How Do VAT Reforms in the Service Sectors Impact TFP in the Manufacturing Sector: Firm-Level Evidence from China

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## Abstract

This paper estimates the impact of a pilot policy reform in China that replaced the business tax (BT) with a value-added tax (VAT) for the service sectors on the total factor productivity (TFP) of manufacturing firms. Employing a difference-in-differences (DD) estimation approach, our results show that through forward and backward linkages (FLs and BLs, respectively) along the value chain, this pilot program has a positive effect on manufacturing firms' TFP. A 1% increase in FLs (BLs) leads to an approximately 7% (16%) increase in firm productivity. This effect is larger for non-state-owned enterprises and labor-intensive firms than for other firms. Manufacturing firms with high intensities of exporting activities are affected only through BLs. Further exploration shows that this increase in productivity is realized mainly through increased specialization of firms. Our findings imply that simplification and unification of the tax system across sectors can help boost firm productivity.



Keywords: VAT pilot program; TFP; China; Forward and backward linkages

JEL classification: H25, D24, O14

## 1 Introduction

Since the late 1970s, as the largest emerging economy, China has experienced rapid economic growth (e.g., Chow and Li, 2002; Wu, 2004; Cheng, 2019; Banerjee et al., 2020). The improved performance of China's manufacturing sector has contributed greatly to this growth (Bosworth and Collins, 2008; Yu, 2015; Wei et al., 2019). However, the 2008 financial crisis damaged the manufacturing sector, leading to excess capacity and lower efficiency. In response, the Chinese government initiated several policies designed to stimulate the economy, including the value-added tax (VAT) pilot program, which aims to unify the tax rates between the manufacturing and service sectors.

The modern tax system in China was formulated in 1994. It established two coexisting indirect taxes, i.e., VAT and business tax (BT). Until 2012, the former applied to the sale of goods and the latter applied to the sale of services. A problem with the BT is that it disallows any input tax credit (e.g., companies cannot deduct expenses) and thus leads to double taxation (Yin, 2015). In response, on January 1$^{st}$, 2012, a program to replace BT with VAT in selected service sectors was implemented in Shanghai and was later expanded to other regions. As of May 1$^{st}$, 2016, it has been applied to all service sectors nationwide.

This paper is connected to an extensive literature on the effect of tax incentives on firm behavior, such as risk-taking (Ljungqvist, 2018), productivity (Zhang, 2019), turnover (Falkenhall et al., 2018), employment (Chaurey, 2017; Saez et al., 2019), charitable contributions (Fack and Landais, 2016), investment (Yagan, 2015; Rao, 2016; Chen et al., 2018; Liu and Mao, 2019), capital structure (An, 2012), and organizational form (Goolsbee, 2004). The VAT pilot program in China recently attracted a great deal of attention, and scholars began investigating its effect on firms' tax burdens (Fang et al., 2017), research and development (R&D) investments (Lan et al., 2020), productivity (Liu and Lu, 2018), and specialization (Fan and Peng, 2017). Among these studies, several are closely related to our study. While they examined the effect of the VAT pilot program on the total factor productivity (TFP) levels of firms in the service sectors (Chen, 2013), our study focuses on the effect on manufacturing firms.

Another study that is closely related to ours is that of Liu and Lu (2018). They also examined this expansion and evaluated its impact on manufacturing firm TFP. Our work differs in terms of at least three aspects. First, Liu and Lu (2018) considered only manufacturing firms in certain sectors (sectors that manufacture articles for culture, education, art, sports, and entertainment and those that manufacture measuring instruments) due to data availability. Second, they did not explicitly investigate the mechanisms through which the expansion targeting the service sectors promoted the TFP of manufacturing firms. Third, they implemented a synthetic control method, whereas we apply a difference-in-differences (DD) method. Importantly, they only considered the variation in the manufacturing sectors during this expansion. By contrast, we also consider the variation in the implementation dates of different regions, which adds additional credibility and robustness to our research design.

By focusing on the impact of a specific tax policy reform on manufacturing firms' productivity in China, the current study contributes to research that investigates how various factors, e.g., tax reform, foreign direct investment (FDI), and R&D investment, promote firm production efficiency in individual developing countries such as India (Arnold, 2016; Rath, 2018; Bhattarai and Negi, 2020), Indonesia (Yang and Chen, 2012), Colombia (Eslava et al., 2004), Chile (Fernandes and Paunov, 2012), Vietnam (Nguyen, 2017), and Cambodia (Cheng, 2012), as well as in a set of countries (Rauch and Weinhold, 1999; Nair-Reichert and Weinhold, 2001).

The idea that forward and backward linkages (FLs and BLs) play an important role in productivity development has been widely recognized in economic literature (e.g., Fleming, 1955; Grossman and Helpman, 1991; Javorcik, 2004; Arnold et al., 2015; Turco et al., 2019). Arnold et al. (2015) conducted an analysis similar to ours. They explored the relationship between liberalization in India's service sectors in the 1990s and downstream manufacturing firms' TFP levels by constructing a condensed indicator of liberalization for each sector evaluated and using an instrumental variables (IV) approach. Our work complements theirs by treating China's VAT pilot program as quasi-experimental, employing a DD analysis and quantitatively estimating how this program, which targets the service sectors, increases the TFP levels of manufacturing firms and how the linkages affect the magnitude of this effect. A tax incentive for the service sectors not only promotes the growth of those sectors but also generates sizable positive effects on those manufacturing firms who provide inputs to the originally targeted sector (Forward Linkage, FL) and those who source inputs from the originally targeted sector's outputs (Backward Linkage, BL) (Javorcik, 2004; Arnold et al., 2015; Turco et al., 2019). Specifically, in our case, the program enables service sector firms to issue deductible VAT invoices to manufacturing sector firms or credit its input VAT from manufacturing sector firms against its own output VAT. In the present study, we calculate the BLs and FLs between different regions and sectors based on the direct input coefficient (matrix) derived from the 2012 China Multi-Regional Input-Output Table of 31 Provincial Units issued by the National Bureau of Statistics. The pilot program has different policy implementation dates for different sectors in different regions. Employing a dataset of listed Chinese manufacturing firms, these variations enable us to apply a standard DD approach to investigate the effect of the program on all listed manufacturing firms' TFP levels.

Our empirical results show that the wider VAT coverage does not significantly improve the TFP levels of manufacturing firms. However, we find significantly positive effects on manufacturing firms with high BLs and FLs, meaning that the linkages play an important role in determining the effect. Specifically, a 1% increase in FLs (BLs) leads to an approximately 7% (16%) increase in firm productivity relative to the average TFP level before the expansion. The heterogeneity analysis shows that the abovementioned effect is smaller for state-owned enterprises (SOEs) than for non-SOEs. This finding is reconciled with the institutional context of China, where non-SOEs are typically profit oriented entities, whereas SOEs often carry policy burdens designated by the government, such as social responsibilities and local employment. It is also found that the estimated effect is greater for labor-intensive firms than for capital-intensive firms. Labor-intensive sectors are closer to the service sectors as they purchase more services and sell more products. In addition, manufacturing firms with high intensities of exporting activities are affected only through BLs as most of their products are sold overseas. Our further evidence suggests that specialization is the main mechanism through which the expansion promotes firm productivity.

The rest of the paper is organized as follows. Section 2 introduces the conceptual framework. Section 3 calculates the linkages between different sectors and regions. Section 4 presents the statistical description of our data and the estimation strategy. Section 5 analyzes the estimation results. Section 6 presents robustness checks and discusses the mechanism. Section 7 concludes our paper.

## 2. Conceptual framework

Unlike BT, VAT is free from the double taxation issue. On January 1st, 2012, the VAT pilot program was implemented in selected modern service sectors and the transportation sector in Shanghai. It was then expanded to more service sectors and regions. On May 1st, 2016, it was applied to all service sectors and regions. The details of the expansion are listed in Table 1 below. The expansion spanned four years, and it had different policy implementation dates in different regions.

Table 1 An overview of the VAT pilot program expansion

| | **Policy implementation date** | **Affected Sectors** | **Affected Regions** |
|---|---|---|---|
| **First Stage** | January 1st, 2012 | Selected modern service sectors (6% or 17%) and transport services (11%) | Shanghai |
| **Second Stage** | September 1st – December 1st, 2012 | Selected modern service sectors (6% or 17%) and transport services (11%) | Beijing, Jiangsu, Anhui, Fujian, Guangdong, Tianjin, Zhejiang, Hubei |
| **Third Stage** | August 1st, 2013 | Selected modern service sectors (6% or 17%) and transport service sectors (11%) | All |
| **Fourth Stage** | January 1st, 2014 | Selected modern service sectors (6% or 17%) and transport service sectors (11%), railway transport service sectors (11%), and postal services (11%) | All |
| **Fifth Stage** | June 1st, 2014 | Selected modern service sectors (6% or 17%) and transport service sectors (11%), railway transport service sectors (11%), postal service sectors (11%), and telecommunications sector (6% or 11%) | All |
| **Final Stage** | May 1st, 2016 | All | All |

Note: (1) The statutory tax rate for each sector is listed in parentheses. Two figures showing the composition of fiscal revenue of China are presented in the appendix. Data source: http://www.chinatax.gov.cn/n810341/n810755/c2043931/content.html, accessed on February 1st, 2021.

(2) Prior to this reform, the statutory business tax rate is 3% or 5%. The 3% rate applies to the following sectors: Transport, post and telecommunication service sectors, construction sector, culture, sports, and entertainment sector. All other sectors are subject to the 5% rate.

(3) Selected modern service sectors include storage service sectors (6%), information transfer (6%), software and information technology service sectors (6%), leasing and commercial service sectors (17%), and scientific research and technical service sectors (6%).

(4) In the second stage, the policy implementation date is September 1st for Beijing, October 1st for Jiangsu and Anhui province, November 1st for Fujian and Guangdong province, and December 1st for Tianjin city and Zhejiang and Hubei province.

Our first hypothesis investigates whether the program has an overall effect on the TFP level of the manufacturing sector.

**Hypothesis 1:** Overall, the VAT pilot program has a significant effect on the TFP level of the manufacturing sector.

Although this pilot program targets the service sectors, it could affect manufacturing firms through FLs and BLs. Specifically, we expect this effect to be heterogeneous for different manufacturing sectors depending on the strength of their linkages with the service sectors.

Consider one manufacturing firm ($A$) and two service firms ($B_0$ and $B_1$). The manufacturing firm has strong FLs and BLs with the service sector firms. $B_0$ and $B_1$ provide identical services. $B_1$ participates in the pilot program, while $B_0$ does not due to its location. As Figure 1 below illustrates, FLs involve manufacturing firms' supplying inputs to firms in the service sectors. In this scenario, manufacturing firms are in an upstream position relative to firms in the service sectors. BLs involve manufacturing firms' purchases of services from firms in the service sectors. In this scenario, the manufacturing firms are in a downstream position relative to the firms in the service sectors (Javorcik, 2004; Amiti and Javorcik, 2008; Debaere et al., 2010; Turco et al., 2019).

