstream firm. For a vertical integration implemented via a vertical M&A, there must be a target firm and an acquiring firm. Our analysis focuses on *backward vertical integrations* in which the acquirers are from downstream and the targets are from upstream. The other type, i.e., forward vertical integrations in which the upstream firms acquire downstream firms, has been studied in the literature and we will

[1] See a literature review by Antras and Rossi-Hansberg (2009).

[2] Not all M&As report their transaction value. Thus, the reported value is only a fraction of the actual total value.

comment on this later. Also to be in sharp contrast to the literature, we investigate the type of trade liberalization on the tariffs of the upstream targets' inputs and those of their outputs. To fix the idea, consider the possibility of a carmaker (downstream) acquiring an engine producer (upstream). The types of tariff reductions we consider are the tariffs on the inputs that the engine producer uses to produce the engines (such as iron and steel), and the tariffs on the engine producer's output, which is engine. Whenever it does not cause a confusion, we refer to the former as *input tariff* and the latter as *output tariff*, for simplicity. Thus, we are interested in how a tariff cut in iron and steel affects the incentive of the carmaker to acquire the engine producer, and how a tariff reduction in engine affects that incentive.

Our empirical results show that the input and output tariff liberalizations have opposite effects on (domestic backward) vertical integrations: the output tariff liberalization *reduces* the number of vertical integrations, while the input tariff liberalization *increases* the number of vertical integrations. The finding is obtained based on our main regression model in which we control for many industry-level characteristics (the upstream industry) including the average age of firms in the industry, the total size of the industry, the degree of market competition of the industry, and the time-varying international shocks in the industry. The finding is also robust to various specifications and possible concerns of the model.

Although there is a large empirical literature on the determinants of firms' vertical integration decisions, the empirical literature on effects of tariffs on vertical integration is new and small. As briefly summarized by Alfaro et al. (2016), the former literature usually focuses a few specific industries. Ornelas and Turner (2012, p31) point out that "the relationship between tariffs and industrial structure has received very little empirical scrutiny". The present paper contributes this latter literature. We provides an indirect empirical test on some predictions from Ornelas and Turner's (2008, 2012) theoretical analysis. Although Ornelas and Turner (2008) try to study the impact of tariffs on trade flows while Ornelas and Turner (2012) analyze how protection affect welfare, the two papers have one thing in common: tariffs affect the organizational form of companies, outsourcing or vertical integration. In particular, Ornelas and Turner (2012) show that protection on the supplier's market (which is equivalent to the output tariff in our model) makes offshoring less attractive and thus raises the attractiveness of domestic integration relative to domestic outsourcing. Our finding that output tariff reduction *reduces* domestic vertical integration provide an empirical support to this prediction. In return, Ornelas and Turner (2008, 2012) provide one theoretical explanation to our empirical result: in the case of hold-up problem with specific input provided by the upstream firm to the downstream firm, output tariff reduction exacerbates the

domestic upstream firm's hold-up problem (reducing specific investment) and thus makes vertical integration more attractive relatively.

Although the empirical research on the impact of trade liberalization on the organization of domestic firms is scant, we are not the first one in this literature. Alfaro et al. (2016) has done one such analysis. Our paper and Alfaro et al. (2016) are complementary to each other. Alfaro et al. (2016) study how tariffs on the product of the downstream firms affect their vertical integration level. They argue that vertical integration is costly but increases productivity. Their model predicts that higher prices of final goods (the downstream firms' output) will make the upstream and downstream firms benefit more from vertical integration. By treating reduction of tariffs as an exogenous shock to prices, their empirical results, using cross country data, show that higher tariff of the firm's final goods increases the firm's vertical integration level, consistent with their theory prediction. In contrast, we focus on the changes in the *upstream* industry's input tariffs and output tariffs, respectively.[1] However, our study is not just an extension of Alfaro et al. (2016) to the effects of upstream industry's input and output tariffs on vertical integration. While a change in tariffs of the goods produced by the downstream firms (as in Alfaro et al., 2016) can be considered as just a change in price or competition, a change in tariffs of the upstream industry is more than just a change in price and competition as far as the downstream industry is concerned. The trade literature has demonstrated, both theoretically and empirically, that trade liberalization in intermediate inputs also results in more input varieties, which increase the downstream firms' production productivity or product quality. Thus, we may expect to see additional incentive for vertical integration as a result of upstream industry's tariff changes.

Our paper is also related to three broad literatures in international trade. The first is the organizational choices under the international trade context. Both transaction cost and property right approaches have been introduced under the international context to address the question of how firms organize their productions globally. Antras and Rossi-Hansberg (2009) and Antras (2016) have reviewed this strand of literature in details. Our paper contributes to this strand literature by empirically investigating the impact of trade liberalization on vertically related domestic firms' organizational choice: vertical integration or outsourcing.

The second strand of literature is about firm-level adjustment/performance in response to trade liberalization. There are many different dimensions of firm-level adjustments, including employment (Autor et al., 2013), quality upgrading (Amiti and Khandelwal, 2013; Fernandes and

[1] In an empirical study, Breinlich (2008) shows that trade liberalization between Canada and the US has increased domestic M&As (by 70%) in Canada. His paper, however, is not specific to vertical M&As, which is our focus.

Paunov, 2013; Martin and Mejean, 2014), firms' growth (Baldwin and Gu, 2009), innovation and R&D activities (Liu and Rosell, 2013; Amiti and Khandelwal, 2013; Li and Zhou, 2015; Bloom et al., 2016), product scope (Bowen and Wiersema, 2005; Baldwin and Gu, 2009; Liu, 2010; Qiu and Wen, 2013), and product mix (Mayer et al., 2014, 2015). Our paper adds to this literature by investigating a novel margin of adjustment: the organizational choices.

