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ABSTRACT

We investigate the impact of tax cascading on upstream and downstream firms. As a natural experiment, we explore a reform that replaced turnover taxes with value-added taxes for service industries in China, which effectively removed tax cascading. We find a relative increase in sales, R&D investment, and employment for affected service firms. These changes are mainly driven by increased outsourcing from manufacturing firms, and are unlikely to be caused by changes in firms' tax burden or output prices. Our study provides new evidence on how taxation affects supplier networks and firm performance.

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1 Introduction

Turnover taxes are levied on revenues and do not allow for input deductions, resulting in tax cascading where final goods are taxed multiple times throughout the production. Many developing countries adopt turnover taxes because they are easier to administer and arguably harder to evade (Best et al., 2015). Meanwhile, turnover taxes are also gaining popularity in developed countries, like the United States (Hansen et al., 2022; Phillips and Ibaid, 2019). In principle, turnover taxes distort business organizations to favor vertical integration, which depresses demand for upstream suppliers (Coase, 1937; Williamson, 1971). This tax distortion may lead to potentially large production inefficiency, especially when turnover taxes are imposed on some, but not all, sectors (or regions) in the economy. In this study, we examine how sector-specific turnover taxes affect the supply chains and business activities of firms in a large developing country, considering the perspectives of both upstream and downstream firms.

As a quasi-natural experiment, we explore a major tax reform in China that replaced the business tax (BT) on gross revenue with the value-added tax (VAT) for firms in service industries starting from 2012 (thereafter, the B2V reform). Before the B2V reform, Chinese service firms were subject to the BT, which is a tax imposed on gross revenue. In comparison, manufacturing firms in China were subject to the VAT, which is imposed on value-added. One feature of this dual tax system is that manufacturing firms could not claim input deductions against their VAT when they purchased intermediate goods from BT-paying service firms. This dual tax system encouraged manufacturing firms to vertically integrate to avoid tax cascading. The reform effectively removed this distortion in the tax system and should have encouraged outsourcing from manufacturing firms. We leverage the staggered implementation of the B2V reform across regions and time to identify its impact on sales, investment, and employment of firms in service industries, based on a sample of Chinese listed firms during 2009-2017.

Our empirical strategy relies on comparing outcomes for service firms that were directly affected by the reform with a group of manufacturing firms that were less exposed to the reform through their purchasing networks. To provide an arguably exogenous classification, we use the 2012 input-output tables from the US Bureau of Economic Analysis (BEA). Our key findings are as follows. First, we find that treated service firms increased sales by 22% on average after the reform, relative to the control group. This suggests that turnover taxes suppressed the demand for treated service firms. We further find that the B2V reform led

to a diversification of the customer base for service firms. For the reformed service firms, the percentage of sales to the top five customers in total sales declined by 7%, relative to the control group. Thus, removing the turnover tax not only increases the total demand for service firms but also has a material impact on their market structure.

In response to the sales increase, we find that reformed service firms experienced a significant increase in R&D investment, employment, and wages, of 18%, 17%, and 10% respectively, relative to the control group. We find no significant change in fixed assets investment as our treated service firms mainly produce intangible goods and tend to be R&D intensive. Given the significant increase in the quantity of innovation that we uncover, we further examine whether the reform affected the *quality* of innovation for service firms. Using different proxies for innovation quality, such as the number of patents and patent citations, we show that treated service firms improved their R&D investment quality since the reform. There are at least two potential explanations for this increase in quality. First, higher investment in R&D increases the chances of more breakthrough research. Second, an increased demand from downstream firms is likely to increase the competition in the supply market, which encourages service firms to improve the quality of their R&D investment.

We then explore possible mechanisms that drive the observed changes in sales, R&D investment, and employment among treated service firms. A simple theoretical model shows that by removing the tax cascading under the BT regime, the reform should encourage outsourcing by downstream manufacturing firms. This leads to a larger demand for intermediate goods provided by the reformed service firms, and should increase the share of inputs purchased from service firms relative to those produced in-house by manufacturing firms. We call this the outsourcing effect. Empirically, by comparing manufacturing firms that are more connected with the service sector with those less connected, we find that the former type of firms experienced a significant increase in outsourced services after the B2V reform, which provides direct evidence for the outsourcing effect.

We further show that the tax burden and product prices of the treated service firms did not change significantly. Thus, the observed changes in service firms' performance were unlikely to be caused by these alternative channels. At the same time, the B2V reform should have lowered the tax burden of the more connected manufacturing firms since they can now claim input VAT on purchases from the treated service firms. We show that their tax burden declined, relative to the group of less-exposed manufacturing firms. However, this decline in tax burden did not translate into a lower output price or larger sales. Thus, there is unlikely to be a trickle-down effect due to a larger demand for the final consumer goods produced

by the manufacturing firms. Instead, we find that the more connected manufacturing firms internalize the lower tax burden by reducing costs and increasing profits. We further rule out the possibility that our benchmark results are driven by treated firms that were more financially constrained, or driven by changes in the cost of capital. These additional checks strengthen our findings that relative changes amongst service firms in terms of sales, R&D investment, and employment are mainly driven by outsourcing by downstream manufacturing firms.

Our study contributes to the small body of empirical research on turnover taxes. Hansen et al. (2022) find that following the replacement of the gross receipt tax with a retail tax on Washington's cannabis industry, the share of vertically integrated cannabis fell immediately while production increased, indicating large production inefficiency associated with the gross receipt tax. Smart and Bird (2009) find that replacing sales taxes with value-added taxes in several Canadian provinces led to significant increases in machinery and equipment investment. Best et al. (2015) emphasize that turnover taxes reduce evasion, which outweighs the associated production inefficiency.[2] Gadenne et al. (2019) explore how the co-existence of turnover tax and VAT in India distorts smaller firms' supply chains. They estimate that on average firms that enter the VAT scheme buy 12% more from their VAT-paying suppliers. Agrawal and Zimmermann (2022) find that following the transition from sales taxes to the VAT, Indian firms' sales increased by 57% in the median run. We find that sales of reformed service firms increased by around 22%, which lies between the existing estimates. Our estimate is smaller than that found by Agrawal and Zimmermann (2022), possibly because the Chinese reform did not reduce the tax burden of the service firms on average. This feature of the Chinese reform, however, allows us to pin down the outsourcing effect and the distortion to the supply chains brought by the turnover taxes.

Second, we add to the discussion on how government can influence private innovation by increasing private demand. The majority of the literature focuses on supply-side government policies (e.g., tax incentives) that change the cost of R&D investment (Agrawal et al., 2020; Akcigit et al., 2018; Bloom et al., 2002; Chen et al., 2021; Einiö, 2014; Guceri and Liu, 2019; Hall and Van Reenen, 2000; Lokshin and Mohnen, 2013; Rao, 2016), while less evidence exists on the effectiveness of policies affecting demand.[3] Based on our estimation results, we calculate the implied elasticity of R&D investment to increase sales to be 0.84 in our

[2]At the same time, there is some agreement in the literature that VAT taxes tend to be harder to evade (Naritomi, 2019; Pomeranz, 2015; Waseem, 2019).

[3]The importance of demand-side policies for innovation has long been recognized (Schmookler, 1962, 1966), but there is limited empirical evidence (Edler and Georghiou, 2007).

baseline specification. As a comparison, the estimated elasticity of R&D investment to policy-induced changes in the tax component of the user cost of capital ranges from 0.14 in the short-run to 2.7 in the long-run (Bloom et al., 2002; Hall, 1993). Our estimated medium-run demand elasticity is large in comparison. This suggests that policies changing firms' demand conditions can be as effective as those changing the marginal cost of R&D investment. Our study also adds to this strand of literature by showing that removing tax cascading in the economy could affect the allocation of innovation activities, which has been shown to influence long-run economic growth (Balasubramanian and Sivadasan, 2011; Doraszelski and Jaumandreu, 2013; Griliches and Mairesse, 1991; Hall and Mairesse, 1995; Hasan and Tucci, 2010; Kogan et al., 2017; Mansfield, 1980).

This paper also has important policy implications. International organizations, such as the IMF, have been encouraging developing countries to move from turnover-type taxes to VAT in the last few decades, notably, with Brazil switching in 2002 and 2003. However, turnover-type taxes remain popular, largely as they are easier to enforce than profit taxes.[4] In more developed economies, while the VAT has been widely adopted, features like VAT exemptions potentially impose similar problems as the Chinese dual tax system before the B2V reform (Ebrill et al., 2001). In the U.S., the state sales tax system also imposes a significant tax on business-to-business transactions (Phillips and Ibaid, 2019). We show that these distortions in the tax system alter firm decisions, and removing them may lead to a more efficient allocation of business activities.

2 Policy background

China's economic growth traditionally depended on its manufacturing sector, but its service sector and, consequently, innovation-driven growth is becoming increasingly important (Chen et al., 2023; Zilibotti, 2017). Since 2011, the aggregate annual output growth rate of the service sector outpaced that of the manufacturing sector and has remained at the double-digit level. By 2017, the service sector contributed to more than 50% of the country's GDP. Therefore, policies targeting the growth of the service sector are likely key to China's productivity and long-run economic performance.