Figure 1 Forward and backward linkages


It is widely documented that specialization has positive impacts on productivity (e.g., Rauch and Weinhold, 1999; Li and Yan, 2018; Constantinescu et al., 2019). FLs and BLs help promote the specialization of manufacturing firms. In the context of FLs, manufacturing firm $A$ sells intermediate inputs to $B_0$ and $B_1$ at a price that includes the VAT paid by $A$. After the implementation of the pilot program, $B_1$ pays less because it can now credit its input VAT against its output VAT. This increases the demand of $B_1$ and thus stimulates production of manufacturing firm $A$. This, in turn, encourages $A$ to direct its resources that were allocated elsewhere to its main businesses (manufacturing). Firm $A$ can exploit economies of scale by increasing its level of specialization and concentrating on its manufacturing business (Lin and Ma, 2012;

Chaney and Ossa, 2013; Fan and Peng, 2017). Moreover, the increase in demand also intensifies competition between $A$ and other manufacturing firms. In response, manufacturing firm $A$ will make more external R&D purchases since this can help overcome the technology bottleneck, decrease the risk of in-house R&D and improve the quality of its products (Zhang et al., 2003; Urraca-Ruiz and Laguna-Molina, 2014; Chen et al., 2015; Amoroso et al., 2017). All of this is reflected as an increase in specialization. The increase in specialization further contributes to an increase in the TFP level.

In the context of BLs, manufacturing firm $A$ chooses $B_1$ over $B_0$ when purchasing services (e.g., transport services, postal services, telecommunications services, and R&D services) as long as $B_0$ is not covered in the expansion. The VAT invoices provided by $B_1$ decrease $A$'s purchasing cost. Since the costs of these services are deductible, $A$ is encouraged to purchase more services and to utilize them to improve its product quality and seize a larger market share. Additionally, the lower purchasing costs of services encourage manufacturing firm $A$ to purchase certain services (e.g., R&D services) from outside vendors instead of providing these services itself (Zhang et al., 2019). Thus, $A$ will direct the resources that were originally deployed to obtain these services to its core manufacturing businesses, thus increasing manufacturing firm $A$'s degree of specialization. Consistent with the literature, the increase in $A$'s productivity is realized through increasing specialization.

Moreover, this effect is larger for manufacturing firms with higher BLs or FLs. Higher BLs imply that a higher proportion of intermediate inputs is purchased from the upstream service firms that are included in the expansion. Thus, for manufacturing firms, higher BLs mean that the expansion can lower the purchasing costs even further. This will encourage more external purchases of services (e.g., R&D services), and more resources can be freed for investment in the main businesses (manufacturing). All of these effects contribute to the increase in the TFP level. In this way, the higher the BLs are, the larger the effect is of this program on manufacturing firms' TFP levels.

Similarly, higher FLs mean that providing intermediate inputs to the service sectors takes a large proportion of manufacturing firms' business. Under the VAT system, firms in the service sectors have a larger incentive to purchase intermediate inputs from manufacturing firms since input VAT is deductible. Under this circumstance, manufacturing firms have a strong incentive to seize this opportunity to obtain a larger share of the downstream market by improving their production efficiency. To achieve this, manufacturing firms may increase specialization, such as focusing on their main businesses (manufacturing) and seeking to purchase more external R&D. Again, all these effects contribute to the increase in the TFP level. Thus, the higher the FLs are, the larger the effect is of this program on manufacturing firms' TFP levels.

**Hypothesis 2:** The VAT pilot program affects the TFP level of manufacturing firms through BLs and FLs, and this effect is larger for manufacturing firms with higher BLs or FLs.

Other firm characteristics may also influence the magnitude of the effect. For example, SOEs are controlled by the state, and profit maximization is not their only objective (Qian, 1994; Lin et al., 1998). Moreover, SOEs are less sensitive to capital costs than private firms (Zhang et al., 2018； Liu and Mao, 2019; Zou et al., 2019). The effect of the program on SOEs may be smaller than that on non-state-owned enterprises (non-SOEs). Additionally, if most of the business revenue of a manufacturing firm originates from abroad rather than the domestic service sector, this effect transmitted through FLs between the manufacturing firm and Chinese service sectors is small. This is because the Chinese tax system only recognizes standard invoices that are issued by Chinese tax authorities. Service sector firms abroad cannot issue invoices for Chinese manufacturing firms that can be used to credit input VAT before or after the expansion. Compared to capital-intensive sectors, labor-intensive sectors are closer to the service sectors, since they purchase more services. Thus, we expect the effect to be larger for labor-intensive firms.

**Hypothesis 3:** The effect of the VAT program is smaller for SOEs than for non-SOEs, and is larger for labor-intensive firms than for capital-intensive firms; manufacturing firms with high intensities of exporting activities are affected only through BLs.

## 3. Measurement of FLs and BLs

Our definitions of FLs and BLs are consistent with those provided in the literature (e.g., Javorcik, 2004; Debaere et al., 2010; Turco et al., 2019). For example, Debaere et al. (2010) use the Chinese and South Korean input-output tables to measure the proportion of each sector's output internationally supplied to or purchased from another sector. Similarly, Turco et al. (2019) apply the Organisation for Economic Co-operation and Development (OECD) IO Tables and calculate the linkages between sectors based on information regarding each sector's purchases from and sales to any other sector. In the current study, we use the most disaggregated IO table available for China to construct a matrix of BLs between manufacturing industries and service industries. A matrix of FLs is constructed in a similar fashion. Specifically, we first identify which sector each firm belongs to according to the industry codes issued by the China Securities Regulatory Commission. We then match the firms' sector codes with the direct input coefficient (matrix) from the 2012 China Multi-Regional Input-Output Table of 31 Provincial Units to derive the BLs and FLs between different regions and sectors.

Specifically, FLs are calculated as follows:

$$FL_m = \sum_n \alpha_{nm} / \sum \alpha_m \qquad (1)$$

where *n* and *m* are sector indicators. $\alpha_{nm}$ denotes the direct input coefficient, which represents the amount of input of sector *m* required per unit of output of sector *n*. As such, the nominator $\sum_n \alpha_{nm}$ denotes the sum of direct input coefficients between manufacturing sector *m* and all service sectors that sector *m* provides inputs to and are included in the expansion. The denominator $\sum \alpha_m$ represents the sum of direct input coefficients between the manufacturing sector *m* and all sectors that sector *m* provides inputs to. $FL_m$ represents the proportion of manufacturing sector *m*'s provisions to the downstream service sectors that are included in the expansion in *m*'s provisions to all sectors. A higher *FL* implies a higher proportion of provisions to the service sectors downstream that are included in the expansion.

BLs represent the ratio of intermediate inputs used by manufacturing sector *m* that are from the service sectors in *m*'s intermediate inputs from all sectors. They are calculated as follows:

$$BL_m = \sum_n \alpha_{mn} / \sum \alpha_m \qquad (2)$$

where $n$ and $m$ are sector indicators. As such, the numerator $\sum_n \alpha_{mn}$ denotes the sum of direct input coefficients between manufacturing sector *m* and all the service sectors that sector *m* purchases intermediate inputs from and are included in the program; the denominator $\sum \alpha_m$ represents the sum of direct input coefficients between the manufacturing sector *m* and all sectors that sector *m* purchases intermediate inputs from. $BL_m$ captures the strength of the linkage between the manufacturing sector *m* and its upstream service sectors that are included in the expansion. A higher $BL$ implies a higher proportion of intermediate inputs purchased from the service sectors upstream that are included in the expansion.

We present a simple numerical example showing the procedure of the above calculation. The example is included in Appendix B of this paper. We employ these two formulas and calculate BLs and FLs before and after the expansion for each manufacturing sector and each region that are in our dataset. The results are reported in Table 2 below. As expected, for most sectors, BLs and FLs are significantly larger after the expansion.

Table 2 FLs and BLs in various sectors

| Sector | Sector Code | Number of Obs. | Before the Expansion in 2016[1] | | After the Expansion in 2016 | | △FL | △BL |
|---|---|---|---|---|---|---|---|---|
| | | | FL | BL | FL | BL | | |
| Foods and tobacco | 6 | 452 | 0.026 | 0.059 | 0.468 | 0.106 | 0.442*** | 0.047** |
| Textiles | 7 | 208 | 0.018 | 0.032 | 0.036 | 0.064 | 0.018 | 0.032** |
| Textile, apparel, footwear, caps, feathers and related products | 8 | 104 | 0.055 | 0.057 | 0.147 | 0.090 | 0.092*** | 0.033 |
| Processing of timber and furniture | 9 | 56 | 0.017 | 0.058 | 0.083 | 0.092 | 0.066** | 0.034* |
| Paper, printing and articles used in cultural, educational and sports activities | 10 | 252 | 0.124 | 0.051 | 0.449 | 0.117 | 0.325*** | 0.066** |
| Processing of petroleum, processing of nuclear fuel, coking | 11 | 88 | 0.211 | 0.113 | 0.324 | 0.166 | 0.113 | 0.053 |
| Chemical products | 12 | 752 | 0.037 | 0.066 | 0.244 | 0.117 | 0.207*** | 0.051*** |
| Nonmetallic mineral products | 13 | 304 | 0.010 | 0.072 | 0.026 | 0.115 | 0.016** | 0.043** |
| Smelting and processing of metals | 14 | 504 | 0.004 | 0.035 | 0.008 | 0.063 | 0.004 | 0.028*** |
| Metal products | 15 | 160 | 0.098 | 0.049 | 0.187 | 0.088 | 0.089** | 0.039*** |
| General-purpose machinery | 16 | 396 | 0.027 | 0.060 | 0.062 | 0.110 | 0.035*** | 0.050*** |
| Special-purpose machinery | 17 | 340 | 0.016 | 0.047 | 0.203 | 0.102 | 0.187*** | 0.055*** |
| Transport equipment | 18 | 608 | 0.091 | 0.046 | 0.149 | 0.077 | 0.058** | 0.031*** |
| Electrical machinery and equipment | 19 | 560 | 0.106 | 0.051 | 0.157 | 0.084 | 0.051* | 0.033** |
| Communications equipment, computers and other electronic equipment | 20 | 416 | 0.202 | 0.050 | 0.268 | 0.087 | 0.066 | 0.037** |
| Measuring instruments | 21 | 96 | 0.094 | 0.064 | 0.176 | 0.106 | 0.082 | 0.042 |
| Waste | 22[2] | 8 | 0.000 | 0.120 | 0.000 | 0.244 | 0.000 | 0.124 |

Note: * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

## 4 Empirical strategy and data

### 4.1 Empirical strategy

As a widely applied technique in policy evaluation (e.g., Zwick and Mahon, 2017; Liu and Mao, 2019), the aim of a DD design is to estimate the treatment effect of a specific policy. Observations are naturally divided into two groups, i.e., a control group and a treatment group, as well as two periods, i.e., the "Before" and the "After" periods. This method includes two steps (differences). The first difference is the difference

[1] The BL and FL do not change until May 1st, 2016, because until 2016 only selected modern service sectors are included (specifically, these are the storage services, information transfer, software and information technology services, leasing and commercial services, and scientific research and technical services sectors). After May 1st, 2016, the program expands to include all service sectors. It is noteworthy that the railway transport services, postal services, and telecommunications sectors were added in 2014. Ideally, the BL and FL should reflect this. However, the data on BLs and FLs are obtained from the 2012 China Multi-Regional Input-Output Table of 31 Provincial Units issued by the National Bureau of Statistics. These three sectors are included in the category "transport, storage, and postal services". The table does not differentiate these three sectors from other sectors in the same category. As a result, the BLs and FLs in this paper do not reflect the inclusion of these three sectors. As a robustness check, we remove this category in total and re-run the regression. Our original conclusion still holds.