The third strand of literature is related to imported inputs and input tariff liberalization. The literature is more recent and emphasizes the importance of intermediate input tariff liberalization. Studies include Amiti and Konings (2007) and Topalova and Khandelwal (2011) on productivity, Goldberg et al. (2010) and Colantone and Crino (2014) on product scope, Fernandes and Paunov (2013), Bas and Strauss-Kahn (2015) and Fan et al. (2015) on product quality, and Liu and Qiu (2016) on innovation. Our paper adds to this list a new dimension: intermediate input tariff reductions affect domestic firms' organizational choices.

The remainder of our paper is organized as follows. In Section 2, we discuss some background institutions of China. Section 3 introduces the econometric specification of the main model and describes our data. Section 4 reports and discusses the basic regression results and check its validity and robustness. Concluding remarks are provided in the last section.

2 Background

2.1 China's Trade Liberalization and Accession to the WTO

China began to apply for WTO entry in the late 1980s. After many rounds of negotiations, China finally joined the WTO in December 2001 and carried out a large cut in tariffs. Figure 1 exhibits the tariff changes during the period of 1998-2007. We use the effectively applied tariffs(AHS) to measure the output tariff at ISIC 4-digit product level. The input tariff is calculated using output tariff and Chinese Input-Output Table (2002) (see details in Section 2.4). The left graph of the figure shows the means and standard deviations of the simple average output tariffs of ISIC 4-digit industries in China while the right graph is for the input tariffs. It is evident that during the pre-WTO entry period, namely 1998-2001, tariffs did not change much, staying at high levels, around 20% for output tariffs and 9% for input tariffs. In 2002, the first year of WTO entry, output tariffs dropped significantly, from 18.67% to 14.10%, and so did input tariffs, from 8.88% to 6.36%. Subsequently, both output and input tariffs continued to decrease and then remained stable after 2005, at around 10.42% for output tariffs and 4.86% for input tariffs. There were also

substantial variations in tariff levels across industries. The standard deviations of output tariffs were around 60% of the means while those of the input tariffs were around 30%.

Figure 2 plots the tariff reductions of all industries during the post-WTO entry period, i.e., 2002 to 2007 against the corresponding industries' initial tariff levels in 2001. We can see strong positive correlations for both the input and output tariffs: Industries with higher initial tariff levels experienced larger tariff reductions in the post-WTO entry period.

[Insert Figures 1 & 2 here]

In summary, the two figures present four features of tariff changes in China during 1998-2007. First, there was a sudden and drastic reduction in 2002. Second, there are substantial variations of tariffs across industries. Third, across all industries, there is a strong and positive correlation between the initial tariff levels (in 2001) and the subsequent tariff reductions. Fourth, tariffs before the WTO entry were somewhat fixed. We can take the advantage of these four characteristics to examine the impacts of trade liberalization on firm activities in general, and domestic firms' vertical integrations in particular as this paper aims to do.

Specifically, the above features of tariff changes enable us to use the tariff levels of each industry in 2001 to represent various degrees of tariff reductions. The validity of our identification strategy relies on the exogeneity of the key explanatory variable, i.e., the tariff levels in 2001. Following Fan et al.(2015), Bloom et al.(2016) and Liu and Qiu(2016), we argue that the nature of China's accession to the WTO provides a quasi-natural experiment for such an identification. The sudden and drastic drop of tariffs in 2002 reflects the pure policy change due to China's access to the WTO. The change is unlikely to be driven by other confounding factors associated with vertical integrations.

2.2 M&As and Related Policies and Regulations

M&As were not active in China until the late 1990s. Table 1 reports the completed domestic M&As in China from 1986-2007. According to Reuters' M&A database, the first domestic M&A in China was completed in 1987. There were only a small number of M&As in the early years, one in 1990, two in 1991 and five in 1992. Since then, the M&A activity began to grow and became very active in late 1990s. In 1998, the total number of completed domestic M&As reached 100 for the first time. It further increased dramatically after China's accession to the WTO, reaching its peak at 969 in 2007.

[Insert Table 1 here]

The first law on M&As promulgated in China is the *Interim Provisions on Enterprises Mergers and Acquisitions (1989).* It officially clarifies the definition of M&A for the first time: The purchase of one firm by another firm which induces the end or change of the target's legal corporation. It also provides guidelines and legal basis for conducting M&As in China. Subsequently, the government introduced a series of laws, provisions, regulations, guidance and policies, some of which are M&A in general and some are M&A specific to FDI in China. As for the general type of M&A laws and regulations, one such example is the *Administration of the Takeover of Listed Companies Procedures (2002).* This is the first regulation on takeovers focusing on special types of M&As, that is, targeting listed companies. Although the introduction of this regulation could affect takeover of listed companies differently from other types of takeovers, our identification strategy will be invalid only if the impacts of this regulation across industries systematically coincide with the impacts of trade liberalization. Yet, to control for this possibility, we will check with a subsample of unlisted firms in our robustness regressions.

Another general regulation is the *Anti-Monopoly Law of People's Republic of China (2008).* It is the most comprehensive law on anti-monopoly in China. The first draft of Anti-Monopoly Law was officially launched as early as in 1994, when it was listed on the legislative agenda by the Standing Committee of National People Congress. The final draft was submitted to the National People's Congress in June 2006 for discussion, and finally passed and adopted at the 29th meeting of the Standing Committee of the Tenth National People's Congress on August 30, 2007. The Anti-Monopoly Law came into effect on 1 August 2008. It is enacted to "prevent and prohibit monopolistic conduct, protect fair competition, improve the efficiency of operation, safeguard consumer and public interests, and promote the healthy development of the socialist market economy". Although M&As, including vertical integration activities, are directly regulated by this law, our data, which ends in 2007, is from the sample period prior to the introduction of this law.