Despite the growing importance of the service sector, until 2012 Chinese service firms were subject to a different tax treatment from that imposed on manufacturing firms. Before

[4]For example, Afghanistan, Ethiopia, Suriname, and Taiwan levy turnover taxes on all firms, while South Africa applies it to small businesses. For more information see `https://www.ibfd.org/sites/ibfd.org/files/content/pdf/ivm_2018_02_int_2.pdf`.

the B2V reform, the VAT broadly applied to the manufacturing sector, and the BT broadly applied to the service sector. Under the VAT, firms are taxed based on value-added, and there is an "input-output" credit mechanism. That is, the buyer pays VAT on her input purchases and subsequently claims tax credit when she sells to downstream customers. In comparison, the BT was imposed on gross revenue and costs of factor inputs could not be deducted. As a result, VAT-paying firms could not claim tax credits on input purchased from the BT-paying firms.

The rationale behind imposing a revenue-based tax on service firms is largely related to tax enforcement. In developing countries, it is difficult for the tax administrator to monitor firms, especially those with little tangible assets. That applies to most firms in the service sector. Compared with profit-based tax, it is more efficient to collect tax based on revenue for such firms. The drawback of the BT-VAT dual tax system is that it breaks the VAT chains in the economy and distorts supply networks. Ample anecdotes suggest that before the B2V reform, manufacturing firms were forced to become "big and comprehensive"—that is, to self-supply intermediate goods and internalize the costs, as outsourcing to service firms implied a higher tax burden. However, such tax-motivated vertical integration may be inefficient.

Starting in 2012, the Chinese government gradually replaced the BT with the VAT. Panel A of Table 1 provides the timeline of the B2V reform. The reform aimed to unify the tax treatment for the manufacturing and the service sectors, and to remove distortion and the inefficiency associated with the BT. Panel B of Table 1 lists the BT rates and the VAT rates for the treated industries. The different VAT rates for different industries are intended to keep the tax burden of the reformed industries largely unchanged. Consistent with this, the VAT rates are set to be higher than the BT rates for all reformed service industries, reflecting a narrower tax base under the VAT. [5] This differs considerably from the Indian transition from the sales tax to the VAT, which resulted in a substantial decline in firms' statutory tax rates (Agrawal and Zimmermann, 2022).

The pilot reform took place in Shanghai on January 1st, 2012, and affected the transportation industry and six "modern services" (R&D and technical services, IT services, cultural and innovation services, logistics auxiliary services, attestation and consulting services, and tangible assets leasing services). The reform was then gradually rolled out to cover more service industries and regions. By May 2016, the reform covered all service industries and

[5]However, for reformed service industries apart from transportation and leasing, the difference between the VAT and BT rates is small, suggesting that these industries may have a small number of deductibles under the VAT system.

effectively eliminated BT from the Chinese tax system. The reform has been hailed as the most important tax reform in China since 1994, involving the countries' two most important taxes (Cui, 2014).

During the analyzed period, the Chinese government enacted several other tax policies. First, there was a nationwide corporate tax rate cut for small and micro-profit enterprises (Cui et al., 2021), which is unlikely to affect listed firms in our sample since these firms are generally large firms. Second, China introduced accelerated depreciation for qualified fixed assets investment for selected manufacturing industries in 2014. However, this tax incentive only targets non-R&D fixed assets investment, and existing study shows that this policy had a rather low take-up and limited impact on firms' fixed assets investment (Cui et al., 2022). There are also tax incentives specifically targeting firms' R&D investment. For example, qualified high-tech firms enjoy a 15% corporate income tax rate, 10% lower than the main rate, that was in place before the B2V reform (Chen et al., 2021). There are also R&D super deductions and subsidies. However, these tax schemes existed well before the B2V reform and apply to firms in all sectors and hence, they are unlikely to threaten our identification strategy.

3 Conceptual framework

In this section, we outline a conceptual framework that will guide our empirical analysis. Specifically, we build a partial equilibrium model with two sectors: service and manufacturing. Our goal is to use the model to shed light on the mechanisms through which the B2V reform can affect the sourcing decisions of manufacturing firms and demand for the products of service firms. In this model, we assume that service firms sell the service goods to both manufacturing firms and final consumers. For simplicity, we assume that service firms use labor as the input for production. This assumption is consistent with the fact that service firms in our sample are R&D intensive, and on average more than 70% of their R&D expenditures are in the form of wages for R&D-related personnel.[6] Manufacturing firms produce output using service goods as intermediate inputs, which they either buy from service firms or produce in-house. Manufacturing firms sell their products only to final consumers who have downward sloping demand for this product, and they make sourcing and producing decisions to maximize their after-tax profit.

[6]According to the Chinese accounting standard, R&D expenditures include both the wages of R&D related personnel and expenses on construction, use, maintenance, and depreciation of R&D-related fixed assets (Liu and Mao, 2019).

In our economy there are two types of taxes, the value-added tax (VAT), denoted as τ_{VAT}, and the business tax (BT), denoted as τ_{BT}. We assume that manufacturing firms are subject to the VAT, while service firms are subject to the BT before the reform and to the VAT after the reform. When a service firm operates under the BT regime, the unit price it charges includes the BT, which the manufacturing firm cannot deduct from its VAT liabilities if it purchases from the service firm. This setup reflects the cascading effect of the turnover taxes. When a service firm operates under the VAT regime, the VAT paid on purchases from the service firm can be credited against the VAT liabilities of the manufacturing firm. We illustrate the taxation and profit maximization problems for service and manufacturing firms, before and after the B2V reform, in more detail below.

3.1 Service firms

There is a representative service firm that produces a service good, y_s, using a linear production technology specified as:

$$y_s = \phi_s l_s \tag{1}$$

where ϕ_s is the productivity parameter and l_s is the labor input. The after-tax profit of a service firm that pays $\tau_s \in \{\tau_{BT}, \tau_{VAT}\}$ can be written as:

$$\Pi_s = (1 - \tau_s) p_s \phi_s l_s - w l_s \tag{2}$$

where p_s is the unit price of the service good produced by the service firm, and w stands for unit wage and is exogenous in our setup. Before the reform, the service firm paid BT on its gross revenue, which amounts to $\tau_{BT} p_s \phi_s l_s$. After the reform, it pays the VAT on the value-added. Note that we assume that the service firm only uses labor as input, and wage is not deductible for VAT purposes. Consequently, the amount of VAT the service firm pays equals to $\tau_{VAT} p_s \phi_s l_s$. It follows that if the BT and VAT rates are similar, the tax burden on service firms would not change under the assumptions we make in this model.[7] Further, Equation 2 implies that the price of the service good produced by the profit-maximizing service firm is:

$$p_s = \frac{w}{(1 - \tau_s)\phi_s} \tag{3}$$

Note that the unit price charged by the service firm is inflated by the tax it has to pay

[7]We empirically test whether the tax burden of the treated service firms changes after the reform in Section 7.2 and find a null effect.

to the tax authorities. This means that the price of the service good, sold by the service firm, is set such that its tax burden is fully transferred to manufacturing firms through the pricing of the goods.

3.2 Manufacturing firms

There is a representative manufacturing firm, m, that produces the final consumer good, y_m, using the service goods as inputs. The manufacturing firm obtains its inputs in two ways: by purchasing from service firms or by producing them in-house. The manufacturing firm employs a constant elasticity of substitution (CES) aggregate of these service goods as inputs in its production process, following the specified technology below:

$$y_m = \phi_m(\mu_s q_s^{\rho} + \mu_{ms} q_{ms}^{\rho})^{1/\rho} \tag{4}$$

where q_s is the service good bought from service firms and q_{ms} is the service good produced in house. Parameter ϕ_m indicates the manufacturing firm's productivity when producing the final consumer goods. Parameter $0 \leq \mu \leq 1$ is the distribution parameter that determines the relative importance or 'weight' of each input from the two sources in total inputs with $\mu_s + \mu_{ms} = 1$, and parameter $0 < \rho < 1$ determines the elasticity of substitution between self-produced and outsourced service goods.[8]

With the production function defined by Equation 4, in the absence of taxes, the unit cost function of the manufacturing firm takes the following form:

$$c(p_s, p_{ms}) = \frac{1}{\phi_m}(\mu_s^{\frac{1}{1-\rho}} p_s^{\frac{\rho}{\rho-1}} + \mu_{ms}^{\frac{1}{1-\rho}} p_{ms}^{\frac{\rho}{\rho-1}})^{\frac{\rho-1}{\rho}} \tag{5}$$

where p_{ms} is the price of the service good produced in-house. The associated demand functions for q_s and q_{ms} are:

$$q_s(p_s, p_{ms}, y_m) = \Big(\frac{y_m}{\phi_m}\Big)\Big(\frac{\mu_s \phi_m c(p_s, p_{ms})}{p_s}\Big)^{\frac{1}{1-\rho}} \tag{6}$$

and

$$q_{ms}(p_s, p_{ms}, y_m) = \Big(\frac{y_m}{\phi_m}\Big)\Big(\frac{\mu_{ms} \phi_m c(p_s, p_{ms})}{p_{ms}}\Big)^{\frac{1}{1-\rho}} \tag{7}$$

Next, we assume the production technology for the service goods produced in-house by

[8]The elasticity of substitution σ is related to ρ by $\sigma = \frac{1}{1-\rho}$.

the manufacturing firm is $y_{ms} = \phi_{ms} l_{ms}$, where ϕ_{ms} is the productivity parameter. We assume that $\phi_{ms} < \phi_s$, which means that service firms have higher productivity—by using the same level of labor input, service firms can produce more service goods, possibly due to specialization. Given this production technology, the unit cost of producing the service goods by the manufacturing firm is $\frac{w}{\phi_{ms}}$, which is the effective price of each unit of q_{ms} (i.e. $p_{ms} = \frac{w}{\phi_{ms}}$).