[2] For sector 22, data are available only for Liaoning and Zhejiang Provinces; therefore, no statistical significance can be derived.

in the means of the outcomes of the two groups. This step removes all of the heterogeneities of the two groups that do not vary over time. Conditional on the first difference, the second difference is the difference between the "Before" period and the "After" period, which removes the common trend shared by both groups.

A DD design serves as an appropriate framework for our study. First, the VAT pilot program can be treated as a natural experiment due to the lack of expectation prior to its announcement. Second, this program was implemented according to a schedule that specified how it would be gradually expanded to include all eligible firms. As illustrated in Table 1, some regions were included in this expansion earlier than others, as were some service sectors. Our DD estimation explores these variations across both regions and times.

The benchmark estimation function is formulated as follows:

$$TFP_{it} = \beta_0 + \beta_1 FL_{jkt} * Reform_{kt} + \beta_2 BL_{jkt} * Reform_{kt} + +\beta_3 FL_{jkt} + \beta_4 BL_{jkt} + \gamma X_{it} + \eta_i + \xi_{kt} + \varepsilon_{it} \quad (3)$$

where *j* is sector, *k* is region, *t* is year, *i* is firm, and $FL_{jkt}$ and $BL_{jkt}$ represent the FLs and BLs of firm *i* in region *k* and sector *j*, respectively, in year *t*. The dependent variable in our regression is TFP, an indicator widely used in the economics and finance literature to measure firms' productivity levels (e.g., Giannetti et al., 2015; Chen, 2017; Liu and Mao, 2019). It captures the portion of output that can be increased when the inputs of all factors of production (including capital and labor) are constant. We exploit the impacts of FL and BL using the interaction terms of these linkages and the binary participation indicator. The identification variable $Reform_{kt}$ is the binary participation indicator, with more details to be provided below. X represents a series of other control variables that influence firms' productivity levels. $\eta_i$ and $\xi_{kt}$ represent the firms' fixed effects and the region-year-specific effects, respectively. The former is used to control for unobservable firm-specific confounders, and the latter is used to control region-specific time trends. $\varepsilon_{it}$ is the error term. Note that with the inclusion of the province-year effects, $\xi_{kt}$, the stand-alone effect of the reform variable, $Reform_{kt}$, is absorbed due to collinearity. Therefore, our identification here comes from the industry heterogeneity of the DD estimate: conditional on being in a reformed region, the variation of the estimated effect of the reform across industries with different linkages with the services sectors. The key parameters of interest are $\beta_1$ and $\beta_2$, which are expected to be positive according to our Hypothesis 2.[3]

### 4.2 Data and variables

Our primary data source is the firm-level dataset from the Wind database. This dataset contains information on all listed manufacturing firms in China between 2009 and 2016, with a balanced panel consisting of 663 firm observations each year.[4] Our calculated measurements of BLs and FLs were merged to this data using industry, region, and time identifiers. We then removed all invalid observations by eliminating the following: (1) all observations before 2009; this was done because another tax reform on all manufacturing firms was implemented in 2009,[5] and restricting our sample to the period between 2009 and 2016 can eliminate the confounding effect of that earlier reform; (2) non-manufacturing firms; (3) firms that were newly listed or delisted after 2009; (4) firms that had ever changed their names or the sectors to which they belonged; and (5) firms for which the variables used in our estimation were missing or had invalid values.[6]

#### 4.2.1 Dependent variables

The dependent variable in our regression is TFP. Following previous studies, we adopt the Cobb-Douglas production function with fixed effects to measure TFP. The basic model is as follows:

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[3] We estimate the stand-alone effect of the reform by replacing the province-year fixed effects with firm and year fixed effects.

[4] All of the observations in our sample are obtained from firms in 31 regions of China, and they extend across 17 different manufacturing sectors. The list of sectors is presented in Table 2. A list of the 31 regions is presented in the appendix. It is not the case that there are firms from all 18 sectors in each region.

[5] This reform was implemented in several regions in northeast China in 2004 before extended to the rest of the country in 2009. It transformed the original production-based VAT into a consumption-based VAT by allowing the deduction of firms' purchases of fixed capital from their VAT bases. This reform can stimulate investment in fixed capital and promotes productivity. Its effect was widely examined in the literature (e.g., Zhang et al., 2018; Liu and Mao, 2019; Zou et al., 2019). Since 2009, all manufacturing firms are subject to a consumption-based VAT. Thus, its impact on manufacturing firms is most likely homogeneous, and controlling for the year fixed effects should mitigate the potential bias. We additionally employ a robustness check by additionally removing all observations in 2009, and our main results still hold.

[6] For example, some firms' debt-to-assets ratios are not between 0 and 1, and some firms' returns of assets are not between -1 and 1. We do not include such observations in our analysis.

$$lnY_{it} = \alpha_0 + \alpha_1 lnK_{it} + \alpha_2 lnL_{it} + \eta_i + \xi_{kt} + \varepsilon_{it} \qquad (4)$$

where $Y_{it}$ denotes firm *i*'s business income in year *t*, and $K_{it}$ and $L_{it}$ denote firm *i*'s capital investment and labor investment, respectively, in year *t*. The meanings of $\eta_i$, $\xi_{kt}$, and $\varepsilon_{it}$ are the same as in eq. (3). Estimating eq. (1) gives us a pair of parameters, i.e., $\beta_1$ and $\beta_2$, which are the output elasticities of capital and labor, respectively. Each firm's TFP in each year can thus be calculated using the following formula:

$$TFP_{it} = lnY_{it} - \alpha_1 lnK_{it} - \alpha_2 lnL_{it} \qquad (5)$$

**4.2.2 Key explanatory variables**

The identification variable $Reform_{kt}$ is a binary indicator that shows whether region $k$ of a manufacturing firm is included in the expansion (in which case it is equal to one) or not (in which case it is equal to zero) in year *t*. The Wind database consists of annual data for listed manufacturing firms in China. As illustrated in Table 1, the VAT pilot program introduced in 2012 was gradually rolled out to include the entire country. It sets up different policy implementation dates for different regions and thus creates an opportunity to evaluate the effect of this program. In the current study, we exploit the multiple implementation dates between the first and third stages, which extend from January 1st, 2012 to August 1st, 2013. The treatment group consists of all manufacturing firms in regions that were included in the expansion on or before November 1st, 2012, and the control group consists of all manufacturing firms in regions that were included after November 1st, 2012. Accordingly, for regions whose implementation dates are on or before November 1st, 2012, we define the identification variable $Reform_{kt}$ as equal to one for all observations after 2012 and zero otherwise. For the regions whose implementation dates are after November 1st, 2012, we define the identification variable $Reform_{kt}$ as equal to one for all observations after 2013 and zero otherwise. We choose November 1st, 2012, as the cutoff date for dividing these two groups because, if the implementation date is very late in the year, it is unlikely that the expansion had its full effect in the same year (2012); we therefore assume that the reform in that region started in 2013 (Fan and Peng, 2017) (alternative settings are tested as robustness checks in Table 7 below).

#### 4.2.3 Other control variables

We include the following determinants of manufacturing firms' TFP to be consistent with the literature (Hsieh and Klenow, 2009; Giannetti et al., 2015; Rath, 2018): (1) firm size, measured as the natural logarithm of the number of employees; (2) firm age, in most cases is positively correlated with firm performance because of more managerial experience; (3) capital intensity, calculated as the ratio of total assets to total revenue; (4) a dummy for whether or not the firm is an exporting firm, judging by whether or not the firm has overseas revenue; (5) debt ratio, measured as the ratio of total debt to total assets;[7] (6) governmental aid, defined as the ratio of governmental aid to business revenue; if firms receive more aid, their performance can improve (due to more investments) or deteriorate (due to more reliance on policies hence less independence)); and (7) ROA, measured as the ratio of net profits to total assets; firms with higher ROAs usually have better performance.

#### 4.2.4 Descriptive statistics

Table 3 below shows the descriptive statistics before and after the second stage of the expansion (November 2012). Before the expansion, the mean of the TFP of the treatment group is significantly higher than that of the control group. This difference, however does not significantly increase after the expansion. This is consistent with our expectation that, overall, this program does not influence manufacturing firms' TFP levels since it targets the service sectors. Concerning FLs and BLs, before the expansion, the FL (BL) of the treatment group is lower (higher) than that of the control group. After the expansion, both groups' FLs and BLs increase, but the FL (BL) of the treatment group is still lower (higher) than that of its counterpart. As discussed above, the expansion increases the connection between manufacturing firms and the service sectors. Shown in Table 3, in response to lower purchasing costs and increasing demand after the expansion, manufacturing firms become more specialized.

[7] Some may suspect that capital intensity, debt ratio, and ROA are endogenous to the policy. We conduct an analysis similar to our benchmark estimation that explores the effect of the program on these outcomes through FLs and BLs. The differences in the results are insignificant, and the results are available upon request.

Table 3 Descriptive statistics

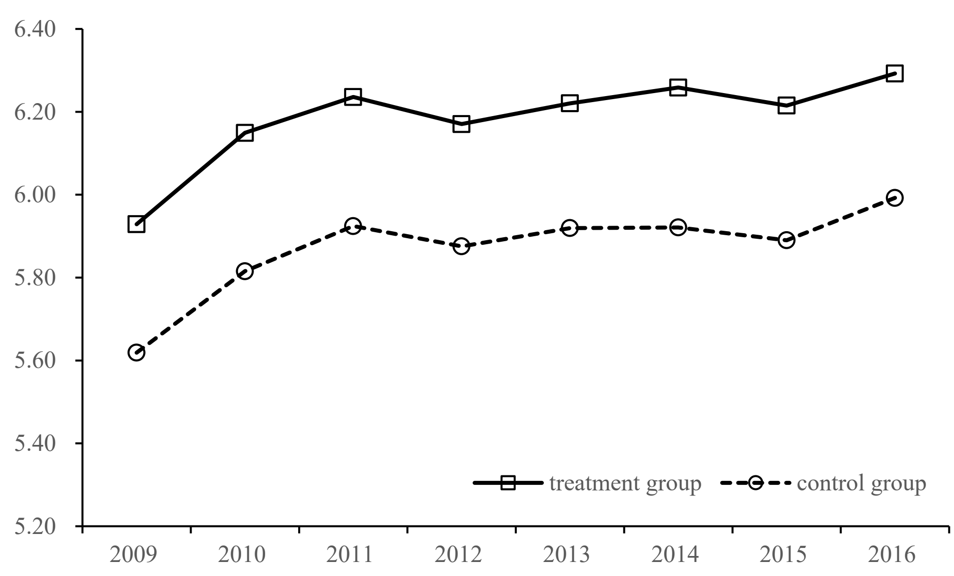
| Variable | Mean Value before the Expansion | | | Mean Value after the Expansion | | |
|---|---|---|---|---|---|---|
| | Control Group | Treatment Group | Difference in the Mean | Control Group | Treatment Group | Difference in the Mean |
| TFP | 5.809 (0.019) | 6.105 (0.041) | 0.296 (0.044)*** | 5.931 (0.019) | 6.231 (0.031) | 0.301 (0.036)*** |
| FL | 0.063 (0.002) | 0.052 (0.002) | -0.011 (0.004)*** | 0.095 (0.003) | 0.071 (0.003) | -0.024 (0.005)*** |
| BL | 0.051 (0.001) | 0.055 (0.001) | 0.004 (0.002)** | 0.060 (0.001) | 0.065 (0.002) | 0.005 (0.002)*** |

Note: Standard errors are reported in parentheses; * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

### 4.2.5 Common Trend

The common trend assumption is vital for the validity of a DD design. First, Figure 2 below shows the average TFP levels of the control and treatment groups across the time interval studied. It provides preliminary visual evidence that the common trend assumption is satisfied. Before the expansion, there is no difference in the trends of the average TFP levels between the control and treatment groups.