There are other policies and regulations which are more specific to certain types of M&As. The first one is M&A policies on foreign invested enterprises (FIEs), i.e., all foreign firms having FDI in China. Laws and policies in this group which were introduced during the sample period of the present study include *Interim Provisions on Purchase of SOEs by Foreign Investors (1999)*, *Provisions on Mergers and Divisions of FIEs(1999)*, *Catalogues Guiding Foreign Investment in Industry (2002)*, *Interim Provisions on Mergers with and Acquisitions of Domestic Enterprises by Foreign Investors (2003).* These policies would not have direct effect on the pure domestic M&As which are the focus of the present study.

The other type of specific policies is related to state-owned enterprises (SOEs). China carried out SOE reforms mainly in the late 1990s and early 2000s. Reforms include privatization, M&As, and bankruptcy, such as *Notice on Several Issues in Trial of Merger and Acquisition and Bankruptcy of SOEs (1996)*, *Notice on Relevant Issues Regarding the Selling of Small SOEs (1999)*, *Interim Provisions on Purchase of SOEs by Foreign Investors (1999)*, *Interim Provisions on Restructuring SOEs Using Foreign Investment (2002)*. These regulations could affect the incentives and outcomes of domestic M&As involving SOEs. To insulate the impacts of these regulations, we control for factors related to SOEs in our robustness checks.

3 Econometric Specification and Data

3.1 Empirical Model

Our objective is to examine the impact of trade liberalization on firms' decisions with regard to outsourcing *vs.* vertical integration. Generally, vertically integration can be achieved by a downstream firm acquiring an upstream firm, called backward vertical integration, or an upstream firm acquiring a downstream firm, called forward vertical integration. This study focuses on domestic backward vertical integration. With this notification, we will use the term "vertical integration" for "backward vertical integration" throughout the paper for succinctness without causing misunderstanding. To identify the causal impact of trade liberalization on vertical integration, we exploit the quasi-natural experiment provided by China's accession to the WTO in 2001 and conduct a difference-in-differences (DID) analysis. Our data covers the period of 1998-2007, which includes both the pre-WTO period (1998-2001) and post-WTO period (2002-2007). China's WTO accession results in a large variation in the tariff reduction across industries. This enables us to conduct DID estimation which examines the difference between the change in vertical integration activities in industries with larger tariff reductions because of the WTO accession (the treatment group) and the corresponding changes in industries with smaller tariff reductions (the control group).

Accordingly, we construct our basic econometric specification as

$$VI_{it} = \beta_1 \cdot WTO_t \times OutT01_i + \beta_2 \cdot WTO_t \times InpT01_i + \mathbf{X}'_{it}\gamma + \lambda_t + \lambda_i + \epsilon_{it}. \quad (1)$$

In model (1), VI_{it} is the number of acquisitions with the targets being the upstream firms in industry i (at ISIC 4-digit level) and the acquirers from the downstream industries of industry i,

in year t. WTO_t is a dummy variable indicating the years after 2001, the post-reform period, i.e., it takes the value zero for all years before 2002, and 1 for all years from 2002 onwards (including 2002). $OutT01_i$ is the initial level of output tariff of industry i in year 2001, the year just before the WTO accession. Similarly, $InT01_i$ is the initial level of input tariff in 2001 of each industry i. Because the initial tariff levels are highly and positively correlated with the degrees of tariff reductions due to the WTO accession, $OutT01_i$ and $InT01_i$ capture the extents of output and input tariff reductions (treatment intensity), respectively, brought by trade liberalization. We use year fixed effect λ_t to control for the time trend and all other possible general time-specific shocks. There is a sizeable variations in vertical integration activities across industries in both sub-periods(see details in subsection 3.4), suggesting that industries might in nature have different patterns of vertical integration. Accordingly, we include industry fixed effect λ_i to control for those time-invariant industry characteristics. In addition, we control for a set of time-varying industry characteristics that might also affect vertical integrations. This set, represented by $\mathbf{X}'_{it}$, includes the average age of firms in the industry, the total scale of the industry, the degree of market competition of the industry, and the time-varying international shocks in the industry. The last term in model (1), ϵ_{it}, is the robust error term clustered at the ISIC 4-digit level. Since the dependent variable is a count variable, we use the fixed effects Poisson model to obtain the estimation results.

In model (1), β_1 and β_2 capture the impacts of trade liberalization on vertical integration activities. In particular, if output tariff reductions discourage vertical integrations, we should expect β_1 to be negative; and if input tariff reductions promote vertical integrations, β_2 should be positive.

The reliability of our estimation depends on the validity of our model specification, that is, whether our regressors of interest are independent of the error term conditional on all the control variables. It is well known that China's WTO accession is a long negotiation process and the timing of accession is highly political and unpredictable, which implies that our WTO_t variable is very likely to be exogenous (Bloom, et al 2016). However, the degree and the procedure of tariff reduction across industries may be an outcome of negotiation and therefore, not likely to be completely exogenous. To deal with this problem, instead of using the actual tariff reduction, we use the initial levels of tariff before the WTO accession to measure the treatment intensity. This helps alleviate the potential endogeneity concern because the initial tariff levels are almosted fixed in the pre-WTO period and thus largely pre-determined before our sample period.

Following Goldberg et al (2010) and Liu and Qiu (2016), we also check whether the levels

of output and input tariffs in 2001 and their actual changes after the WTO entry are related to the industry performances in the pre-WTO period. The regression results are reported in Table 2. If the tariffs are endogenously influenced by industries' lobbying pressures, or by policies targeting specific industries based on the pre-WTO performance, we would expect a statistically significant correlation between tariffs and industry performance in the pre-WTO period. Column (1) of Table 2 shows that vertical integration in the pre-WTO period is not correlated with the initial levels of output and input tariffs in 2001. In columns (2)-(5), the dependent variables are other pre-WTO industry performance measures including output(sales) of all firms, output of domestic firms, value added per capita and capital-labor ratio, respectively. The results show that these pre-WTO industry performances are not significantly related with the initial tariff levels in 2001. In columns (6)-(10), we use the actual reductions of tariffs in the post-WTO period as our independent variables. The results are not significant either. Hence, we are confident to say that the output and input tariffs in 2001 are not influenced by the industry performances in the pre-WTO period.