In our setup, the manufacturing firm always pays VAT. The output VAT equals τ_{VAT} times revenue. If the service firm is also subject to the VAT, the manufacturing firm can deduct the input VAT related to the purchased service goods from its output VAT according to the credit-invoice method. However, if the service firm is subject to the BT, there is no input VAT deduction for the purchased service goods. Let ν_s be the indicator for which tax regime the service firm is subject to: when $\nu_s = 1$, the service firm is subject to the VAT, and when $\nu_s = 0$, it is subject to the BT. We can then define the after-tax profit of the manufacturing firm as:

$$\Pi_m = (1 - \tau_{VAT}) P_m \phi_m (\mu_s q_s^\rho + \mu_{ms} q_{ms}^\rho)^{1/\rho} - (1 - \nu_s \tau_{VAT}) p_s q_s - p_{ms} q_{ms} \tag{8}$$

where P_m is the price of final consumer goods produced by the manufacturing firm.

3.3 The effects of the tax reform

First, we use this model to show the impact of the B2V reform on the proportion of service inputs procured by manufacturing firms from service firms. By solving the optimization problem for the manufacturing firm using Equation 8, we get the following first-order conditions:

$$[q_s] : (1 - \tau_{VAT}) P_m \phi_m (1/\rho)(\mu_s q_s^\rho + \mu_{ms} q_{ms}^\rho)^{1/\rho - 1} \mu_s \rho q_s^{\rho - 1} - (1 - \nu_s \tau_{VAT}) p_s = 0$$

$$[q_{ms}] : (1 - \tau_{VAT}) P_m \phi_m (1/\rho)(\mu_s q_s^\rho + \mu_{ms} q_{ms}^\rho)^{1/\rho - 1} \mu_{ms} \rho q_{ms}^{\rho - 1} - p_{ms} = 0$$

Therefore, the ratio of service goods procured by a manufacturing firm from service firms relative to those produced in-house is:

$$\frac{q_s}{q_{ms}} = \Big(\frac{\mu_s}{\mu_{ms}} \frac{(1 - \tau_s)\phi_s}{(1 - \nu_s \tau_{VAT})\phi_{ms}} \Big)^{\frac{1}{1-\rho}} \tag{9}$$

Equation 9 shows that when service firms are more efficient in producing intermediate service goods than manufacturing firms (i.e., $\phi_{ms} < \phi_s$), manufacturing firms should purchase a larger share of their intermediate service inputs from service firms. However, this tendency will be dampened by the existence of the BT. To see this, note that a higher BT rate before the reform (i.e., when $\tau_s = \tau_{BT}$) will increase the tax burden passed on to manufacturing firms. This, in turn, will lower the ratio of service goods purchased from service firms relative to those produced in-house, $\frac{q_s}{q_{ms}}$. Instead, the BT encourages manufacturing firms to rely more on service goods produced in-house, even though the in-house production is less efficient. This highlights the distortionary nature of the BT.

Equation 9 also shows that as ν_s shifts from 0 to 1, indicating a transition from the BT to the VAT for service firms, there will be a corresponding increase in the demand for service firms relative to the internally produced service goods. We refer to this as an increase in outsourcing. Formally, we state the following:

Proposition 1. *A switch from BT to VAT increases the share of service goods the manufacturing firms buy from the service firms, relative to service goods produced in-house, assuming all other factors remain constant.*

This increase in the demand for goods produced by service firms should lead to an expansion of their production. Given the nature of the production technology employed by service firms, as shown in Equation 1, this expansion will translate into a higher demand for labor inputs. This increase in labor predicted by the model will be reflected by increases in total wages and employment in the data. Moreover, since the reformed service industries we examine tend to be R&D intensive and wages of R&D personnel form around 70% of their R&D expenditures, we should also observe a simultaneous increase in service firms' R&D expenditures. We summarize these consequences of the B2V reform on service firms in the following Corollary:

Corollary 1. *The reform should increase sales, R&D investment, total wage and employment for the service firms.*

Note that this corollary underscores the dual impact of the B2V reform, highlighting its potential to stimulate both employment and innovation in service firms. Our model also offers predictions for which manufacturing firms are more likely to be affected by the B2V reform. We can show that the change in $\frac{q_s}{q_{ms}}$ after the reform equals $(\frac{\mu_s}{\mu_{ms}}\frac{\phi_s}{\phi_{ms}})^{\frac{1}{1-\rho}}[1-(1-\tau_{BT})^{\frac{1}{\rho-1}}]$.

A manufacturing firm with a higher ratio of $\frac{\mu_s}{\mu_{ms}}$ *a priori*, has a stronger connection with service firms. It follows that these firms should also experience a larger increase in $\frac{q_s}{q_{ms}}$ after the B2V reform, all else equal. Formally, we state that:

Proposition 2. *Manufacturing firms that are more connected with service firms should outsource more after the B2V reform.*

Further, our model allows us to form predictions on the effect of the B2V reform on the prices of final consumer goods produced by the manufacturing firm. In our model, the unit cost function for a manufacturing firm, when we consider the potential deduction of the value-added tax paid on the service goods, can be written as:

$$c(p_s, p_{ms}) = \frac{1}{\phi_m}(\mu_s^{\frac{1}{1-\rho}}((1-\nu_s\tau_{VAT})p_s)^{\frac{\rho}{\rho-1}} + \mu_{ms}^{\frac{1}{1-\rho}}p_{ms}^{\frac{\rho}{\rho-1}})^{\frac{\rho-1}{\rho}} \tag{10}$$

This implies that as service firms switch to the VAT tax regime, the unit cost for manufacturing firms will decrease, even if q_s and q_{ms} do not change. If we assume that service firms are more efficient in producing service goods due to specialization, the unit cost of production for manufacturing firms should decline even further as they shift towards procuring a larger share of their inputs from service firms after the B2V reform. If the price of the final consumer goods equals the unit cost of production, it should decline accordingly. Coupled with the assumption of a generally elastic downward-sloping demand curve, this implies an increase in demand for the final consumer goods. In turn, this can have a trickle-down effect on the demand for the service firms. Formally, we state the following:

Corollary 2. *The B2V reform lowers the production cost and the price for the final consumer goods. This price reduction should boost sales of the manufacturing firms if the demand curve is elastic and downward sloping.*

Note that Corollary 2 only holds if we assume that the tax burden of the manufacturing firm is fully passed on to the final consumers. In reality, the manufacturing firms may choose to pocket the profit, due to a lower tax burden, while keeping the price and demand for the final consumer goods unchanged. Hence, how the sales, output prices, and profits of the manufacturing firms change, remains an empirical question.

4 Data and empirical strategy

4.1 Data

For empirical analysis, we mainly use the sample of all Chinese firms listed in Shanghai and Shenzhen Stock Market Exchanges during the period 2009-2017, provided by the database CSMAR. In the benchmark analysis, we compare firms in service industries that experienced the transition from the BT to the VAT by 2015, as shown in Table 1[9], with manufacturing firms that always paid the VAT and had a low degree of exposure to the service sector. To provide an arguably more exogenous classification, we use the 2012 input-output tables from the US Bureau of Economic Analysis (BEA) to classify manufacturing firms into more or less connected with service sector by the nature of their business operations. Overall, we obtain a balanced sample of 205 service firms and 620 manufacturing firms. Table C1 provides summary statistics for key outcome and control variables. Appendix A provides the variable definitions.

We complement the listed firms' sample with data from two additional sources. The first data is the National Tax Survey Data (NTSD). Around 700,000 firms are surveyed by the NTSD each year, distributed across firm sizes and industries. The overall tax receipts reported by the sampling firms account for 75% of the aggregate national tax revenue in 2014 (Fan and Liu, 2020). We use the NTSD to obtain information on firms' outsourcing activities. To analyze the price changes, we utilize the Chinese Customs Trade Statistics (CCTS) collected by the Chinese Customs Office, as used and described in Manova and Zhang (2009, 2012). While we have no price information for domestically sold products, we use the CCTS to collect the product-level prices of exported goods for a subset of firms in our dataset.[10] Existing studies suggest that firms' export prices are sensitive to shocks to production costs (Fontagné et al., 2024). Hence, analyzing changes in firms' export prices could shed light on the impact of the B2V reform on firms' pricing strategies in general.

We focus our analysis on the sample of listed firms and use consolidated financial data. While the NTSD covers a broader distribution of firms in the population, it is collected at the unconsolidated level without ownership information to link parent firms to subsidiaries. As a result, we cannot differentiate between independent service firms and those that are

[9]We exclude real estate, construction, finance, and other service industries that were reformed in 2016 to allow for adequate post-reform time.

[10]The sample size becomes smaller as we fail to match all listed firms with the CTTS, likely as these firms do not export.

subsidiaries of manufacturing firms while using the NTSD. Suppose a manufacturing firm chose to vertically integrate before the B2V and set up a service subsidiary. If this manufacturing firm replaces self-production (i.e., producing intermediate service goods by its service subsidiary) with outsourcing (i.e., purchasing from a third-party service firm) after the B2V, we will observe a decline in the sales, R&D investment, and employment of its service subsidiary. This would create a downward bias in the estimated effects of the reform if we classify this service subsidiary as an independent service firm. Using the consolidated data for listed firms helps us avoid this bias. Further, since we observe positive effects of the reform on the quantity of innovation of service firms, it is interesting to examine the *quality* of innovation performed by these firms. We observe the quality of innovation activities, such as the number of patent applications and patent citations, for the listed firms only.