Figure 2 Average TFP levels of the two groups




Next, we conduct a basic regression analysis to confirm the common trend. To do this, we create a dummy variable *sdfirm* whose value equals one if a manufacturing firm is in a region that is included in the program and zero otherwise. The dependent variable is the TFP level of the manufacturing firm. All of the control variables described above are included. Our key explanatory variables of interest are the interaction terms between *sdfirm* and year dummies (between 2009 and 2015; 2016 was excluded to avoid collinearity). As expected, the results, which are presented in Table 4, show that the coefficients of all seven interaction terms are statistically insignificant. This again indicates that there was no systematic difference in the trends of TFP levels of firms in the pilot and nonpilot regions before the implementation of the pilot program, eliminating the risk of self-selection bias regarding this policy.

Table 4 Testing for common trend

| Variable | TFP |
|---|---|
| *sdfirm × 2009* | 0.028 |
| | (0.037) |
| *sdfirm × 2010* | 0.038 |
| | (0.034) |
| *sdfirm × 2011* | 0.025 |
| | (0.033) |
| *sdfirm × 2012* | 0.014 |
| | (0.032) |
| *sdfirm × 2013* | -0.023 |
| | (0.032) |
| *sdfirm × 2014* | 0.017 |
| | (0.033) |
| *sdfirm × 2015* | -0.005 |
| | (0.034) |
| | |
| Adjusted $R^2$ | 0.918 |
| Controls | Yes |
| Time fixed effects | Yes |
| Firm fixed effects | Yes |
| Observations | 5148 |

Note: Heteroscedasticity-consistent robust standard errors are reported in parentheses; * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

# 5 Empirical results

## 5.1 Main results

Table 5 presents the estimation results. The firms' TFP levels are estimated using a fixed-effect model. Heteroscedasticity-consistent robust standard errors are used in all baseline specifications. We gradually add in more variables including the identification variable, firms' characteristics, FLs and BLs, and the interaction terms between those linkages and the identification variable.

Column (1) of Table 5 below reports the basic estimation result for the stand-alone effect of the reform with firm and time fixed effects but without province-year fixed effects. It shows that the pilot program has an insignificant effect on manufacturing firms' TFP levels. In column (2), we further control for a series of control variables such as firm characteristics. The coefficient of our identification variable remains insignificant. This indicates that, overall, the pilot program does not promote manufacturing firms' productivity; thus, Hypothesis 1 is rejected.

Next, we include FL and BL in our estimation and evaluate their effects on manufacturing firms' TFP levels. We further control for the interacted fixed effects between regions and years. Columns (3) and (4) present the estimation results for this specification. The results in column (3) show that the coefficient of the interaction term between FLs and reform is statistically significant and positive at the 1% level, suggesting that this effect of reform increases as FLs increase.

Similarly, the results in column (4) show that the coefficient of the interaction term between BL and our identification variable is also statistically significant and positive at the 1% level. This effect also increases as the BL increases. Finally, the results in column (5) show that when both interaction terms are included, they both have statistically significant and positive coefficients. Specifically, a 1% increase in FLs (BLs) leads to a 6.99% (16.07%) increase in firm productivity relative to the average TFP level before the expansion (5.862). Although this pilot program targeted the service sectors, it had a significant and positive effect on manufacturing firms; this confirms Hypothesis 2, which posits that the effects are larger for manufacturing firms with higher FLs or BLs.

For columns (3) to (5), we control for the province-time fixed effects and allow for heterogeneous time trends within different provinces. If we relax this assumption by controlling only for time fixed effects (assuming that the time trends within different provinces are identical), the results, which are presented in column (6), show that the coefficients of the two interaction terms are significant but smaller in magnitude. Thus, failing to consider the heterogeneous time trends within different provinces will underestimate this effect.

The control variables related to firm characteristics explain part of the differences in TFP levels. Exporting firms and firms with higher debt ratios and ROAs have higher TFP levels. More exporting activities, less financing constraints, and higher profitability are all associated with high productivity. At the same time, firms with larger sizes, higher capital intensities, and more governmental aid have lower TFP levels. These findings imply that economies of scale do not exist in our sample, labor-intensive firms still prevail, and governmental aid harms firms' independence. [8]

Table 5 The effect of the VAT pilot program on TFP: benchmark results

| Variable | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| FL*Reform | | | 0.380*** | | 0.410*** | 0.343*** |
| | | | (0.100) | | (0.101) | (0.096) |
| BL*Reform | | | | 0.874*** | 0.942*** | 0.786*** |
| | | | | (0.271) | (0.272) | (0.232) |
| Reform | -0.021 | 0.003 | | | | -0.059** |
| | (0.025) | (0.019) | | | | (0.024) |
| FL | | | -0.287** | | -0.328*** | -0.280** |
| | | | (0.126) | | (0.126) | (0.118) |
| BL | | | | -0.378 | -0.462 | -0.618* |
| | | | | (0.411) | (0.414) | (0.341) |
| Firm size | | -0.050*** | -0.053*** | -0.050*** | -0.053*** | -0.051*** |
| | | (0.016) | (0.016) | (0.016) | (0.016) | (0.016) |
| Firm age | | 0.067*** | 0.017 | 0.016 | -0.007 | 0.065*** |
| | | (0.004) | (0.094) | (0.092) | (0.095) | (0.004) |
| Capital intensity | | -0.208*** | -0.209*** | -0.208*** | -0.208*** | -0.206*** |
| | | (0.012) | (0.012) | (0.012) | (0.012) | (0.012) |
| Exporting indicator | | 0.123*** | 0.115*** | 0.116*** | 0.115*** | 0.122*** |
| | | (0.024) | (0.024) | (0.024) | (0.024) | (0.024) |
| Debt ratio | | 0.287*** | 0.274*** | 0.276*** | 0.273*** | 0.283*** |
| | | (0.058) | (0.059) | (0.059) | (0.058) | (0.058) |
| Governmental aid | | -0.900*** | -0.828*** | -0.832*** | -0.827*** | -0.899*** |
| | | (0.253) | (0.254) | (0.255) | (0.255) | (0.252) |
| ROA | | 1.318*** | 1.269*** | 1.282*** | 1.271*** | 1.313*** |
| | | (0.174) | (0.173) | (0.172) | (0.172) | (0.173) |
| Constant | 5.689*** | 5.302*** | 6.350*** | 6.319*** | 6.797*** | 5.384*** |
| | (0.018) | (0.135) | (1.930) | (1.885) | (1.932) | (0.137) |
| Adjusted $R^2$ | 0.842 | 0.918 | 0.919 | 0.919 | 0.920 | 0.919 |
| Time fixed effects | Yes | Yes | No | No | No | Yes |
| Province-time fixed effects | No | No | Yes | Yes | Yes | No |
| Firm fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 5301 | 5148 | 5148 | 5148 | 5148 | 5148 |

Note: (1) Heteroscedasticity-consistent robust standard errors are reported in parentheses; * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

(2) We also run regressions without interaction terms between *Reform* and IO linkages. The coefficients of FL and BL are

[8] In the benchmark regression, we do not consider the relative price adjustment. In response, we set the 2009 PPI as the benchmark and adjust all price-related variables used to derive TFP. Based on eqs. (4) and (5), we recalculate the TFP levels considering relative price adjustment. We then re-run our benchmark regression based on eq. (3). The results are similar. We acknowledge that given the research question explored in our paper and the data we have, this paper is essentially a partial equilibrium analysis that focuses on all manufacturing and services firms. Our study may have ignored the economy-wide relative price adjustment that follows the VAT reform. A possible extension of this research is to use a computable general equilibrium model to analyze the full impact of the program on the whole economy. We thank an anonymous referee for this suggestion.

both positive but insignificant. The results in column (3) of Table 5 show that after the expansion (*Reform*==1) the total marginal effect of FL is equal to (0.380 – 0.287 = 0.093). It is significantly positive, meaning that the program improves TFP levels more for firms with higher linkages. However, before the expansion (*Reform*==0), the total marginal effect of FL is significantly negative; this means that, even for firms with high linkages, it is difficult to increase the TFP levels. This is because some sectors are subject to BT, and some sectors are subject to VAT. The difference in taxes increases firms' costs and thus impedes the improvement of productivity. In summary, the two opposing effects observed before and after the reform are reflected in the insignificant standalone coefficients of FL and BL when we run regressions without including interactions.

### 5.2 Heterogeneity

We now check how the estimated effect differs across firms. State-owned enterprises (SOEs) enjoy a number of privileges compared to non-SOEs, such as market entry (Frensch, 2004), governmental aid (Eckaus, 2006), and financial constraints (Poncet et al., 2010). At the same time, they also have disadvantages in terms of the ability to seek profit maximization (Lin et al., 1998) and R&D efficiency (Jefferson et al., 2006). These differences between SOEs and non-SOEs may cause heterogeneous effects.

Manufacturing firms are categorized into several groups as follows: SOEs (central government), SOEs (local government), and non-SOEs. During our sample period, all firms that had their ownership changed from SOEs to non-SOEs are excluded.

Columns (1) – (3) of Table 6 report the estimation results for these three groups. The coefficients of the interaction terms for both types of SOEs (central government and local government) are statistically insignificant, and those for non-SOEs are significantly positive at the 5% or the 1% level. This effect is significantly positive only for non-SOEs. While non-SOEs focus on profit maximization, SOEs may have to pursue other goals, such as the fulfillment of social responsibilities, into consideration. The results illustrated here indicate that different types of firms have different degrees of sensitivity to capital costs, an implication that is consistent with the recent literature (e.g., Zhang et al., 2018; Liu and Mao, 2019; Zou et al., 2019).

The effect on exporting firms may be different from the effect on other firms. If an exporting firm provides most of its intermediate inputs to firms abroad, this effect is likely to be less strong because overseas buyers are not affected by this pilot program. We should then expect a smaller effect through FLs for exporting firms. At the same time, the effect through BLs is not *a* priori clear since it depends on how much exporting firms rely on the provision of services from the service sectors.

We measure the intensity of exporting activities as the ratio of overseas revenue to firms' total revenue. The results are displayed in column (4) of Table 6. The regression results confirm our speculation above, i.e., no effect is observed through FLs for exporting firms, while the effect through BLs remains virtually the same as before.

Exporting firms are often found to be more productive than their non-exporting counterparts (e.g., Bernard and Jensen 2004; Cadot et al. 2011; De Loecker, 2013). At the same time, due to their deeper engagement in the global market, exporters may have different industrial links with the domestic sectors than non-exporters. To see how the tax reform has a different impact on exporters, we exclude all non-exporting firms and redo the estimation reported in column (4). The results shown in column (5) are not much different from the previous ones, although with less statistical precision.