[Insert Table 2 here]

3.2 Construction of Key Variables

There are two key variables in our empirical analysis, the vertical integration activities and the tariff levels.

In the main analysis, we measure vertical integration activities using the number of acquisitions by firms from downstream industries targeting upstream industries (VI_{it}). We check the robustness of our results using the value of those acquisitions for VI_{it}.[1] Theoretically, for any given industry, the upstream and downstream are easy to define. In practice, it is less straightforward. We follow Antras et al. (2012) to identify upstream and downstream by calculating the upstreamness index. The upstreamness index captures the average position of an industry's output in the value chain. Basically, for each industry i, its gross output (Y_i) equals the sum of its use as final goods (F_i) and its use as intermediate inputs to other industries. We use d_{ij} to denote the dollar amount of industry i's output needed to produce one dollar's worth of industry j's output.

[1] As argued by Breinlich(2008), using the count instead of total value of transactions at lease have two advantages. First, the count measure is more readily available in the database because some transactions haven't published transaction values. Second, the distribution of transaction values is quite dispersed.

$$Y_i = F_i + \sum_{j=1}^{N} d_{ij}F_j + \sum_{j=1}^{N}\sum_{k=1}^{N} d_{ik}d_{kj}F_j + \sum_{j=1}^{N}\sum_{k=1}^{N}\sum_{l=1}^{N} d_{il}d_{lk}d_{kj}F_j + ...$$

Antras et al. (2012) define the upstreamness index by multiplying each of the terms in the above equation by their distance from final use plus one and dividing by Y_i.

$$U_i = 1 \cdot \frac{F_i}{Y_i} + 2 \cdot \frac{\sum_{j=1}^{N} d_{ij}F_j}{Y_i} + 3 \cdot \frac{\sum_{j=1}^{N}\sum_{k=1}^{N} d_{ik}d_{kj}F_j}{Y_i} + 4 \cdot \frac{\sum_{j=1}^{N}\sum_{k=1}^{N}\sum_{l=1}^{N} d_{il}d_{lk}d_{kj}F_j}{Y_i} + ...$$

Then, the upstreamness index U_i measures the extent of upstreamness of industry i's use. Higher U_i means this industry is more upstream in the value chain.

We use China's Input-Output Table (2002) to calculate this upstreamness index and match it back to ISIC rev.3 industries.[1] Within each vertical integration, if the target's upstreamness index is lower than the acquirer's, we define it as a (backward) vertical integration.

Trade liberalization in each industry includes both output tariff reduction and input tariff reduction. Our output tariff $OutT_{it}$ is the AHS simple average tariff at ISIC 4-digit product level, which is directly available from the World Integrated Trade Solution (WITS). We construct input tariff following Topalova(2010) and Liu and Qiu (2016). Specifically, input tariff for industry i (according to the classification in Input-Output Table) in year t is defined as the weighted average of the tariffs of goods that are used as inputs for industry i; that is,

$$InT_{it} = \Sigma_j CostShare_{ij} \cdot OutT_{jt}$$

where InT_{it} is the input tariff of industry i in year t, $OutT_{jt}$ is the output tariff of industry j in year t, and $CostShare_{ij}$ is the cost share of industry j in producing 1 unit of output of industry i. $CostShare_{ij}$ is based on China's IO Table (2002). The initial input tariff of 2001 is thus defined as $InT01_i = InT_{i2001}$.

3.3 Data

Our empirical analysis relies on many types of data. We obtain some of them and construct some others from three data sources.

The first data source is the Mergers and Acquisitions database from Thomson Reuters SDC

[1] We use the IO table of 2002 because China's IO table is available every five years and 2002 is in the middle of our sample and close to the time of China's WTO entry.

Platinum (SDC). This database includes transaction-level data of M&As involving at least 5% ownership of the target and a transaction value of one million U.S. dollars or more or where the value of the transaction is undisclosed, all around the world. Data are mainly collected from over 200 English and foreign language news sources, SEC filings and their international counterparts, trade publications and proprietary surveys of investment banks, law firms and other advisors. The database provides information on targets and acquirers, such as firm name, country, major industry, parent firm information and a bunch of financial characteristics. It also provides information on the M&A itself, such as the announced time, status, completed time, value of transaction, and share of transaction.

We calculate our vertical integration variable (VI_{it}) based on the SDC database. First of all, we only extract data on completed transactions with both the acquirer and target nations stated as "China" (excluding Hong Kong, Macau and Taiwan for the purpose of pure "domestic" in this study). Second, we focus on M&As related to manufacturing sector only because M&As in other sectors could be very different from those in manufacturing sector. In all Chinese domestic M&As, some belong to a category in which M&As are conducted by "Financial Buyer" (mostly are private equity, venture capital firms or other financially oriented investors). This part accounts for 3% of the sample only. Third, we confine to the type of M&As belonging to (backward) vertical integrations according to our definition provided above. Each deal in the sample is counted as one vertical integration. For example, if one car producer acquires an engine supplier, we define it as one vertical integration targeting at the engine industry. If there is also a truck producer acquires one engine supplier at the same year, then we define $VI = 2$ for the engine industry in this year. Forth, we also use the total value of those M&A transactions to calculate our alternative measure of vertical integrations in the robust check. Transaction values are deflated to 1996 US dollar using CPI index provided by U.S. Department of Labor Bureau of Labor Statistic.