4.2 Empirical strategy

Our empirical analysis aims to examine the impact of the B2V reform on the business operations of the affected service firms. The main identification challenge is to find an appropriate control group. The conceptual framework above suggests that the B2V reform should have a limited impact on manufacturing firms that were less connected to the service industries. This provides us with an opportunity to conduct a standard difference-in-differences analysis, by comparing outcomes for service firms with those for manufacturing firms that were less connected to the service sector before the reform.

Our preferred measure of inter-industry connectedness is based on the industry-level input–output tables published by the US Bureau of Economic Analysis (BEA) in 2012. The BEA data is likely to be exogenous to the Chinese economy and represent the 'true' inter-industrial connectedness. We use this data to calculate intermediate goods purchased from and sold to reformed service industries, as a share of total purchases and sales, for each manufacturing industry. We then use the distribution of these ratios to divide all listed manufacturing firms into two groups based on the sample median. Manufacturing firms with a below-the-median ratio of connectedness form our control group.[11] We assume that these

[11] In Table C3, we show results using two alternative measures of connectedness. One measure of connectedness utilizes that same approach as our preferred one but instead uses the 2012 industry input-output table from the National Bureau of Statistics of China. However, a concern with using the Chinese input-output table is that it may be endogenous to the reform as the purchasing ratios could be affected by firms' vertical integration decisions. The second alternative measure is upstreamness, as proposed by Antràs et al. (2012). It measures the average distance from final use in terms of the number of production stages a good must go through. The more stages a good has to go through, the higher the degree of upstreamness. We take advantage of the upstreamness data for China, based on the 2005 input-output tables for China, provided

manufacturing firms are less affected by the reform through their supply chains. However, if the reform still leads to increases in sales, R&D investment, and employment in these control firms, possibly due to improvement in production efficiency, our DID estimates will provide a lower bound for the true treatment effects. In Table C1 we demonstrate that more connected manufacturing firms tend to conduct more R&D investment and have a higher R&D to sales ratio than less connected manufacturing firms. This could explain why these manufacturing firms are more connected with the reformed service firms, which also tend to be R&D intensive.

We use the following general specification for estimations:

$$Y_{i,t} = \alpha + \beta \times Service_i \times Post_{i,t} + \eta_t + \psi_i + \epsilon_{i,t} \tag{11}$$

where $Y_{i,t}$ is a set of outcome variables at the firm level, which in the baseline specifications includes sales, customer concentration, capital expenditures, $R\&D$ expenditures, the number of employees and total wage bills (all in natural logarithms). $Service_i$ is a dummy variable that equals to 1 when a firm belongs to the reformed service industry, and 0 if it belongs to the less-connected manufacturing industries. The B2V reform was implemented in different industries across provinces in different years (see Table 1) and hence, our $Post_{i,t}$ variable varies across firms in our sample. We set it to 1 starting in the year the reform was implemented. Since in some provinces, the reform was implemented in the last quarter of the year, it is possible that the effect of the reform can occur in year t+1. η_t is the time fixed effect, ψ_i is a firm-specific fixed effect and $\epsilon_{i,t}$ is the unobserved error term. We cluster standard errors at the firm level.[12] The parameter β captures the relative difference in the outcome variables averaged across all service firms compared with manufacturing firms after the reform. We use the same empirical approach to evaluate the effects of the B2V reform on more connected manufacturing firms when we test the mechanisms through which the B2V reform affects the service firms. In those regressions, we replace the $Service_i$ dummy with the $Connected_i$ dummy and use the same control group of less connected manufacturing firms.

To causally identify the effects of the reform on service firms' outcomes relative to those of manufacturing firms, we require the assumption of parallel trends to hold in our setting. The event study methodology allows us to verify the plausibility of this assumption. We

directly in Antràs et al. (2012).

[12]We test the robustness of this clustering method in Table C4, where we instead cluster the standard errors at the province-industry level.

can also use this approach to evaluate the speed with which the reform affects our outcome variables. Specifically, we estimate Equation 12:

$$Y_{i,t} = \alpha + \sum_{\kappa=-3}^{3} \beta_{i,\kappa} 1[t = \kappa] + \eta_t + \psi_i + \epsilon_{i,t} \tag{12}$$

where $1[t = \kappa]$ is a set of dummy variables that equals 1 in each of the κ years relative to the year in which the reform affected firm i. The coefficient on each of those dummies indicates the difference in each outcome variable in that year relative to year t-1, which we omit from the specification and serves as a benchmark. We estimate and plot the results from these equations for our treated and control groups, separately. We control for firm-specific fixed effects and year-fixed effects in each specification.

A potential concern about using the traditional two-way fixed effects approach that we use in our setting is the staggered and heterogeneous nature of the reform implementation across provinces and years. As such, one may be concerned that the estimated effects may be contaminated when "already-treated" observations act as a control group. These problems arise from negative weights in the computation of the average treatment effect. We tackle this issue in three distinct ways. First, we only use firms in service industries that were reformed in 2012, 2013, and 2014. We exclude the 2016 reformed industries due to limited post-reform data. Our strategy thus limits the staggered nature of the implementation, as 89% of our treated service firms were reformed in 2012.[13] Second, following Goodman-Bacon (2018), we decompose our estimator into its sources of variation. In Table C2 we show that our estimates rely almost exclusively on the comparison of "treated" with "never-treated" groups. Hence, the variation in reform timing is not a substantial issue in our setting. Third, to address the remaining concerns about the heterogeneous treatment effects in a staggered difference-in-differences framework, when estimating the event study models with two-way fixed effects, we use alternative estimators to correct for this issue including those provided by de Chaisemartin and D'Haultfoeuille (2020), Sun and Abraham (2020), Callaway and Sant'Anna (2020), and Borusyak and Jaravel (2021).

[13]This is also another reason why we do not use firms in the 2016 reformed industries as our control group, in addition to the fact that they are likely to differ from service firms in other industries.

5 The effects of the reform on service firms

5.1 Impact on sales, investment, and employment

We start our analysis by documenting the changes in sales, customer base, investment, employment, and wages of service firms relative to the sample of less-connected manufacturing firms after the B2V reform. We report the results based on Equation 11 in Table 2. In column 1, the estimated coefficient on sales is positive and highly significant. We find that on average, service firms experienced a 22% increase in sales relative to less-connected manufacturing firms since the B2V reform.

This is a large response compared to the existing literature. For example, Gadenne et al. (2019) estimate that Indian firms that enter the VAT scheme buy 12% more from their VAT-paying suppliers, compared with non-VAT paying suppliers. Our estimate of sales increase for service firms is larger. This may reflect that the B2V reform affects firms of all sizes, while non-VAT paying firms examined by Gadenne et al. (2019) are below a certain size threshold. Panel A of Figure 1 plots the dynamic evolution of sales for the two groups. Each dot in the sub-figure represents the point estimates, $\beta_{i,\kappa}$, based on Equation 12, where we separately estimate the annual coefficients for the treatment and control groups. The vertical lines represent the 95% confidence intervals associated with the corresponding point estimates. Before the B2V reform, sales of two groups of firms evolved in parallel, both increasing at similar rates. Further, the 95% confidence intervals before the reform consistently overlap, suggesting no significant difference between the two groups before the reform. Since the year of the B2V reform, however, there has been a gradual increase in sales for the service firms relative to the control group.

Panel A of Figure 1 shows a common evolution of output for the service and manufacturing firms in our sample before the reform. At the aggregate level, however, the Chinese service sector experienced a higher growth rate than the manufacturing sector since 2011. To reconcile the micro-level trend with the macro-level one, note that much of increases in the service sector's aggregate growth is due to a high entry rate of firms and a high rate of firm survival. As documented by Chen et al. (2023), China's service sector has a significantly higher net entry rate than the manufacturing sector during the period 1995-2019. Moreover, the share of active firms in the service sector increased substantially, from 61% in 1995 to 79% in 2019, which is mostly driven by producer service industries.[14] In contrast, the share

[14]The producer services correspond to the six modern services reformed in 2012, as shown in Panel A of Table 1.

of active firms in the manufacturing sector declined substantially. These changes at the extensive margins may contribute significantly to the higher growth rate of the service sector measured at the aggregate level. However, these extensive margin changes are absent from our firm-level analyses, as we use a balanced sample of firms for estimations.

In column 2 of Table 2, we examine whether the B2V reform affected the customer structure for service firms. At the extensive margin, the reform may have spurred more manufacturing firms to outsource and consequently, increased the number of customers for the upstream service firms. To test this hypothesis, as a dependent variable, we use customer concentration, which is defined as the logarithm of the ratio of sales to the top five customers to total sales for each firm in each year.[15] Column 2 shows that customer concentration declined by roughly 7% for service firms after the reform. Panel B of Figure 1 shows no significant difference in the evolution of the customer base between service and less-connected manufacturing firms before the reform, and a drop in service firms' customer concentration following the reform. These findings are consistent with our hypothesis that the reform enlarged the pool of customers for service firms, possibly as more manufacturing firms started outsourcing.

Next, we examine how service firms' investment was affected by the reform. In Table 2, we consider capital expenditures in column 3, and R&D expenditures in column 4. We find that only R&D expenditures increased significantly after the reform for service firms. In Panel C of Figure 1, we document a gradual and statistically significant increase in R&D investment by service firms after the reform relative to the control group, with no discernible pre-trends. It is not surprising that we observe a larger and more significant impact of the B2V reform on treated service firms' R&D expenditures as they are from R&D intensive industries, with R&D expenditures consisting of, on average, 74% of all their expenditures before the reform (Table C1). According to Table 2, service firms increased R&D investment by around 18.3% (column 4). Based on these results, we can calculate the elasticity of R&D investment to changes in sales to be 0.84 (=18.3%/21.9%). This elasticity is large relative to the literature that estimates the short-run elasticity of R&D investment to changes in the marginal cost, as discussed in the Introduction.