Finally, we divide these manufacturing sectors into two groups, i.e., labor-intensive (sector codes between 6 and 10 and sector code 22) and capital-intensive (sector codes between 11 and 21) sectors (all sector codes are presented in Table 2 above) based on Black et al. (2016) and on the classification of manufacturing industries provided by the OECD Directorate for Science, Technology, and Industry (Criscuolo and Martin, 2004). The results show that the expansion increases manufacturing firms' TFP through FLs and BLs and that the effects are significantly higher in labor-intensive sectors.[9] This finding can be rationalized by the fact that labor-intensive sectors are closer to the service sectors since they purchase more services and sell more products. Thus, we have confirmed Hypothesis 3.

[9] We compare the BLs and FLs of these two groups. T-tests are conducted to compare them. The results show that BLs and FLs are both significantly higher in labor-intensive sectors.

Table 6 Heterogeneity: ownership types and exporting activities (dependent variable: TFP)

| Variable | SOEs (central government) | SOEs (local government) | Non-SOEs | Intensity of exporting activities | Intensity of exporting activities (subsample of exporting firms) | Capital-intensive | Labor-intensive |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Exporting intensity *FL*Reform | | | | 0.547 | 0.259 | | |
| | | | | (0.591) | (0.665) | | |
| Exporting intensity *BL*Reform | | | | 4.439** | 4.514* | | |
| | | | | (2.205) | (2.513) | | |
| Exporting intensity *FL | | | | -0.145 | -0.497 | | |
| | | | | (0.772) | (0.890) | | |
| Exporting intensity *BL | | | | -2.631 | -3.101 | | |
| | | | | (2.737) | (2.529) | | |
| Exporting intensity *Reform | | | | -0.193 | -0.182 | | |
| | | | | (0.123) | (0.143) | | |
| Exporting intensity | | | | 0.244* | 0.155 | | |
| | | | | (0.139) | (0.155) | | |
| FL*Reform | 0.110 | -0.095 | 0.258** | 0.384*** | 0.511*** | 0.334*** | 0.946*** |
| | (0.377) | (0.234) | (0.131) | (0.128) | (0.162) | (0.112) | (0.282) |
| BL*Reform | 0.313 | 0.789 | 1.068*** | 0.683** | 0.374 | 0.566** | 2.299*** |
| | (0.500) | (0.468) | (0.357) | (0.316) | (0.425) | (0.264) | (0.789) |
| FL | 0.511 | 0.258 | -0.482** | -0.315** | -0.426** | -0.100 | -1.163*** |
| | (0.468) | (0.261) | (0.241) | (0.144) | (0.201) | (0.210) | (0.346) |
| BL | 0.246 | -0.090 | -0.556 | -0.455 | 0.116 | -0.255 | -1.210 |
| | (1.530) | (0.595) | (1.137) | (0.438) | (0.529) | (0.612) | (0.958) |
| Constant | 8.164** | 8.970*** | 8.146*** | 6.407*** | 6.064*** | 6.580*** | 4.478 |
| | (3.419) | (2.279) | (3.110) | (1.634) | (2.085) | (2.245) | (2.830) |
| Adjusted $R^2$ | 0.932 | | 0.906 | 0.920 | 0.929 | 0.920 | 0.924 |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Province-time fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 807 | 1523 | 1717 | 5115 | 3709 | 4121 | 1027 |

Note: Heteroscedasticity-consistent robust standard errors are reported in parentheses; * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

## 6 Robustness checks and mechanism

### 6.1 Robustness checks

In this subsection, we employ a series of robustness checks to validate our previous main results. First, we choose two hypothetical alternative policy implementation dates, i.e., one and two year(s) before the actual year of implementation (2012). We excluded all observations made between 2012 and 2016. If the significant effects we observed are not due to the pilot program but are instead due to an unobserved event, that event should also cause significant effects for the alternative policy implementation dates. Columns (1) and (2) in Table 7 report the results obtained assuming that the policy implementation dates were 2010 and 2011, respectively. All coefficients of the interaction terms are insignificant, indicating that our original results are exclusive to the actual tax reform we look at.

For several regions, the policy was implemented in November or December 2012 (November 2012 for Fujian Province and Guangdong Province; December 2012 for Tianjin City, Zhejiang Province, and Hubei Province). In our benchmark estimation, we treat the policy implementation date of those regions as 2013. We replace that date with 2012; the regression results under this alternate situation are presented in column (3). The results show that both of the coefficients of the interaction terms are still significant at the 1% level.

Next, since the implementation date for Shanghai is January 2012 and the implementation dates for the other eight regions (Beijing, Jiangsu, Anhui, Fujian, Guangdong, Tianjin, Zhejiang, and Hubei) are all later than August 2012, we assume that the expansion began in 2012 in Shanghai and that it began in 2013 in the other eight regions. The implementation dates for the rest of the country are August 1st, 2013. Thus, we assume that the expansion began in 2014 for those regions. The results, which are presented in column (4), are still consistent with the previously presented results.

Extreme values might substantially bias our estimation. Although the financial data of listed companies are now widely accepted and studied, some firms (especially ST firms[10]) may have manipulated or misreported their information. To address this concern, we delete the top and bottom 1% of the observations in terms of our productivity measure to mitigate the possible influence of outliers. The results in column (5) show that our findings are robust to the exclusion of these observations.

Alternate measures of TFP, such as Levinsohn-Petrin (e.g., Halpern and Muraközy, 2007) and Olley-

[10] Since 1998, under the regulations of the Shenzhen Stock Exchange and Shanghai Stock Exchange, the stocks of firms that suffer losses for two consecutive years or more should carry “ST” (special treatment) tags. This is done to warn investors that the future of these companies is difficult to judge and that this may endanger the interests of their investors.

Pakes (e.g., De Loecker, 2007; Bournakis and Mallick, 2018), are widely applied in the empirical literature for correction of estimation bias caused by endogenous input choices. The Levinsohn-Petrin (LP) measure requires information on the firm's intermediate inputs, and the Olley-Pakes (OP) measure requires information on the firm's trading status (information on whether or not it is in operation). Unfortunately, this information is not available in our dataset. Therefore, we use two proxies for these measures. For the LP measure, we use payments for purchases of commodities and labor services as a proxy variable for intermediate inputs; for the OP measure, we use an indicator that is one if a firm has ever changed its main business category or its name and zero otherwise. The results in columns (6) and (7) of Table 7 show that use of these two alternate measures in the analysis does not qualitatively change our results.

Moreover, to ease the concern regarding sample selection of pilot regions and sectors, we employ a standard PSM-DD method to test the robustness of our results. We first use the logit model and regress the indicator of whether a manufacturing firm is in the treatment group on a series of covariates (firm size, firm age, capital intensity, debt ratio, ROA, exporting indicator, governmental aid, and time fixed effects). This yields a propensity score for each manufacturing firm. We then use the DD method to run our benchmark regression again on those observations that satisfy the common matching conditions. The results in column (8) show that the estimation results achieved in this way are similar to those reported in Table 5.

While the benchmark estimation in Table 5 applies heteroscedasticity-consistent robust standard errors, our FLs and BLs are measured at the region×sector level. Thus, in columns (9) and (10), we cluster standard errors at the region and dyadic region-sector levels, respectively, to correct for the possible correlations in errors within regions or region-sector dyads. The effects remain statistically significant under these two situations. We further control for region-sector fixed effects in column (11), and the result shows that our main conclusion still holds.

Since the pilot program was implemented gradually, it was possible that manufacturing firms could exploit the regional differences in tax burdens. Specifically, firms located in regions in which the VAT had not been introduced to obtain service inputs from regions in which the VAT had already been introduced and thus benefit from increased business revenue and lower tax burdens. To account for this possibility, we now relax the assumption that firms only engage in transactions with other firms in the same region. This enables us to develop an alternative set of BLs and FLs in which we include the reciprocal of the geographical distance between regions as an additional weight.

Specifically, we define the distance between any two firms as the distance between the capital cities of the provinces these firms are located in. The weighting is constructed such that a smaller weight is assigned if the distance is larger to take in account the fact that it is more likely for a firm to source from nearby regions, other things equal.[11] The empirical results obtained after replacing the original BLs and FLs with the weighted BLs and FLs are presented in column (12) of Table 7. The results show that when considering the distance between firms, higher FLs and BLs still lead to larger effects of this expansion on firms' TFP levels. This indicates that, even though firms can engage in transactions with firms in other regions, our benchmark results still hold.

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[11] Two steps are used to calculate this alternative set of BLs and FLs, as follows:
(1) A 31×31 matrix W that represents the reciprocal of the distance between any two provincial capitals in China is constructed. For example, Wkq indicates the reciprocal of the distance between the capital of province k and the capital of province q.
(2) The weighted FL and BL are calculated as follows (taking the FL as an example):

$$FL_{kj}^{w} = \sum_{k=1}^{31} W_{kq} * FL_{kj}$$

where $FL_{kj}$ is the FL from the IO table of region k and sector j. The weighted BL is calculated following the same method.

Table 7 Robustness checks

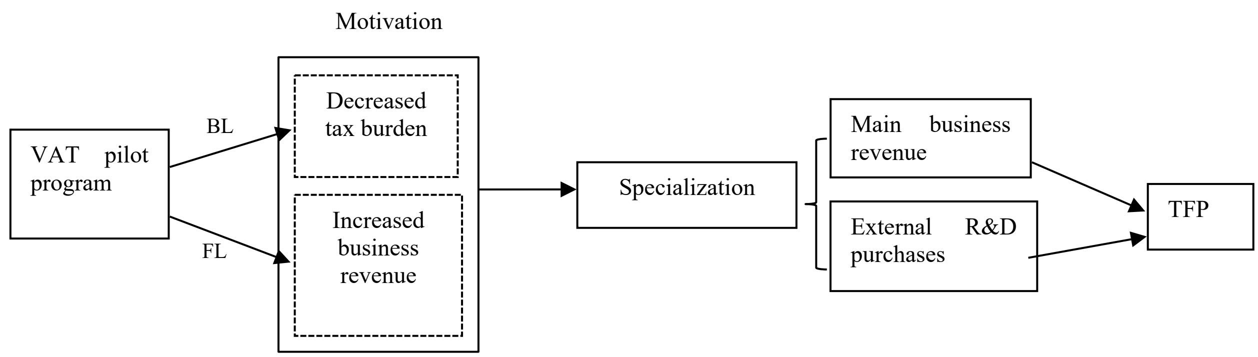
| Variable | Falsification tests: policy implementation date | | Identification strategy | | Extreme values | LP | OP | PSM-DD | Clustered S.E (region). | Clustered S.E (region-sector). | Region-sector fixed effects | Weighted FL and BL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| FL*Reform | -0.118 | -0.219 | 0.361*** | 0.483*** | 0.427*** | 0.148** | 0.409*** | 0.491** | 0.410** | 0.410** | 0.414*** | 0.397*** |
| | (0.177) | (0.181) | (0.103) | (0.104) | (0.100) | (0.069) | (0.101) | (0.223) | (0.168) | (0.168) | (0.101) | (0.099) |
| BL*Reform | -0.348 | -0.368 | 0.956*** | 1.106*** | 1.125*** | 0.439*** | 0.934*** | 1.412*** | 0.942** | 0.942** | 0.945*** | 0.946*** |
| | (0.341) | (0.319) | (0.274) | (0.279) | (0.298) | (0.162) | (0.271) | (0.381) | (0.433) | (0.433) | (0.272) | (0.271) |
| FL | | | -0.279** | -0.403*** | -0.359*** | -0.134 | -0.328*** | -0.518** | -0.328* | -0.328* | -0.328*** | -0.316** |
| | | | (0.128) | (0.128) | (0.125) | (0.086) | (0.126) | (0.263) | (0.188) | (0.188) | (0.127) | (0.124) |
| BL | | | -0.476 | -0.646 | -0.762* | -0.213 | -0.453 | -1.119** | -0.462 | -0.462 | -0.467 | -0.595 |
| | | | (0.415) | (0.413) | (0.434) | (0.239) | (0.415) | (0.473) | (0.517) | (0.517) | (0.414) | (0.401) |
| Constant | 6.220*** | 6.260*** | 6.566*** | 6.706*** | 6.289*** | 3.786*** | 6.529*** | -1.912 | 4.715*** | 4.715*** | 6.586*** | 6.449*** |
| | (0.711) | (0.732) | (1.635) | (1.705) | (1.625) | (1.234) | (1.624) | (1.588) | (1.257) | (1.257) | (1.651) | (1.623) |
| Adjusted $R^2$ | 0.962 | 0.962 | 0.920 | 0.920 | 0.915 | 0.863 | 0.947 | 0.928 | 0.920 | 0.920 | 0.920 | 0.920 |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Province-time fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1922 | 1922 | 5148 | 5148 | 5104 | 5148 | 5148 | 2344 | 5148 | 5148 | 5148 | 5148 |