The second database is the World Integrated Trade Solution (WITS), which provides import tariff data of many countries including China. As pointed out earlier, we use the AHS simple average tariff data at ISIC 4-digit product level, which is directly available from WITS.[1]

The third database is Above-scale Industrial Firms Panel 1998-2007 (ASIFP). The ASIFP is provided by China's National Bureau of Statistics (NBS). It covers all SOEs and non-SOEs with

[1]We use tariff data instead of Non-Tariff Barriers (NTB) because the comparability of NTB is problematic in manufacturing-wide studies and are more difficult to get. In contract, tariff data are price-based measures, more comparable across sectors and time, and also readily available. Moreover, compared to other indirect measures such as import penetration rates, tariff cuts are a direct policy instrument and less suffered to the endogenous problems (Trefler, 2004; Breinlich, 2008).

annual sales of at least 5 million RMB in China's mining, manufacturing, and utilities industries. The number of firms in this dataset varies from over 140,000 in the late 1990s to over 336,000 in 2007. Firms are from all 31 provinces and directly-administrated municipalities in China. We only use data from manufacturing industries. The database provides detailed information of each firm, including official name, industry, location, and ownership. It also contains most operation and performance items of each firm such as age, employment, capital, intermediate inputs, and new product sales. We clean the ASIFP data by dropping observations according to the basic rules of the Generally Accepted Accounting Principles (Cai and Liu 2009). We also drop firms with fewer than eight workers since those firms are subject to different legal regime (Brandt et al., 2012), firms with obviously wrong establishing years such as earlier than 1900. In addition, we drop firms in tobacco manufacturing because they are in a highly regulated industry. Based on this database, we construct a set of time-varying industry-level control variables, which might affect M&A activities and at the same time be correlated with tariff reductions.[1]

We merge the above three databases to construct our dataset at the ISIC 4-digit industry level.[2] The starting time of our dataset is 1998, the earliest available year of the ASIFP data. The ending time is 2007, which is chosen to avoid potential biases caused by the worldwide financial crisis in 2008. In our merged dataset, we have data for 102 ISIC 4-digit industries in 1998-2007.[3]

3.4 Summary Statistics

Table 3 provides descriptive statistics on vertical integrations and tariffs across ISIC-2 digit industries, in different time periods. Columns (1)-(4) show the total number of vertical integrations targeting in each ISIC-2 digit industry. Column (1) is the total number of vertical integrations for the whole sample period, 1998-2007. There exist large variations across industries in vertical integration activities. The most active industry, chemicals and chemical products, has 156 acquisitions, while other transport equipment industry has only 1 acquisition. Column (2) is the total number of vertical integrations in the pre-WTO period, 1998-2001. Column (3) is the total num-

[1]Though the NBS data is firm level, we only use it to construct time-varying industry level covariates. The reason why we don't conduct firm level analysis is that firms' names in ASIFP are in Chinese while those in SDC are in English and they cannot be matched well. Other information on identity cannot generate good matches either.

[2]All M&A transactions in SDC are classified into SIC 4-digit industries based on the primary field of the target company or acquired division in SDC. We convert SIC 4-digit industry to ISIC 4-digit industry using correspondence table provided by UNSTAT. Variables from ASIFP database are classified by Chinese Industry Classification, which is modified from the ISIC Rev.3. Thus, we also need to reclassify firms into ISIC 4-digit industry according to the provided official correspondence.

[3]Tobacco manufacturing is not included since it subjects to high regulation in China and thus might have very different reactions respect to increased import competition. And the number of M&As in Tobacco is quite small, thus excluding them won't affect our results.

ber of vertical integration in the post-WTO period, 2002-2007. Column (4) reports the changes between column (3) and column (2). We can see that there are limited vertical integrations in pre-WTO period, and most M&As happen in the post-WTO period (This is true even after to consider for the different time span of these two periods). The changes of upstream acquisitions between before and after WTO also vary substantially across industries. Statistics of output and input tariffs are reported in columns (5)-(10). Column (5) is the levels of output tariff in year 2001, column (6) is the levels of output tariff in 2007, and column (7) reports the difference between column (5) to column (6). It is clear that most industries experienced huge tariff reductions from 2001 to 2007, but there is a large variation across industries in terms of the degree of reduction. A similar pattern can be found for input tariffs.

[Insert Table 3 here]

4 Econometric Analysis

4.1 Basic Results

Table 4 reports our basic regression results. In all regressions the dependent variable is the number of vertical integrations targeting at industry i. We find consistent results that output tariff reduction of an industry significantly decreases acquisitions targeting at this industry by acquirers from the downstream firms, while input tariff reduction of an industry significantly increases acquisitions targeting at this industry by acquirers from the downstream firms.

Column (1) is the basic result with only industry and year fixed effect controlled for. We find a significant and negative estimate for $WTO \times OutT01_{it}$ and a significant but positive estimate for $WTO \times InT01_{it}$. It indicates that after China's accession into WTO, firms in industries which experience higher output tariff reduction, are less likely to be integrated by firms from downstream industries; on the other hand, firms in industries which experience higher input tariff reduction are more likely to be integrated by firms from downstream industries. To check whether this correlation is due to other potentially omitted driving forces, we now further introduce some industry time-varying characteristics that might be related with firm's upstream integration decisions into our basic regression step by step.

Average Firm Age

Industries with different average firm age are in different stage of its products' life cycle and thus might have a very different pattern in vertical integration. Basically, if the industry is still not

mature enough, it will be more dynamic and thus might have more vertical integration targeting on them; on the other hand, if the industry is a very mature one, there might be few vertical integrations. Column (2) includes the logarithm of average firm ages into our basic regression. We find that the estimates on output and input tariffs are not affected by average firm age. And there are less vertical integrations targeting at more mature industries.