Finally, in columns 5 and 6 in Table 2, we show that following the B2V reform, both employment and wages in service firms increased significantly relative to the control group. Both effects are large in magnitude and statistically significant at the 1 percent level—we

[15] Alternatively, we use an Herfindahl-Hirschman Index (HHI) based on sales to the top five customers. The treatment effect is significantly negative when we use this HHI as the outcome variable, leading to the same conclusion.

observe a 17.4% increase in employment and a 10.6% increase in wages. Panel D of Figure 1 shows the dynamic effects of the B2V reform for employment and provides further evidence that service firms increased employment in response to stronger demand.

Robustness check One potential concern about our baseline estimate is related to the staggered nature of the reform implementation. In this case, the traditional two-way fixed effects estimation may not capture the true effect of the reform, as the already treated units may act as the control group in later years. Further, given the heterogeneous implementation across provinces, this may exacerbate the biases. As already discussed, using Goodman-Bacon decomposition, we show that this concern is of small magnitude in our sample. Here, we take it a step further. In Figure C1, we plot the dynamic changes in the main variables of interest: sales, customer concentration, R&D investment and employment for service firms relative to the control group, using various estimators that correct for the staggered and heterogeneous implementation of the reform. Our baseline results remain robust and we continue to find a significant increase in sales, R&D investment and employment, and a significant reduction in customer concentration. On average, across different methods, we find no significant pre-trends using these corrections.

5.2 Impact on the quality of innovation

Since we show that the B2V reform led to an increase in R&D investment by treated service firms, a relevant question is whether the increase in the *quantity* of innovation also translates into a higher *quality* of innovation. It is possible that with a higher market demand for service firms, they could have stronger incentives to improve innovation quality. We test this hypothesis in this section.

We proxy the quality of innovation by the number of patents, the number of new patent applications, and the number of citations for all and newly obtained patents. For the total number of patents, we use the stock of patents held by each firm in each year. We utilize the application year of the patent to identify the number of new patent applications in year t. The total number of patents and total patent citations may indicate how innovative the firm has been historically, while new patent applications and citations of the newly obtained patents may proxy for changes in the quality of innovative output. We use these indicators as alternative outcome variables in the DID estimations. We summarize the results in Table 3. In columns 1-4, we examine the effect of the reform on the number and citations for firms' total patents. In columns 5-6, we examine the number and citations for new patents.

The estimated coefficients are positive across all columns, and we find a stronger effect for new patents. This evidence suggests that service firms not only increased R&D expenditures, but they also improved the quality of innovation activities significantly when facing a stronger market demand after the B2V reform. This is especially true for the quality of new patents, which further indicates an improvement in innovation quality. In Figure 2, we plot the dynamic effects of the B2V reform on service firms' patenting activities. Consistent with the DID estimates in Table 3, we find a parallel trend between the treated and control groups before the B2V reform, and a gradual increase in the number of patents and citations for the treated firms since the reform.

What can explain the improvements in the quality of innovations that we observe for service firms? First, following the B2V reform, service firms that have invested more in R&D, may have a higher chance of making breakthrough discoveries. Second, as the demand for their services grows, market competition may intensify, providing stronger incentives for service firms to enhance the quality of their innovations. Both of these explanations are consistent with the "demand-pull" theory for R&D, which was originally proposed by Schmookler (1962, 1966).

5.3 Which service firms benefit more?

We then examine which types of treated service firms benefit most from the B2V reform. We focus on heterogeneity in terms of firm size, measured by the natural logarithm of firms' total assets before the reform. We set a dummy $Large_i$ that is equal to 1 when a firm's size is above the sample median. Then, we interact $Large_i$ with $Service_i \times Post_i$, and include this term as an additional regressor in the DID estimations. We report the triple DID estimation results in Table 4.

We find that larger service firms generally benefit more from the reform. Specifically, the increase in sales (column 1), employment (column 3), and wages (column 4) is significantly larger for larger service firms in the triple DID estimations. We also show that R&D investment increased more for larger service firms, although the triple DID estimate is not statistically significant (column 2). Further, in column 5, we find that only larger service firms experienced a significant increase in the quality of innovation after the reform, measured by the number of new patent applications. Overall, results in Table 4 indicate that the B2V reform mainly benefited larger service firms, possibly due to their larger market power or their ability to be competitive in this market. We also tested the potential heterogeneous impact of the B2V reform across other firm characteristics, such as the quality of innovation

before the reform. However, we do not find any significant differences in responses between firms in these other dimensions.

5.4 Results based on tax survey

One concern is that listed firms are different from the rest of the firms in the economy and that the B2V reform may have affected firms across the size distribution differently. In this section, we use the National Tax Survey Data (NTSD) to assess whether our baseline results can be generalized.

As mentioned in Section 4.1, one problem with the NTSD is that the data is unconsolidated and does not distinguish between standalone firms and subsidiaries that belong to a firm group. While the NTSD does not provide any ownership information, we can link some of the NTSD firms with the Bureau van Dijk Orbis data that provides information on ownership structures for Chinese firms. Specifically, we first identify Chinese parent firms and their subsidiaries in Orbis.[16] Next, we identify all subsidiaries of the Chinese parent firms, as reported in Orbis. We then match the NTSD with the Orbis to identify these parent and subsidiary firms in the NTSD, based on firm names. Using this method, we identify around 8% of NTSD firms that belong to a corporate group and we classify the remaining NTSD firms as standalones. There are two caveats with this method. First, the coverages of Orbis and the NTSD are different, and we can only use firm names for a fuzzy matching across the datasets. Hence, it is possible that we fail to match an NTSD firm with Orbis due to different coverage and consequently, misclassify an unmatched NTSD firm as a standalone when it is not. Second, we only have firms' ownership information available for the most recent year and hence, there is considerable noise in the data matching process given that firms' ownership structure may change over time.[17] With these caveats, to examine the effects of the B2V reform based on the NTSD, we focus on standalone NTSD firms that we identify using this method, which is likely to reduce some of the potential estimation bias we discuss in Section 4.1.

In Table B1, we report the estimation results based on Equation 11 using the NTSD. Column 1 of Table B1 suggests that sales increased by around 7.5% among treated service firms relative to the less-connected manufacturing firms. Compared with listed firms, the NTSD firms report a large number of zero R&D expenditures. Thus, to examine the impact

[16]We define a firm as a Chinese parent firm if it is the Global Ultimate Owner in Orbis and it is located in mainland China.

[17]For the majority of firms in Orbis, the ownership information is collected in 2022.

of the B2V reform on R&D investment using the NTSD, we use the level of R&D investment as the outcome variable in Equation 11 and estimate it by the Ordinary Least Squares (OLS) estimator in column 2. As a robustness check, and following (Chen and Roth, 2023; Mullahy and Norton, 2023), we use the Poisson estimator in column 3. In both columns, we find a positive and significant impact of the reform on firms' R&D investment. Based on the Poisson estimation, the B2V increased treated service firms' R&D investment by around 15%. The NTSD data also allows us to estimate the effect of the B2V reform on the extensive margin of R&D investment (column 4). We are unable to examine this margin using the sample of listed firms, where only a small number of firm-year observations report zero R&D investment. Column 4 indicates that following the B2V reform, treated service firms became around 2% more likely to conduct R&D investment. In column 5, we show that employment of treated service firms increased by around 7% based on the NTSD data.[18] Figure B1 reports the corresponding dynamic effects using the NTSD, which shows that the parallel trend assumption is largely satisfied, except for employment.

We find a smaller increase in service firms' sales, R&D investment, and employment using the NTSD sample, compared with estimates in Table 2. There are two potential explanations for this. First, as discussed in Section 4.1, using the NTSD is likely to introduce a downward bias for the effects of the B2V reform on these outcome since we may mix independent service firms with service subsidiaries of manufacturing firms. Second, smaller firms may be less responsive to the B2V reform. In fact, in Figure B2 we show that based on the NTSD, across quintiles of firm size distribution measured in 2011, the response of service firms' R&D expenditures to the reform tends to be larger for large firms. Despite this difference, the results based on the NTSD are qualitatively consistent with those based on listed firms' data.

6 Testing the channels

6.1 Outsourcing

Our conceptual framework indicates that removing tax cascading should lead to higher demand for the products of service firms. We already show that the customer concentration for treated service firms declined after the B2V reform, which suggests an expansion of their customer base and points towards increased outsourcing. To directly test the outsourcing

[18]The NTSD does not report total wages.

effect, ideally we should examine whether the share of inputs purchased from service firms in total inputs used by manufacturing firms increased after the B2V reform. Unfortunately, we do not observe this variable. However, starting in 2011, the NTSD reports the amount of outsourced services in the following categories: R&D and technical services, information technology services, cultural and creative services, logistics support services, tangible movable property leasing services, and forensic consulting services.[19] In Panel A of Figure C2, we plot the pre-reform average amount of outsourced services by categories for the more and less connected manufacturing firms. In Panel B, we plot the percentage of firms that reported a positive amount of outsourced services across different categories before the reform. Consistently across all categories, we find that more connected manufacturing firms outsourced more services before the reform. By comparing outsourced services by more connected manufacturing firms to those by less connected manufacturing firms before and after the B2V reform, we can shed light on how the reform influences manufacturing firms' sourcing decisions.