Note: Heteroscedasticity-consistent robust standard errors are reported in parentheses in all columns except (9) and (10) where clustered standard errors are used; * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

### 6.2 Mechanism

In this section, we explore the potential mechanism – specialization – through which the VAT pilot program promotes the TFP levels of manufacturing firms. First, manufacturing firms are encouraged to increase specialization because of its two benefits, i.e., decreased tax burden and increased business revenue. Second, an increase in specialization can be reflected in an increase in the main business revenue and the increase in external R&D purchases, both of which contribute to an increase in the TFP levels. This can be summarized in Figure 3 below.

Figure 3 Mechanism of the effect of the VAT pilot program on manufacturing firms' TFP




We first investigate how BLs and FLs lead to greater specialization. Specifically, we document two distinct motivations. On one hand, BLs are related to the decreased tax burden. Based on its definition, a higher BL implies a higher demand for intermediate inputs provided by upstream service-sector firms. Before the expansion, the business tax increases the costs of purchasing these inputs due to the double taxation. Manufacturing firms are thus forced to produce these services internally to avoid the unfairly high tax rate. After the expansion, these costs fall because firms in the service sectors can now issue invoices for manufacturing firms to credit input VAT. Naturally, manufacturing firms would revert to purchase services instead of supplying the services themselves. Thus, the tax reform induces a higher degree of specialization of manufacturing firms around their core businesses.

On the other hand, FLs are related to increased business revenue. Based on its definition, a higher FL implies that a higher proportion of the products manufactured by a firm are sold to downstream service-sector firms. The demand for these products is higher after the expansion. This is because, similarly, the purchasing costs for firms in the service sectors are lower since manufacturing firms can now issue invoices that include credits for the input VAT. Faced with this increased demand, manufacturing firms are motivated to enhance the quality of their products. A possible way in which firms can increase product quality is to invest more resources in their main businesses (manufacturing) and purchase other needed services (such as technical services) from specialist providers. This again contributes to increased specialization.

A firm's tax burden is calculated as follows. The annual reports of listed companies contain no information on the actual turnover tax paid; they report only the turnover tax payable. Under most circumstances, the latter does not accurately reflect the turnover tax paid due to tax evasion, and this can cause serious measurement errors. Following the literature (e.g., Fang et al., 2017), we use education surcharges to deduce the actual turnover tax payments. Education surcharges are based on the turnover tax. The turnover tax burden is measured using the ratio of VAT paid to industry value added. Industry value added is the sum of compensation of employees, total profits, depreciation of fixed assets, and turnover tax payments (Bai et al., 2008). The following formulas show how we calculate turnover tax burden with our data:

$$\text{turnover tax burden} = \frac{turnover\ tax\ payments}{industry\ value\ added} \qquad (6)$$

where $turnover\ tax\ payments = \frac{educational\ surtax}{educational\ surtax\ rate}$, and

$$industry\ value\ added = \text{compensation of employees} + \text{total profits} + \text{depreciation of fixed assets} + \text{turnover tax payments} \qquad (7)$$

Columns (1) and (2) of Table 8 below show that the pilot program has significant and positive effects on the tax burden and the business revenue of manufacturing firms. Moreover, these effects are realized through IO linkages. This program decreases the tax burden through BL and increases business revenue through FL. These two motivations (decreased turnover tax burden and increased business revenue) are consistent with the literature (e.g., Clark, 2006; Shuai, 2013; Fang et al., 2017; Fan and Peng, 2017; Ward et al., 2018).

Table 8 Tax and revenue motivation for specialization

| Variable | Turnover tax burden | Business revenue |
|---|---|---|
| | (1) | (2) |
| FL*Reform | | 0.392*** |
| | | (0.110) |
| BL*Reform | -0.203** | |
| | (0.097) | |
| FL | | -0.268* |
| | | (0.140) |
| BL | 0.117 | |
| | (0.135) | |
| Constant | 0.390 | 6.942*** |
| | (0.793) | (1.884) |
| Adjusted $R^2$ | 0.503 | 0.966 |
| Controls | Yes | Yes |
| Province-time fixed effects | Yes | Yes |
| Firm fixed effects | Yes | Yes |
| Observations | 4950 | 5078 |

Note: Heteroscedasticity-consistent robust standard errors are reported in parentheses; * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Next, we analyze how the program improves firms' productivity through increased specialization. In theory, this pilot program enables service sector firms to issue deductible VAT invoices and thereby decreases the purchasing costs incurred by manufacturing firms. Thus, manufacturing firms purchase more services instead of providing services themselves. The firms can thus invest more resources in their manufacturing businesses. For each firm, Wind records the five business categories with the highest revenue. Following Gort (1962) and Fan and Peng (2017), specialization is measured using the natural logarithm of the firm's average business revenue from the five business categories listed. The main idea is that, if the firm decides to redirect resources that were allocated to other businesses to its main businesses, this will result in a higher concentration of its main business revenue, indicating a higher degree of specialization.

The results are presented in column (1) of Table 9 below. When including BLs and FLs, both interaction terms have significantly positive signs, suggesting that the effect of BLs and FLs on firm productivity is mediated by their effect on specialization.

Table 9 Testing the working mechanism of specialization

| Variable | Main Business | R&D-related sectors | Purchasing technical services |
|---|---|---|---|
| | (1) | (2) | (3) |
| FL*Reform | 0.443*** | 0.736*** | 0.052*** |
| | (0.167) | (0.136) | (0.013) |
| BL*Reform | 1.266** | 1.785*** | 0.036* |
| | (0.504) | (0.656) | (0.019) |
| FL | -0.363* | -0.658*** | -0.061*** |
| | (0.204) | (0.161) | (0.015) |
| BL | -1.028* | -1.184* | -0.028 |
| | (0.595) | (0.711) | (0.036) |
| Constant | 7.352*** | 7.410*** | 0.128 |
| | (2.479) | (1.699) | (0.174) |
| Adjusted $R^2$ | 0.944 | 0.920 | 0.473 |
| Controls | Yes | Yes | Yes |
| Province-time fixed effects | Yes | Yes | Yes |
| Firm fixed effects | Yes | Yes | Yes |
| Observations | 4829 | 5148 | 5148 |

Note: Heteroscedasticity-consistent robust standard errors are reported in parentheses: * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Finally, as our analysis suggested, the lower cost of services that results from the VAT reform is supposed to encourage manufacturing firms to purchase more services instead of providing them in-house. This allows manufacturing firms to invest more resources in their manufacturing businesses and leads to greater specialization. Next, we investigate the change in external R&D purchases. We provide relevant evidence from two perspectives.

First, we select two sectors that are closely related to R&D services, i.e., (1) the information transfer, software and information technology service sector, and (2) the scientific research and technical service sector. We now redefine BLs and FLs based on this narrower and finer selection. The results are shown in column (2) of Table 9 above. They indicate that for manufacturing firms with closer linkages to firms in the technical service sector, the positive effect of the pilot program is more salient. This indicates the importance of external R&D purchases for manufacturing firms. The reform has a larger effect on the increase of the TFP levels of manufacturing firms with closer linkages to technical services.

Second, the iFinD database provides information on Chinese listed firms' expenditures on purchasing technical services, which is a reasonable proxy for external R&D purchases (e.g., Hagedoorn and Wang, 2012; Ito and Tanaka, 2016).[12] Based on this proxy, we further derive the ratio of technical services expenditure by dividing that expenditure by all operating costs. A higher ratio indicates that the firm has a stronger incentive to invest in external R&D purchases. Presented in column (3) of Table 9, the results show that the coefficient of the interaction term between FL and Reform is significant at the 1% level and that the coefficient of the interaction term between BL and Reform is significant at the 10% level. The results indicate that this reform significantly increases external R&D purchases by manufacturing firms with high FLs and BLs. This can be interpreted as another evidence that supports the specialization mechanism, through which the VAT reform promotes firm productivity.

## 7 Conclusion

This study contributes to the literature with a quantification of the impact of a VAT pilot program in China. In contrast to other studies that focus on the effect of the program on the service sectors, our paper investigates the effect of the program on the TFP levels of manufacturing firms. We exploit the setting of the gradual rollout of the program across space and time by using a difference-in-differences estimation to investigate its effect on manufacturing firms' productivity.

Our empirical results show that, overall, this program has no statistically detectable effect on manufacturing firms' TFP levels. However, it does have a strong effect on the productivity of manufacturing firms who are closely linked to the reform service sectors through input-output linkages. Specifically, a 1% increase in FLs (BLs) leads to a 6.99% (16.07%) increase in firm productivity relative to the average TFP level before the expansion (5.862). The heterogeneity analysis shows that this effect is smaller for SOEs than for non-SOEs and that it is higher for labor-intensive firms than for capital-intensive firms. Manufacturing firms with high intensities of exporting activities are affected only through backward linkages with service sectors. Finally, the empirical results identify the mechanism (specialization) through

[12] The iFinD database is another widely applied database that contains information on listed companies in China. Compared to the Wind database, it selects several different characteristics on firm' performance.

which the expansion promotes firm productivity.

The results of the current study shed some light on the possible ways the VAT system in China could be improved in the future. First, it should be beneficial to further simplify the current VAT system. Since the VAT is transmittable, reducing the turnover tax burden of only the service sectors creates pressure on other sectors and generates distortions of the firms' behavior. In response, the government should continue making attempts to unify tax rates between different sectors. Second, our results indicate that firms should seize this opportunity to increase their specialization, such as through focusing on their core businesses and increasing external R&D purchases, which ultimately leads to an increase in their productivity. Finally, since 2016, the VAT reform has concentrated on the reduction of rates. It would be interesting to examine whether similar results and mechanisms discovered in the current study can also be observed with the recent reform that focuses on lowering VAT rates.