Industry Scale

Different industries have different scales. A large scale industry with a lot of firms is more likely to have mergers than a small industry with only a few firms. Thus, industry scale is closely related with the number of mergers in the industry. Furthermore, during the process of trade liberalization, the composition of industries might have also changed. Some industries who benefit more from trade liberalization might expand; while some might also shrink because of comparative disadvantage or limited endowment. In this sense, even if the occurrence rate of mergers stayed unchanged before and after trade liberalization, the number of mergers will still change because of the change of industry scales. Though we have included industry fixed effect in our regressions which partly controlled for industry scale, we further add to our regression industry scale $logN$, the logarithm of total number of firms in each industry for each year, to control for the dynamic impact of industry scale changes. We find in column (3) that industry scale is not significant. And our main results on tariffs remain unchanged.

Industry Competition

In addition to industry scale, the degree of industry competition may also affect firm integration behaviors. We further include the Herfindahl-Hirschman Index (HHI) in our regression to capture the general competition situation of an industry due to local firms (rather than competition from imports). Result in column(4) shows that our main estimates on tariffs are still not affected.

Time-varying International Industry Shocks

Though we've controlled for industry fixed effect and time fixed effect in our specification and allow industry trend to change year by year, vertical integration activities might also be affected by omitted time-varying international industry shocks (like technology shock). Following Breinlich (2008), we include the total number of completed vertical integration targeting at the same industry in India and Brazil to control for the possible time-varying international industry shocks. India and Brazil are quite similar with China as large developing economies and are often taken as counterparts of China. Thus, if there are international factors affecting world vertical integration activities, these trends are likely to be similar for China, India and Brazil. Furthermore, there is no significant trade liberalization happened in these two countries around China's entry

into WTO, which makes the number of vertical integrations in these two countries a clean proxy of international industry shock. Thus we add activities of India and Brazil in our regression to control for this possible omitted factor. The result in column (5) shows that controlling for the potential international industry shock doesn't affect the main result.

In sum, the negative effect of output tariff liberalization and the positive effect of input tariff liberalization on vertical integration are very robust to different considerations, and we find that the magnitudes of the effects are very stable in different model specifications.

Insert Table 4 here

4.2 Validity and Robustness Checks

In this subsection, we conduct a series of validity tests of our identification and robust checks on our econometric results. First of all, the reliability of our estimates depends on the validity of our DID specification, that is, the conditional comparability of trends between the treatment group and the control group. We first conduct some checks on the trends and then we test the robustness of our results.

4.2.1 Validity of DID

Flexible Estimation

Till now in our DID specification, we have estimated the average treatment effect of output tariff cut and input tariff cut on vertical integration activities, which is the difference between the treatment group and the control group in their average differences between the pre-WTO and post-WTO periods. Now we check the dynamic impact of output tariff cut and input tariff cut with a more flexible model specification. This test helps answer two questions: whether the two groups have comparable trend before the WTO accession; and whether the divergence emerges after the WTO accession. We do the flexible estimation by replacing the WTO dummy with a vector of year dummies λ_t, indicating the years 1998 to 2007 with year 2001 as the omitted reference year. With this specification, we have little timing structure assumptions on the model and simply examine how the difference in vertical integration activities between industries with different tariff reduction levels vary over time.

We plot the estimated coefficients of the interaction terms $\lambda_t \times OutT01_i$ and $\lambda_t \times InT01_i$ in Figure 3. The detailed results are reported in Appendix, see Table A1. The subfigure (a) reports coefficients on output tariff, i.e. $\lambda_t \times OutT01_i$. Before China's accession into WTO, the

coefficients are mostly not significant (See Table A1) and jump up and down around zero, showing no clear or significant relations between output tariffs and vertical integration activities. There is a sudden drop in 2002, the year right after China's accession into WTO and the coefficients since 2002 remain significant and negative. The decreasing trend from pre-WTO period to post-WTO period is clear. We further plot the mean of the coefficients in pre-WTO period and post-WTO period, and it is clear from the means that the mean of the pre-WTO period is around zero, and that there is a significant drop in the mean of the coefficients in post-WTO period. The subfigure (b) similarly plots coefficients on input tariff. The pattern is also clear but presents an opposite trend to that of subfigure (a). Before China's accession into WTO, the coefficients are mostly insignificant, jumping up and down around zero and then experience a sudden increase in 2002, and the coefficients are positive and significant since then. The increasing trend in the post-WTO period is clear, and the mean of coefficients of pre- and post-WTO period also shows the jump. Basically, the results of the flexible estimation are supportive for our DID specification.

Expectation Effect

Though the process of China's WTO accession is highly political and widely regarded as unexpected, we further check whether firms in different industries change their vertical integration behaviors in a way correlated to the industrial tariff cut as a response to the anticipation of the WTO accession. We add the interaction terms $OutT01_i \times Year2001$ and $InT01_i \times Year2001$ to our benchmark regression, where $Year2001$ is a dummy for year 2001. The result is reported in column (1) of Table 5. It shows that the coefficients of $OutT01_i \times Year2001$ and $InT01_i \times Year2001$ are insignificant, which implies that there is no such expectation effect and the treatment group and the control group don't show differentiated expectation. What's more, the coefficients of our interested regressors, $WTO_t \times OutT01_{it}$ and $WTO_t \times InT01_{it}$, remain significantly negative and positive, respectively.

Industry-Specific Trends Change

In our DID specification, we implicitly assume that conditional on $(\mathbf{X}'_{it}, \lambda_t, \lambda_i)$, our treatment groups and control groups have common trends in pre- and post-WTO period. This assumption allows us to use vertical integration activities of the control groups as the counterfactual of the treatment groups in the post-WTO accession period. Thus, by differencing out the trend change of control group allows us to isolate the effect of tariff reductions on vertical integration activities. However, if industries are affected differently by confounding industry-time specific factors, they might have different trends in pre- and post-WTO period. The optimal way to rule out this possibility is to allow industries to have different time trends for pre- and post-WTO period by

controlling a vector of industry-WTO dummies $\sum_i \lambda_i \times WTO_t$. However, this is not applicable in our specification since our key variables are defined at the exactly same ISIC4 industry-WTO level. Thus, we alternatively control for the industry trends in a more aggregate level, ISIC 2-digit industry level, by adding a set of dummies $\sum_i ISIC2_i \times WTO_t$ in our previous regressions.