We start by plotting the total amount of outsourced services, aggregated across the six categories, for more- and less-connected manufacturing firms in Figure 3. We use the year of the reform as the benchmark and normalize the total amount of outsourced services to zero in that year to capture at least one pre-reform year. Figure 3 shows that while both types of manufacturing firms increased outsourcing one year after the reform, this increase is more pronounced for more connected manufacturing firms. We observe a similar pattern for most categories of outsourced services, as shown in Figure C3. These figures provide graphical evidence for the outsourcing channel, as outlined in Propositions 1 and 2.

To quantify the magnitudes of the outsourcing effect, we use the difference-in-differences approach and estimate Equation 12 by comparing outsourcing activities between more and less connected manufacturing firms based on the NTSD. Note that only 13% of more connected, and 11% of less connected manufacturing firms in the NTSD report a positive amount of outsourced services, leaving a large number of zero in the data. To tackle this issue, we use the level of outsourced services as the outcome variable rather than taking the log of this variable.[20] We present the OLS estimation results based on this specification in Table 5. Across different columns, the point estimates on the interaction term $MoreConnected \times Post$ are positive and statistically significant. Based on column 7, we conclude that more-connected manufacturing firms increased the outsourcing of services by around 6% (=95/1624) after

[19]This roughly corresponds to the six reformed modern service industries as listed in Panel A of Table 1.
[20]The unit for outsourced services is 1,000 RMB

the reform, relative to the control group.[21] Broadly, these results suggest that following the reform, manufacturing firms increased outsourced services and this is likely to be the main driver of the observed increases in sales, employment, and R&D investment among treated service firms.

6.2 Tax burden and price changes

Since the VAT is imposed on a narrower base than the BT, the B2V reform may lower the tax burden for service firms if they have a non-trivial amount of deductibles. While the VAT rates for the reformed service industries are set to be higher than the BT rates (Panel B, Table 1), the government chose these rates to ensure the tax burden of each reformed industry would, in principle, not increase.[22] Nevertheless, if the reform did result in a lower tax burden for treated service firms, this may encourage the service firms to set a lower price for their products. Consequently, the quantity of goods sold would increase, if demand is elastic. A lower tax burden may also relax service firms' financial constraints, potentially leading to more investment and employment.

We use our baseline empirical strategy to examine these alternative channels, using the sample of listed firms, and report the estimation results in Table 6. In columns 1 and 2, we consider the effects of the B2V reform on service firms and in columns 3-8, we consider the effects of the B2V reform on manufacturing firms. In column 1, we use firms' tax burden, which is the sum of BT and VAT paid scaled by total assets, as the outcome variable. Relative to the control group, we do not find any significant change in treated service firms' tax burden. This is consistent with our assumption that treated service firms tend to be labor-intensive and have limited input deductibles for VAT purposes. As the service firms' tax burden does not change, we expect to observe limited changes in their product prices. In column 2, we use the product-level export price (in logs), for each firm as the dependent variable and run the regression at the product-firm-year level including product fixed effects. We find no effect of the reform on product-level prices of service firms, with the coefficient on the interaction term being small and insignificant. These null effects are also supported by graphical evidence in Panels A and B of Figure 4. Based on these results, we can rule out that the changes in service firms' sales, R&D investment, and employment are caused

[21] In Table C5 in the Appendix, we use the Poisson estimator instead and continue to find very similar effects.

[22] It remains controversial whether firms' tax burden declined after the B2V. Some firms reported increased tax burden after the reform, as illustrated by this media report: https://www.chinadaily.com.cn/bizchina/2014-07/30/content$_1$8207183.*htm*.

by changes in their tax burden or product prices.

The B2V reform could also affect the tax payments of manufacturing firms. In particular, more connected manufacturing firms, already purchasing a larger share of intermediate goods from service industries, should experience a reduction in their tax burden after the B2V reform since they now can claim deductions on such input purchases. As our theoretical model predicts (see, Corollary 2), this reduction in tax burden may lead to lower prices of the final consumer products, possibly generating a higher demand for both manufacturing firms and service firms. We examine these effects in columns 3-8 of Table 6, where we compare the more connected manufacturing firms with the less connected ones. Consistent with our hypothesis, column 3 shows a relative 0.2 percentage point drop in tax burden for the more connected manufacturing firms after the reform, which is statistically significant at the 1 percent level. Compared with the mean tax-asset ratio before the reform, this translates into a 6.7% reduction in tax burden.[23]

It is then interesting to examine whether the lower tax burden affects the pricing and sales of the more connected manufacturing firms. In column 4, we fail to identify any significant change in the prices of goods exported by the more connected manufacturing firms. In column 5, we further use the producer price indices for more and less connected manufacturing industries, based on the official statistics provided by the National Bureau of Statistics. Again, we find no change in the aggregated price index for the more-connected manufacturing industries after the B2V reform. Graphical evidence from Panels C-D in Figure 4 lends further support to these findings. In column 6, we directly compare the sales of the more and the less connected manufacturing firms and fail to find a significant difference between them. Instead, we find that more connected manufacturing firms increased their profits (proxied by earnings before corporate income tax, column 7) and reduced their costs of production (column 8). Taken together, these results suggest that while the more connected manufacturing firms experienced a tax reduction, this helped them reduce the costs and increase profits, rather than translated into an increase in sales or a reduction in product prices. Therefore, it is unlikely that this tax reduction would result in any trickle-down impact on the demand for service firms.

[23]The pre-reform average tax burden as a ratio to total assets for the more connected manufacturing firm is 3%.

6.3 Other explanations

In this section, we discuss further alternative explanations for the observed increase in the service firms' sales, R&D investment, and employment. We summarize the results of this analysis in Table 7.

6.3.1 The role of financial constraints

We start by looking at the role that financial constraints play in our setting. As the B2V reform significantly increased sales for service firms, this in principle could enhance the liquidity of financially constrained service firms. If our baseline results are driven by the relaxation of financial constraints, we should observe a stronger increase in R&D investment and employment among financially constrained service firms. To test this we conduct heterogeneity analysis, using two alternative proxies for financial constraints: 1) the dividend payout ratio, defined as dividend per share relative to net asset per share, averaged across years before the B2V reform; and 2) the investment rating by financial analysts, averaged across years before reform. Arguably, firms with a higher dividend payout ratio are less likely to be constrained. Firms with a better investment rating by analysts may also find it easier to raise external financing.

We present the results in columns 1 - 4 of Table 7, where we interact $Service \times Post$ with dummies $More\ constrained_i$ to indicate firms with the above-median dividend payout ratio (columns 1 and 3) and firms with above-median investment rating (columns 2 and 4), both before the reform. We estimate the triple DID model using both R&D investment and employment as the outcome variables. In all columns, we find that the estimated coefficients on the interaction terms are statistically insignificant for both outcome variables. These results imply that the increase in service firms' R&D investment and employment is unlikely to be driven by liquidity improvement.

6.3.2 Changes in the cost of capital

Next, we consider the role of the cost of capital, since the B2V reform could have lowered the cost of capital for R&D investment for service firms. This is because before the reform, service firms could not deduct inputs for the BT, but can claim input VAT after the reform. However, if the majority of the R&D expenditures are in the form of wages, the reform should have a limited impact on the cost of capital for R&D investment, as we argue previously. On the other hand, if the change in the cost of capital is important, we should observe a larger

response among service firms spending more on R&D-related equipment and less on R&D personnel.

To examine the importance of the cost of the capital channel, we hand-collect R&D personnel wage for each service firm in our sample from the annual financial statements and then calculate the ratio of R&D personnel wage to total R&D expenditures for each service firm.[24] On average, more than 70% of R&D expenditures of treated service firms in our sample went into wage. This suggests that the majority of the R&D expenditures for a typical service firm were not deductible against the VAT after the B2V reform. We then construct an indicator variable called *Highlabor*, which equals 1 for a firm if its ratio of R&D personnel wage to total R&D expenditures is above the sample median. We interact this indicator with $Service \times Post$, and present results for R&D investment and employment in columns 5 and 6 in Table 7. We find that firms that spent a larger proportion of their R&D expenditures on wages did not respond differently from those that spent less. Thus, changes in the cost of capital are unlikely to drive the observed increase in R&D investment and employment among service firms.

6.3.3 R&D relabeling

Alternatively, firms could manipulate their financial statements, for example by relabeling, to qualify for certain tax benefits (Chen et al., 2021). Given the wide range of R&D tax incentives available during our sample period that we discuss in Section 2, firms may have strong incentives to engage in relabeling. However, there is little reason for service firms to engage in such manipulation more than manufacturing firms. The B2V reform is also unlikely to trigger R&D relabeling since it does not target R&D investment per se. Moreover, if service firms did increase relabeling after the B2V reform for other unknown reasons, we should find a significant reduction in their non-R&D investment after the reform. As Table 2 shows, the estimated treatment effect on service firms' non-R&D capital expenditures is positive, albeit insignificant. All of these suggest that the increase in R&D investment by service firms is unlikely to be caused by relabelling.

6.3.4 Compliance

Under the BT regime, service firms are more likely to under-report revenue to evade the business tax. Consequently, increasing tax compliance is one of the benefits of introducing

[24]Since Chinese listed firms were not required to disclose this data before 2015, we can only collect this information for years 2017 and 2018.

the VAT (Morrow et al., 2022; Pomeranz, 2015). When service firms switch to the VAT regime, they may face stricter monitoring by both the tax authority and the downstream firms. This is likely to increase their reported sales. However, our baseline estimation results are unlikely to be driven by improved compliance for the following three reasons. First, the literature suggests that smaller firms tend to have a lower degree of tax compliance than larger ones. If this is true, the increase in sales should be more prominent among smaller service firms. This is inconsistent with our empirical evidence. In column 1 of Table 4, we show that the sales increase is more prominent among larger service firms. Second, if compliance is the driving factor, we should not observe increases in firms' real activities, such as R&D investment or employment. Third, better compliance should be reflected in a larger tax burden, which in turn should negatively affect service firms' investment and employment. The null impact on service firms' tax burden, as shown in column 1 of Table 6, provides further evidence against the compliance channel.