**Appendix A**

Table A1 Summary of variable definitions

| Acronym | Meaning |
|---|---|
| **TFP** | Total factor productivity |
| **SOEs** | State-owned enterprises |
| **Non-SOEs** | Non-state-owned enterprises |
| **BL** | Backward linkage |
| **FL** | Forward linkage |
| **R&D** | Research and development |
| **DD** | Difference-in-differences |

**Appendix B**

In this section, we present a simple example illustrating how FLs and BLs shown in Table 2 are calculated. In our paper, FLs and BLs are calculated based on the direct input coefficient (matrix) from the China Multi-Regional Input-Output Table of 31 Provincial Units. The FL is related to manufacturing sectors' supply inputs to service sectors. The BL is related to manufacturing sectors' purchasing of services from service sectors. In the following example, there are two manufacturing sectors, A and B, and two service sectors, C and D. Sector C is included in the expansion in 2012 and D is included in 2016. In Table B1, the numbers in the four columns represent the direct input coefficients related to the manufacturing sectors' purchasing of services from the service sectors, and the numbers in the four rows represent the direct input coefficients related to the manufacturing sectors' selling of products to the service sectors. Next, we calculate FLs and BLs of these two manufacturing sectors.

Table B1 Forward and backward linkages: an example

| Input \ Output | A | B | C | D | Total intermediate consumption |
|---|---|---|---|---|---|
| A | 0.20 | 0.15 | 0.05 | 0.10 | 0.50 |
| B | 0.10 | 0.25 | 0.10 | 0.20 | 0.65 |
| C | 0.05 | 0.05 | 0.25 | 0.10 | 0.45 |
| D | 0.05 | 0.10 | 0.30 | 0.10 | 0.55 |
| Total intermediate inputs | 0.40 | 0.55 | 0.70 | 0.50 | |

BLs of manufacturing sector A: Before 2016, only sector C is included in the expansion. Based on eq. (1) on page 9, BL (columns) = (the coefficient of input-output linkage between A and C)/(the total intermediate inputs between A and all sectors combined) = 0.05/0.40= 0.125. After 2016, both C and D are included in the expansion, and BL = (0.05+0.05)/0.40 = 0.25.

FLs of manufacturing sector A: Before 2016, only sector C is included in the expansion. Based on eq. (2) on page 8, FL (rows) = (the coefficient of input-output linkage between A and C)/(the total intermediate consumption between A and all sectors combined) =0.05/0.50 = 0.10. After 2016, both C and D are included in the expansion, and FL = (0.05+0.10)/0.50 = 0.30.

BLs of manufacturing sector B: Similarly, before 2016, only sector C is included in the expansion. Based on eq. (1) on page 8, BL = (the coefficient of input-output linkage between B and C)/(the total intermediate inputs between B and all sectors combined) = 0.05/0.55 = 0.09. After 2016, both C and D are included in the expansion, and BL = (0.05+0.10)/0.55 = 0.27.

FLs of manufacturing sector B: Before 2016, only sector C is included in the expansion. Based on eq. (2) on page 8, FL = (the coefficient of input-output linkage between B and C)/(the total intermediate consumption between B and all sectors combined) = 0.10/0.65 = 0.154. After 2016, both C and D are included in the expansion, and FL = (0.10+0.20)/0.65 = 0.46.

**Appendix C**

In this section, we present two figures that summarize the current status of fiscal revenue in China. Figure C1 shows the fiscal revenue by type of tax between 2009 and 2016. Figure C2 shows the fiscal revenue by sector between 2009 and 2016. The data are obtained from the National Bureau of Statistics of China and EPS China Data.

Figure C1 China tax revenue by type of tax

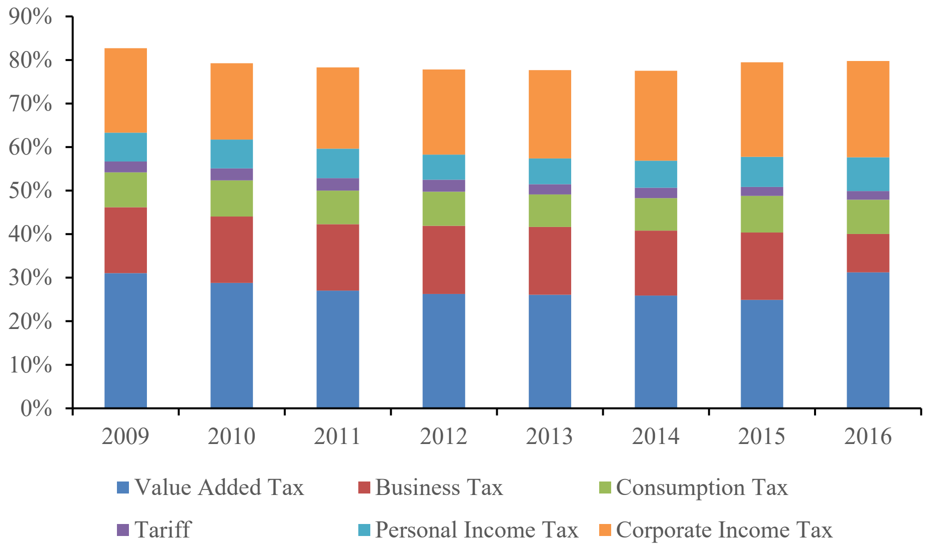
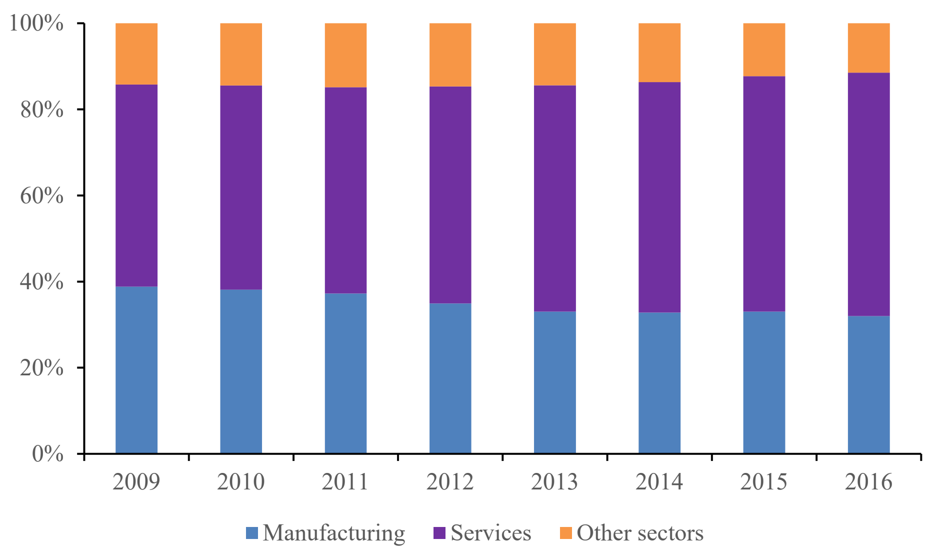



Figure C2 China tax revenue by sector



**Appendix D**

In this section, we list all 31 regions of China in which the firms in our dataset are located. The regions are presented in Table D1 below.

Table D1 List of the studied regions

| Code | Region name | Code | Region name | Code | Region name | Code | Region name |
|---|---|---|---|---|---|---|---|
| 1 | Hebei | 9 | Fujian | 17 | Sichuan | 25 | Tibet |
| 2 | Shanxi | 10 | Jiangxi | 18 | Guizhou | 26 | Ningxia Hui |
| 3 | Liaoning | 11 | Shandong | 19 | Yunnan | 27 | Xinjiang Uighur |
| 4 | Jilin | 12 | Henan | 20 | Shaanxi | 28 | Beijing |
| 5 | Heilongjiang | 13 | Hubei | 21 | Gansu | 29 | Tianjin |
| 6 | Jiangsu | 14 | Hunan | 22 | Qinghai | 30 | Shanghai |
| 7 | Zhejiang | 15 | Guangdong | 23 | Inner Mongolia | 31 | Chongqing |
| 8 | Anhui | 16 | Hainan | 24 | Guangxi Zhuang | | |

*Data regarding other regions of China are missing, and those regions were excluded from our analysis.

**References**

Acemoglu, Daron, Ufuk Akcigit, and William Kerr. "Networks and the macroeconomy: An empirical exploration." *NBER Macroeconomics Annual* 30.1 (2016): 273-335.

Amiti, Mary, and Beata Smarzynska Javorcik (2008), Trade costs and location of foreign firms in China, *Journal of Development Economics* 85, 129–49

Amoroso, Sara, Pietro Moncada-Paternò-Castello, and Antonio Vezzani. "R&D profitability: the role of risk and Knightian uncertainty." *Small Business Economics* 48.2 (2017): 331-343.

An, Zhiyong. "Taxation and capital structure: empirical evidence from a quasi-experiment in China." *Journal of Corporate Finance* 18.4 (2012): 683-689.

Arnold, Jens Matthias, et al. "Services reform and manufacturing performance: Evidence from India." *The Economic Journal* 126.590 (2016): 1-39.

Atella, Vincenzo, and Beniamino Quintieri. "Do R&D expenditures really matter for TFP?." *Applied Economics* 33.11 (2001): 1385-1389.

Beata S. Javorcik (2004), "Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages" *American Economic Review*, 94(3), 605-627.

Bengoa, Marta, Valeriano Martínez-San Román, and Patricio Pérez. "Do R&D activities matter for productivity? A regional spatial approach assessing the role of human and social capital." *Economic Modelling* 60 (2017): 448-461.

Bernard, Andrew B., and J. Bradford Jensen. "Exporting and Productivity in the USA." *Oxford Review of Economic Policy*20.3 (2004): 343-357.

Bhattarai, Keshab, and Vipin Negi. "FDI and Economic Performance of Firms in India." *Studies in Microeconomics* (2020): 2321022220918684.

Bhattarai, Keshab, and Dawid Trzeciakiewicz. "Macroeconomic impacts of fiscal policy shocks in the UK: A DSGE analysis." *Economic Modelling* 61 (2017): 321-338.

Bhattarai, Keshab. "Dynamic CGE model of the Chinese economy for fiscal and financial policy analysis." *China-USA business review* 16, no. 4 (2017).

Bournakis, Ioannis, and Sushanta Mallick. "TFP estimation at firm level: The fiscal aspect of productivity convergence in the UK." *Economic Modelling* 70 (2018): 579-590.

Bosworth, Barry, and Susan M. Collins. "Accounting for growth: comparing China and India." *Journal of Economic Perspectives* 22.1 (2008): 45-66.

Cadot, Olivier, Céline Carrère, and Vanessa Strauss-Kahn. "Export diversification: What's behind the hump?." *Review of Economics and Statistics* 93.2 (2011): 590-605.

Chaney, Thomas, and Ralph Ossa. "Market size, division of labor, and firm productivity." *Journal of International Economics* 90.1 (2013): 177-180.

Chaurey, Ritam. "Location-based tax incentives: Evidence from India." *Journal of Public Economics* 156 (2017): 101-120.

Chen, Xiaoguang. "Different effective tax rates of VAT and efficiency loss: With some implications for 'replacing the business tax with a value-added tax'." *Social Sciences in China* (2013), 8, 67-84+205-206.