Column (2) of Table 5 reports the results after controlling for all ISIC-2 digit industry-specific trend changes in post-WTO period. After controlling for these industry-specific trends changes, the results stay qualitatively the same and quantitatively larger.

Placebo Test: Pre-WTO Period

Following Topalova (2010), we conduct a placebo test to examine the impacts of output and input tariffs on vertical integration in the pre-WTO period (1998-2001). The premise is that because tariffs did not change much during that period, we should not expect any significant impacts of tariffs on vertical integration; if the results are the contrary, then there might be some underlying confounding industrial factors (other than the WTO accession) that drive vertical integration. Accordingly, we replace our key variables $OutT_i \times WTO_t$ and $InT_i \times WTO_t$ by $OutT_{it}$ and InT_{it} and rerun the regression for the sample in the pre-WTO accession period. The estimates are given in column (3) of Table 5. The impacts of $OutT_{it}$ and InT_{it} are not statistically significant. This test lends further support to the validity of the common trend assumption of our DID specification.

4.2.2 Robustness

We further address some other concerns that might be correlated with both vertical integration activities and trade liberalization.

Contemporary Policy Reforms

If there are other policy reforms that were introduced around the time of the WTO accession and may affect our treatment and control groups differently, then the effects of those policy reforms will also be included in the DID estimates. In that case, the regression result from our specification will not be the pure effect of trade liberalization. Indeed, two important reforms took place in the early 2000s: the State Owned Entrepreneur(SOE) reform and the relaxation of FDI entry regulations. These are on-going reforms that had started in the 1980s and 1990s, respectively, and accelerated after the WTO accession. The SOE reform results in a large-scale privatization, close-down of small SOEs, and efficiency improvement in the surviving (large) SOEs. The new FDI regulations relax the entry requirement for foreign investors and reduce the range of industries restricted to foreign investment. The strength of these reforms may not vary across industries

thus not be closely correlated with the degree of industrial output and input tariff reductions. However, to control for any possible confounding effects from these two policy reforms, we include two additional control variables in our DID estimation: $SOEShare_i$ (measured by the ratio of the number of SOEs over the total number of domestic firms) and $FIEShare_i$ (measured by the ratio of the number of Foreign Invested Firms(FIE), including firms invested by Hong Kong, Macau and Taiwan, over the total number of firms).[1] Results in Column (4) of Table 5 show that including policy reforms on SOE and FIEs doesn't affect our estimates of output and input tariffs. Thus, we rule out the possibility that our results are caused by the contemporary SOE and FIE reforms.

Besides these two important phenomena, there is also one specifically related policy change, the enforcement of the *Administration of the Takeover of Listed Companies Procedures (2002)*. It is a general regulation on takeovers of listed companies across all industries and thus not likely to confound with the deferential impacts of trade liberalizaiton across industries. However, to exclude the possibility of its confounding effect, we run the regression with the subsample of unlisted firms. We exclude all VIs with listed companies as targets in our data and re-count the total number as our dependent variable. The results in column (5) indicate that, after excluding all takeover of listed companies, the impacts of output and input tariffs are still consistent and significant. Thus, the enforcement of regulation of listed firms doesn't affect our basic results.

Export Opportunities

Along with the tariff cut by China due to its WTO accession, other countries also liberalize their markets to Chinese firms, which implies expanded market opportunities to Chinese firms. On the one hand, China formed the Permanent Normal Trade Relations(PNTR) with countries in the WTO, and thus have greater export opportunities, either because of lowered tariffs, resolved uncertainty (Pierce and Schott, 2016) or other considerations. On the other hand, while China undertook large trade liberalization during the period of 1998-2007, trade liberalization also happened in other countries. When foreign countries lower their tariffs on Chinese products, the market opportunity for Chinese exporters is enlarged, which may also affect the incentives for Chinese domestic firms to acquire domestic firms. In fact, any changes in foreign markets coincidentally happened in the post-WTO period would possibly affect the demand for Chinese exports differently from the pre-WTO period. The demand change will affect the Chinese exporters' market decisions(Mayer et al., 2014) and might also affect their decisions of vertical integration.

Here we control for the export expansion opportunity in two ways. First, in column (6) we

[1]Following Wang & Wang(2015), we classify firms into four categories: stated or collectively owned domestic firms (SOE), privately owned domestic firms(P); mixed domestic firms(Mix); and 4) FDI firms(FIE) including firms that are partially or fully owned by investors from Hong Kong, Macau and Taiwan.

add a term of logarithm industrial total exports, $Export$, to our benchmark regression. Any possible changes that would affect the demand for Chinese exports would ultimately be reflected in the increased exports. Alternatively, in column (7) we include the weighted average tariff faced by Chinese exports to the world, $ForeignTariff$, to capture the possible market expansion opportunity along with the WTO accession period. This tariff measure is directly available from the WITS, which is the weighted average tariffs with *exporter* as "CHN" and *importer* as "World". The estimates of our key variables remain unchanged in column (6) and (7) after we take into account the export opportunity.

Comparative Advantage Industries

Besides the demand side changes which may affect vertical integration, we also take into account the supply side, that is, the industry capabilities to utilize the expanded markets along with China's entry into the WTO. From the traditional Ricardian Model we know that industries with comparative advantages can better make use of the foreign markets and benefits more, compared with industries of comparative disadvantages. Firms in industries with high comparative advantages have higher capabilities of utilizing the foreign market and thus are more likely to expand and earn more profits. In this sense, they might have higher demands for potential assets.