7 Conclusions

Turnover taxes cause production distortions due to tax cascading. In particular, they lead to inefficient vertical integration and misallocation of resources. In this paper, we examine how the removal of turnover taxes affects the supply chain and firm performance, by investigating China's transition from the business tax to the value-added tax as a quasi-natural experiment. We find that service firms moving from business tax to the value-added tax significantly increased sales, R&D investment and employment. We provide evidence that these effects are mainly driven by an increase in outsourcing from manufacturing firms. Such reallocation also improves the quality of innovation for affected service firms.

This paper improves our understanding of the negative impact of turnover taxes imposed on supply chains and contributes to the debate on future tax reforms. For example, in the U.S., the state sales tax system derives a large proportion of its revenue from taxing business purchases of intermediate goods and services.[25] There are also proposals to expand the state sales tax base to cover a wide range of services since the overall proportion of services in the U.S. relative to the sales of tangible goods has been growing. Our study implies that such proposals would exacerbate distortions associated with sales tax, unless states can provide adequate exemptions for inputs purchased by businesses.

[25] According to Phillips and Ibaid (2019), over 41% of state and local sales tax revenues came from those on business inputs in 2017.

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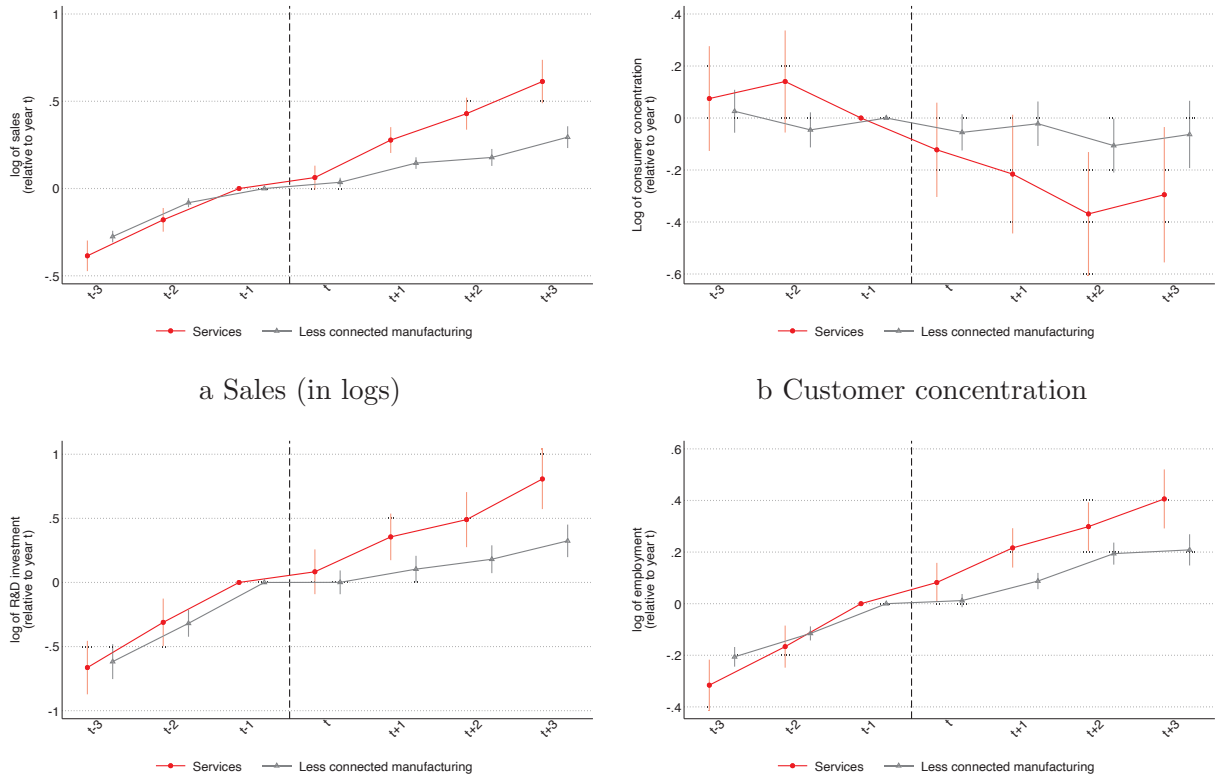
Figure 1: Dynamic effects of the B2V reform



a Sales (in logs)

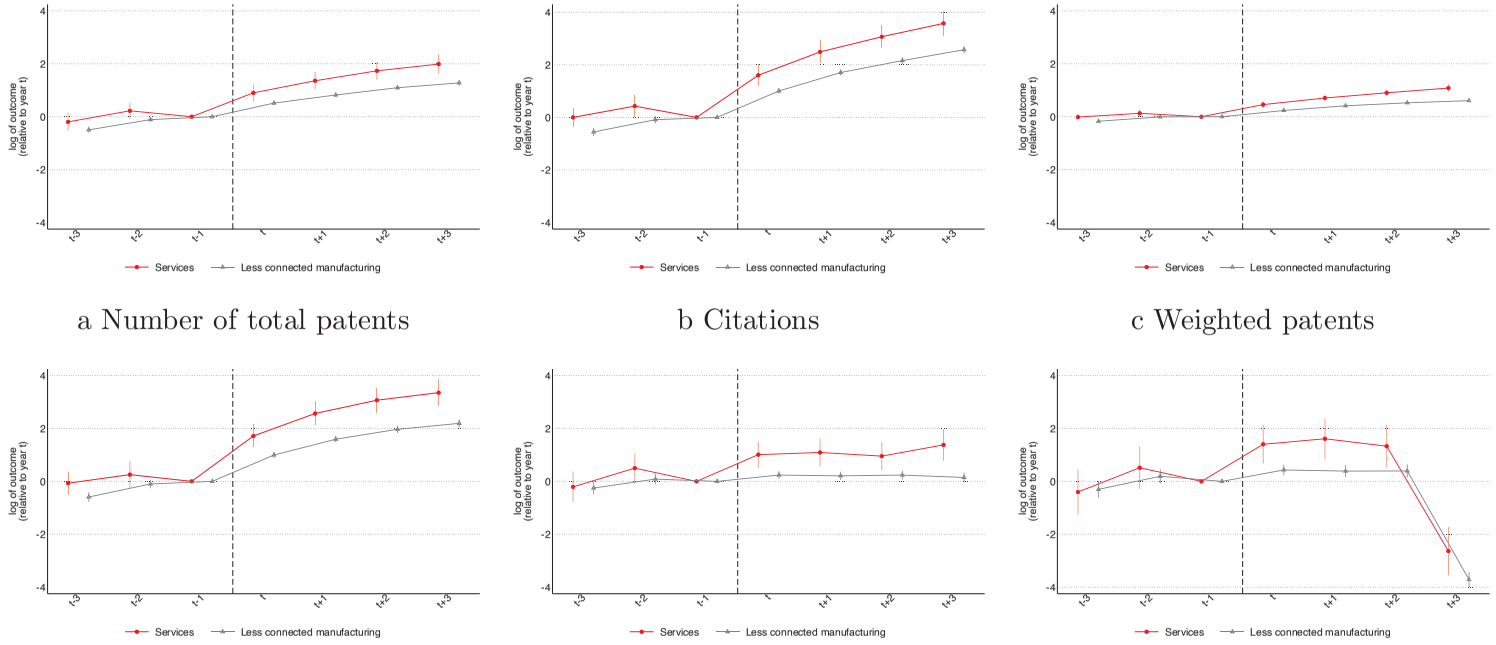
b Customer concentration

c R&D investment (in logs)

d Employment (in logs)

Note: This figure reports the dynamic effects of the reform on sales (panel a), customer concentration (panel b), R&D expenditures (panel c), number of employees (panel d), wages (panel e), and capital expenditures (panel f). We use year t=-1 as the benchmark. For each outcome variable, we plot the estimated difference in that outcome between each year and the benchmark year, for the treatment (red filled dots) and control groups (grey hollow diamonds), up to three years before and three years after the reform. We control for year and firm-level fixed effects when estimating these differences. The vertical bars represent the 95% confidence intervals. The treated group consists of listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of all manufacturing firms. Standard errors are robust and clustered at the firm level.