Chen, Shawn Xiaoguang. "VAT rate dispersion and TFP loss in China's manufacturing sector." *Economics Letters* 155 (2017): 49-54.

Chen, Zhao, et al. Notching R&D investment with corporate income tax cuts in China. No. w24749. *National Bureau of Economic Research*, 2018.

Chen, J. R., Chu, Y. P., Ou, Y. P., & Yang, C. H. (2015). R&D specialization and manufacturing productivity growth: A cross-country study. *Japan and the World Economy*, 34, 33-43.

Cheng, Savuth. "Foreign direct investment and productivity spillovers: Empirical evidence from Cambodia." *Economics Bulletin* 32, no. 3 (2012): 2015-2025.

Clark, Don P. "Country and industry-level determinants of vertical specialization-based trade." *International Economic Journal* 20.2 (2006): 211-225.

Constantinescu, Cristina, Aaditya Mattoo, and Michele Ruta. "Does vertical specialization increase productivity?." *The World Economy* 42.8 (2019), 2385-2402.

Criscuolo, C. and R. Martin (2004), "An Emerging Knowledge-Based Economy in China?: Indicators from OECD Databases", *OECD Science, Technology and Industry Working Papers*, 2004/4, OECD Publishing. doi:10.1787/256502026705

De Loecker, Jan. "Do exports generate higher productivity? Evidence from Slovenia." *Journal of international economics* 73.1 (2007): 69-98.

De Loecker, Jan. "Detecting learning by exporting." *American Economic Journal: Microeconomics* 5.3 (2013): 1-21.

Debaere, Peter, Joonhyung Lee, Myungho Paik. Agglomeration, backward and forward linkages: evidence from South Korean investment in China. *Canadian Journal of Economics*, 43(2) (2010). 52-546.

Disdier, Anne-Célia, and Keith Head. "The puzzling persistence of the distance effect on bilateral trade." The *Review of Economics and statistics* 90.1 (2008): 37-48.

Eckaus, Richard S. "China's exports, subsidies to state-owned enterprises and the WTO." *China Economic Review* 17.1 (2006): 1-13.

Eslava, Marcela, John Haltiwanger, Adriana Kugler, and Maurice Kugler. "The effects of structural reforms on productivity and profitability enhancing reallocation: evidence from Colombia." *Journal of development Economics* 75, no. 2 (2004): 333-371.

Fack, Gabrielle, and Camille Landais. "The effect of tax enforcement on tax elasticities: Evidence from charitable contributions in France." *Journal of Public Economics* 133 (2016): 23-40.

Falkenhall, Björn, Jonas Månsson, and Sofia Tano. "Impact of VAT reform on Swedish restaurants: A synthetic control group approach." *The Scandinavian Journal of Economics* (2018).

Fan, Ziying and Fei Peng. "The effects of 'business tax replaced with VAT reform' on firms' tax cuts and industrial division based on the perspectives of industrial interconnection." *Economic Research Journal* (2017), 52(2), 82-95.

Fang, Hongsheng, Yuxin Bao, and Jun Zhang. "Asymmetric reform bonus: The impact of VAT pilot expansion on China's corporate total tax burden." *China Economic Review* 46 (2017): S17-S34.

Fatica, S., Heyndericks, W., & Pagano, A. (2020). Banks, debt and risk: assessing the spillovers of corporate taxes. *Economic Inquiry*, 58(2), 1023-1044.

Fernandes, Ana M., and Caroline Paunov. "Foreign direct investment in services and manufacturing productivity: Evidence for Chile." *Journal of Development Economics* 97, no. 2 (2012): 305-321.

Fleming, Marcus. "External economies and the doctrine of balanced growth." *The Economic Journal* 65.258 (1955): 241-256.

Frensch, Richard. "Public governance as the source of quality and variety gains from transition." *Journal of Comparative Economics* 32.3 (2004): 388-408.

Giannetti, Mariassunta, Guanmin Liao, and Xiaoyun Yu. "The brain gain of corporate boards: Evidence from China." *The Journal of Finance* 70.4 (2015): 1629-1682.

Goolsbee, Austan. "The impact of the corporate income tax: evidence from state organizational form data." *Journal of Public Economics* 88.11 (2004): 2283-2299.

Gopalan, R., Hamilton, B. H., Kalda, A., & Sovich, D. (2020). State minimum wages, employment, and wage spillovers: Evidence from administrative payroll data. *Journal of Labor Economics*, Forthcoming.

Gort, Michael. Diversification and integration in American Industry. Greenwood Press, 1962.

Grossman, Gene M., and Elhanan Helpman. Innovation and growth in the global economy. MIT press, 1991.

Hagedoorn, John, and Ning Wang. "Is there complementarity or substitutability between internal and external R&D strategies?." Research policy 41.6 (2012): 1072-1083.

Halpern, László, and Balázs Muraközy. "Does distance matter in spillover? 1." *Economics of Transition* 15.4 (2007): 781-805.

Hsieh, Chang-Tai, and Peter J. Klenow. "Misallocation and manufacturing TFP in China and India." The *Quarterly Journal of Economics* 124.4 (2009): 1403-1448.

Ito, Banri, and Ayumu Tanaka. "External R&D, productivity, and export: evidence from Japanese firms." *Review of World Economics* 152.3 (2016): 577-596.

Jefferson, Gary H., et al. "R&D performance in Chinese industry." *Economics of innovation and new technology* 15.4-5 (2006): 345-366.

Jeon Y , Park B I , Ghauri P N . Foreign direct investment spillover effects in China: Are they different across industries with different technological levels?[J]. *China Economic Review*, 2013, 26:105-117.

Lan, Fei, Wei Wang, and Qingzi Cao. "Tax cuts and enterprises' R&D intensity: Evidence from a natural experiment in China." *Economic Modelling* 89 (2020): 304-314.

Li Y. Y, Yan C. (2018). Will replacing BT with VAT for the service industry lead the manufacturing industry to upgrade? *Economic Research Journal*, (4): 18-31.

Lin, Justin Yifu, Fang Cai, and Zhou Li. "Competition, policy burdens, and state-owned enterprise reform." *The American Economic Review* 88.2 (1998): 422-427.

Lin, Songhua, and Alyson C. Ma. "Outsourcing and productivity: Evidence from Korean data." *Journal of Asian Economics* 23.1 (2012): 39-49.

Liu, Yongzheng and Jie Mao. "How do tax incentives affect investment and productivity? Firm-level evidence from China." *American Economic Journal: Economic Policy* 11.3 (2019): 261-291.

Ljungqvist, Alexander, Liandong Zhang, and Luo Zuo. "Sharing risk with the government: How taxes affect corporate risk taking." *Journal of Accounting Research* 55.3 (2017): 669-707.

Nair-Reichert, Usha, and Diana Weinhold. "Causality tests for cross-country panels: a New look at FDI and economic growth in developing countries." *Oxford bulletin of economics and statistics* 63, no. 2 (2001): 153-171.

Nguyen, Huong Quynh. "Business reforms and total factor productivity in Vietnamese manufacturing." *Journal of Asian Economics* 51 (2017): 33-42.

Poncet, Sandra, Walter Steingress, and Hylke Vandenbussche. "Financial constraints in China: firm-level evidence." *China Economic Review* 21.3 (2010): 411-422.

Qian, Yingyi. "A Theory of Shortage in Socialist Economies Based on the" Soft Budget Constraint"." *The American Economic Review* (1994): 145-156.

Rauch, James, and Diana Weinhold. "Openness, Specialization, and Productivity Growth in Less Developed Countries." *Canadian Journal of Economics*, 32.4 (1999): 1009-1027.

Rao, Nirupama. "Do tax credits stimulate R&D spending? The effect of the R&D tax credit in its first decade." *Journal of Public Economics* 140 (2016): 1-12.

Rath, Badri Narayan. "Productivity growth and efficiency change: Comparing manufacturing-and service-based firms in India." *Economic Modelling* 70 (2018): 447-457.

Saez, Emmanuel, Benjamin Schoefer, and David Seim. "Payroll taxes, firm behavior, and rent sharing: Evidence from a young workers' tax cut in Sweden." *American Economic Review* 109.5 (2019): 1717-63.

Smarzynska Javorcik, Beata. "Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages." *American economic review* 94.3 (2004): 605-627.

Shuai, Xiaobing. "Will specialization continue forever? A case study of interactions between industry specialization and diversity." *The Annals of regional science* 50.1 (2013): 1-24.

Turco, Alessia Lo, Daniela Maggioni, and Alberto Zazzaro. "Financial dependence and growth: The role of input-Output linkages." *Journal of Economic Behavior & Organization* (2019).

Urraca-Ruiz, Ana, and Nuria Esther Laguna-Molina. Dynamic technological specialization, aggregated convergence and growth. *International Economics and Economic Policy* 13.2 (2016): 195-221.

Ward, Eric J., et al. "Effects of increased specialization on revenue of Alaskan salmon fishers over four decades." *Journal of applied ecology* 55.3 (2018): 1082-1091.

Wei, Wei, Wan-Li Zhang, Jun Wen, and Jun-Sheng Wang. "TFP Growth in Chinese Cities: The Role of Factor-Intensity and Industrial Agglomeration." *Economic Modelling* (2019), forthcoming.

Weijiang, L. and Zhuo, L., 2018. Replacing Business Tax with VAT, Servitization of Manufacturing and Total Factor Productivity Increase: An Empirical Study Based on the DI Synthetic Control Methods. *South China Journal of Economics*, (5), p.1.

Yagan, Danny. "Capital tax reform and the real economy: The effects of the 2003 dividend tax cut." *American Economic Review* 105.12 (2015): 3531-63.

Yang, Chih-Hai, and Ying-Hui Chen. "R&D, productivity, and exports: Plant-level evidence from Indonesia." *Economic Modelling* 29.2 (2012): 208-216.

Yin, Ran. "Study on the Problem of China's Business Tax Changes to VAT—Based on the Panel Data of Listed Companies in the Transport Industry." *Open Journal of Social Sciences* 3.11 (2015): 157.

Yu, Miaojie. "Processing trade, tariff reductions and firm productivity: evidence from Chinese firms." *The Economic Journal* 125.585 (2015): 943-988.

Zhang, Anming, Yimin Zhang, and Ronald Zhao. "A study of the R&D efficiency and productivity of Chinese firms." *Journal of Comparative Economics* 31.3 (2003): 444-464.

Zhang, L., Y. Chen, and Z. He, 2018, "The Effect of Investment Tax Incentives: Evidence from China's Value-added Tax Reform", *International Tax and Public Finance*, (25): 913-945

Zhang, D., 2019. Can export tax rebate alleviate financial constraint to increase firm productivity? Evidence from China. *International Review of Economics & Finance*, 64, pp.529-540

Zhang, Lei, Yuyu Chen, and Zongyan He. "The effect of investment tax incentives: evidence from China's value-added tax reform." *International Tax and Public Finance* 25.4 (2018): 913-945.

Zou, Jingxian, Guangjun Shen, and Yaxian Gong. "The effect of value-added tax on leverage: Evidence from China's value-added tax reform." *China Economic Review* (2019): 135-146.

Zwick, E. , and J. Mahon, 2017, "Tax Policy and Heterogeneous Investment Behavior", *The American Economic Review*, 107(1): 217–248.