We use the revealed comparative advantage index (RCA) to control for the potential capabilities of benefiting from entering into WTO. The RCA index of an industry is calculated as the ratio of the share of the industry's export in China's total exports over the share of the industry's export in the total exports of the world. We find in column (8) that the impacts of output and input tariffs are not affected by including this supply side factor.[1]

In column (9), we include all of these variables in our basic regression. Our findings are robust to these considerations.

Insert Table 5 here

4.3 Alternative Measures and Estimation Methods

We now do some checks on our results to demonstrate that they are not caused by specific measures or estimation methods. Our results are robust to alternative measures and estimation methods.

Value Measure

In previous regressions, we all use the number of vertical integrations targeting at suppliers' industry as our dependent variable. Now we use the total value instead of total number as an

[1]The results are not affected even if we further include the interactions between RCA and the two tariffs.

alternative measure of the extent of vertical integration. We calculate the logarithm of the total transaction value of these integrations in each industry. Since our dependent variable is now a continuous and non-negative one, we use tobit model to estimate it.[1] The result is reported in column (1) of Table 6. It shows that our results also hold for value measure. Industries experience higher output tariff reductions have relative lower values of vertical integrations targeting at them in value. And the contrary is true for input tariffs.

Poisson Pseudo-Maximum Likelihood Model

Another commonly used count model is Poisson Pseudo-Maximum Likelihood(PPML) method developed by Silva and Tenreyro (2010). It uses the method of Silva and Tenreyro (2010) to identify and drop regressors that may cause the non-existence of the (pseudo) maximum likelihood estimates. This is especially necessary when there are a lot of zeros in data, which might cause potential convergence problem. In our sample, there are a lot of industries have zero VI in some years and thus have a lot of zeros in our data. Thus we use the Poisson Pseudo-Maximum Likelihood(PPML) method developed by Silva and Tenreyro (2010) to re-estimate our results. Result using PPML in column (2) confirms that our results are stable and almost the same with the results using fixed effect poisson model. Thus, our baseline model doesn't suffer from potential convergence problems due to the zero observations.

Random Effect Poisson Model

In previous regressions, we all use fixed effect poisson method to estimate our empirical model. Industries have no VI during the whole sample period will be automatically dropped in regressions using this estimation. To see if these dropped industries will affect our result, we run a regression using the random effect poisson method, which keeps all observations. The regression results in column (3) show that the impacts of tariffs are robust even if we include all zero observations.

Fixed Effect Negative Binomial Model

Poisson estimator is consistent as a pseudo-maximum likelihood estimator regardless of how the data are in fact distributed. However, if the data is over-dispersed, with variance greater than mean, using negative binomial model will improve the estimation efficiency. Thus, we use fixed effect negative binomial model to do a robustness check, in case the data is over-dispersed. The fixed effect negative binomial regression results in column (4) are quite similar to previous ones.[2]

Tobit Model

[1] Note that when using tobit model, all observations, including industries that never have had any VI during the whole sample period, will be included. This is different with the fixed effect poisson model, which only includes industries with at least one VI, while automatically drops industries with no VI during the whole sample period.

[2] Standard error here is observed information matrix (oim) type error, since cluster is not allowed in this model.

Due to the fact that our dependent variable, the number of vertical integration activities, is a count variable, all estimation models we have used so far are count models. We now convert our dependent variable into a continuous variable by taking logarithm $y_{it}^{NEW} = log(y_{it} + 1)$ and use Tobit model to rerun our regression. We choose Tobit because that the new dependent variable is always non-negative. Results in column (5) are qualitatively the same with previous results using count models.

Two-Periods Sample

Since the occurrence of M&As is not so frequent, especially in pre-WTO years, there are a lot of zeros in our data. To smooth the data and reduce the zero observations, we follow Breinlich (2008) to construct a two-periods sample to re-run the regression. We collapse our yearly panel data to a two-periods (the pre-WTO and post-WTO period) panel data to conduct our estimation using fixed effect poisson regression. The results are reported in column (6). The coefficients are still robust.

Insert Table 6 here

5 Conclusion

Despite the large scale of reorganizations of firms' production domestically, the impacts of trade liberalization on how firms organize their production domestically have been ignored in the literature. This paper tries to fill in some of the gaps by empirically investigating the impacts of output and input trade liberalization on domestic vertical integrations. We make use of China's accession into WTO as an exogenous shock with the DID method to identify the causal relationship. Our results show that both output and input tariff reductions do have effects on domestic vertical integrations, but their effects are opposite. In particular, firms in industries which have experienced higher output tariff reduction and/or lower input tariff reductions are less likely to be vertically integrated by firms from downstream industries. The contrary holds for lower output tariff reduction and/or higher input tariff reduction.

Our result on output tariff reduction is consistent with Ornelas and Turner (2012)'s hold-up problem framework. The intuition is that though the output tariff reduction will reduce the attractiveness of outsourcing domestically relative to integrating domestically through the deterioration of under-investment problem due to increased outside option for buyers, it will benefit the total profit under outsourcing through substitution effect by reducing the use of high cost domestically produced inputs. And the second efficiency effect always dominates the first under-investment effect. So the integration is relatively less towards industries experiencing higher output tariff reduction. It is also consistent with Alfaro et al. (2016) when the final good producer is a net buyer. Our result on input tariff reduction also emphasizes the importance of supplier's input tariff liberalization's effect through input-output linkages and spillovers, consistent with Kee and Tang (2016). Its promotion effect on vertical integration is also consistent with the literature on benefits of imported inputs.

This paper contributes to the understanding of how trade liberalization affects firms' domestic organizational choices. Further studies on this topic are still needed. For example, a more detailed investigation using firm-level data rather than industry level data.

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A Results of Flexible Estimation

This table reports results of flexible estimation with year 2001 as base year. All controls and industry, year fixed effect are included.

Insert Table A1 here