Figure 2: Dynamic effects of the B2V reform on patent quality



a Number of total patents

b Citations

c Weighted patents

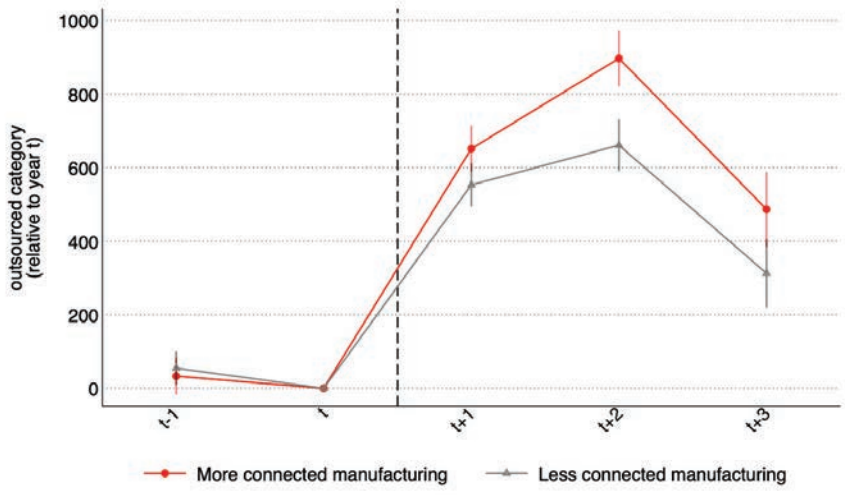
d 5-year citations

e Number of new patents

f 5-year citations for new patents

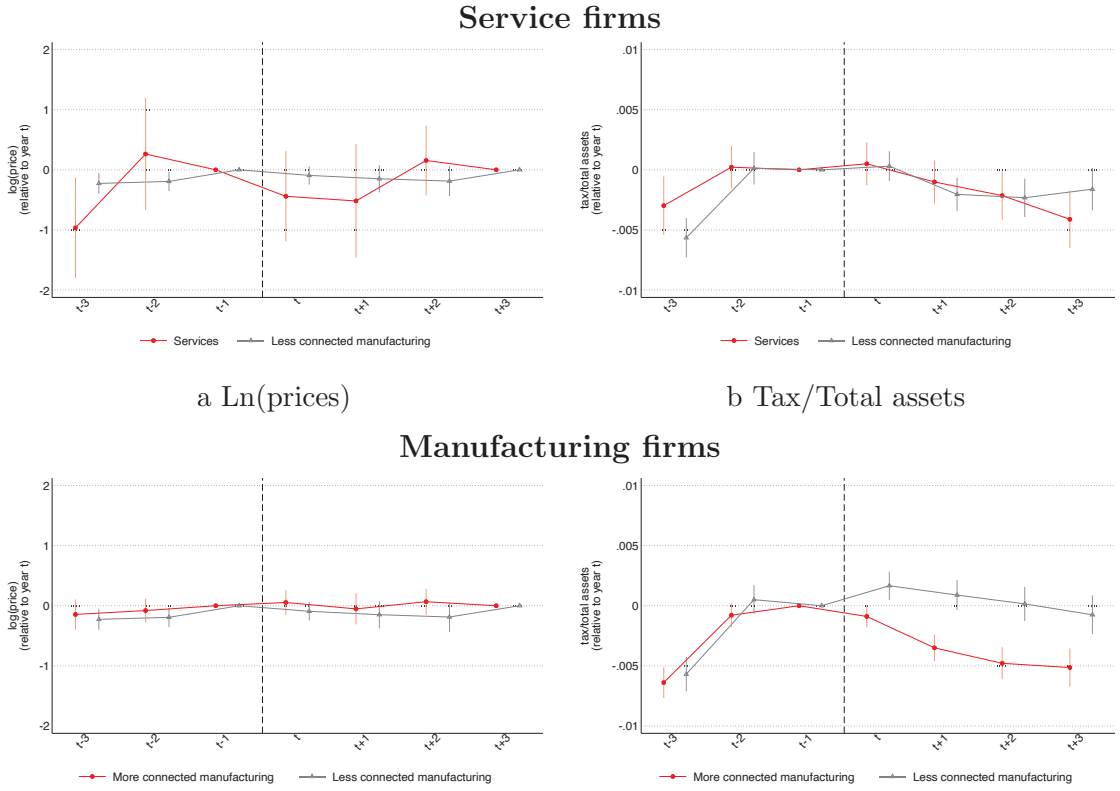
Note: This figure reports the dynamic effects of the reform on sales (panel a), customer concentration (panel b), R&D expenditures (panel c), number of employees (panel d), wages (panel e), and capital expenditures (panel f). We use year t=-1 as the benchmark. For each outcome variable, we plot the estimated difference in that outcome between each year and the benchmark year, for the treatment (red filled dots) and control groups (grey hollow diamonds), up to three years before and three years after the reform. We control for year and firm-level fixed effects when estimating these differences. The vertical bars represent the 95% confidence intervals. The treated group consists of listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of all manufacturing firms. Standard errors are robust and clustered at the firm level.

Figure 3: The impact of the B2V reform on outsourcing



Note: This figure plots the dynamic effects of the B2V reform on the total amount of outsourced services using the NTSD data. We use the year before the B2V reform (t=-1) as the benchmark. We plot the estimated difference in that outcome between each year and the benchmark year, for the more-connected (red-filled dots) and the less-connected manufacturing firms. We measure connectedness using the 2012 US input-output tables. We control for year and firm-level fixed effects when estimating these differences. The vertical bars represent the 95% confidence intervals. Standard errors are robust and clustered at the firm level.

Figure 4: Alternative mechanisms: changes in prices and tax burden



a Ln(prices) b Tax/Total assets

c Ln(prices) d Tax/Total assets

Note: These figures plot the dynamic effects of the reform on firms' export prices at the product level and tax burdens. We use the year before the B2V reform (t=-1) as the benchmark. For each outcome variable, we plot the estimated difference in that outcome between each year and the benchmark year, for the treatment (red-filled dots) and control (gray-filled dots) groups, up to three years before and three years after the reform. In panels a and b, we compare service firms with the less-connected manufacturing firms. In panels c and d, we compare more connected manufacturing firms with less connected ones. Panel a results correspond to column (1) in Panel A of Table 6, Panel b results to column (2) in Panel A, Panel c results to column (1) in Panel B, and Panel d to column (2) in Panel B. We measure connectedness using the 2012 US input-output tables. We control for year and firm-level fixed effects when estimating the effects on taxes and for year, firm and product fixed effects when estimating the effects on prices. The vertical bars represent the 95% confidence intervals. Standard errors are robust and clustered at the firm level.

Table 1: B2V reform: timeline and reformed industries

Panel A: timeline of the reform

Reformed industries	Regions	Implementation date
Transportation and six service industries (R&D and technical services, IT services, cultural and innovation services, logistics auxiliary services, attestation and consulting services, and tangible assets leasing services)	Shanghai	2012.01.01
	Beijing	2012.09.01
	Jiangsu	2012.10.01
	Anhui	2012.10.01
	Fujian	2012.11.01
	Guangdong	2012.11.01
	Hubei	2012.12.01
	Tianjin	2012.12.01
	Zhejiang	2012.12.01
	Nationwide	2013.08.01
Postal service, rail transportation	Nationwide	2014.01.01
Telecommunication	Nationwide	2014.06.01
Real estate, construction, finance, and other services	Nationwide	2016.05.01

Panel B: tax rates across industries

Industry name & code	BT rate	VAT rate[26]
Railway transportation, G53	3%	11%
Road transportation, G54	3%	11%
Water transportation, G55	3%	11%
Air transportation, G56	3%	11%
Portage and transportation agency, G58	3%	6%
Warehousing, G59	5%	6%
Telecomms, broadcast TV and satellite transmission services, I63	5%	6%
Internet services, I64	5%	6%
Software and information technology services, I65	5%	6%
Leasing, L71	5%	11% or 17%[27]
Business services, L72	5%	6%
Research and experimental development, 73	5%	6%
Professional technical services, M74	5%	6%
News and publication, R85	5%	6%
Radio, television, film and recording production, R86	5%	6%
Culture and art, R87	5%	6%

Note: Panel A of this table outlines the waves of the B2V reform across different industries and regions. Panel B of this table reports the business tax rate and the VAT rate (since the B2V reform) for the reformed industries in our sample. The B2V reform provides a general guide for industries that are subject to the reform (as in Panel A). We therefore match industries for listed firms, as provided by the China Securities Regulatory Commission, with those outlined by the policy guideline.

[26]These were VAT rates applicable by June 1st, 2017. The VAT rates were reduced for certain industries in later years.

[27]The VAT rate is 17% for movable property leasing and 11% for immovable property leasing.

Table 2: Baseline result: Impact of the B2V reform on firm performances

	(1) Ln(Sales)	(2) Ln(Conctr)	(3) Ln(Capex)	(4) Ln(R&D)	(5) Ln(Empl)	(6) Ln(Wage)
$\text{Service}_i \times \text{Post}_{i,t}$	0.219***	-0.073**	0.048	0.183***	0.174***	0.106***
	(0.044)	(0.030)	(0.111)	(0.066)	(0.044)	(0.037)
Year FE	✓	✓	✓	✓	✓	✓
Firm FEs	✓	✓	✓	✓	✓	✓
Observations	5597	4996	4212	3851	5591	5584
# firms	667	934	881	847	967	967
Mean	21.245	3.055	18.504	17.526	7.627	18.896

Note: This table reports the estimated effects of the B2V reform on treated service firms' sales (column 1), customer concentration (column 2), capital expenditures (column 3), R&D expenditures (column 4), number of employees (column 5) and wages (column 6). We define each of those variables in Appendix A. The treated group consists of listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of less connected manufacturing firms. We define less connected firms according to the median level of connectedness, measured using the 2012 US input-output tables. Standard errors are robust and clustered at the firm level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table 3: Quality of innovation

	(1)	(2)	(3)	(4)	(5)	(6)
	Total patents				New patents	
	No. of patents	Citations	Weighted patents	5-year citations	No. of patents	5-year citations
$\text{Service}_i \times \text{Post}_{i,t}$	0.184*	0.203	0.157***	0.430***	0.564***	0.839***
	(0.101)	(0.141)	(0.042)	(0.162)	(0.161)	(0.226)
Observations	3538	3758	3758	3758	3758	3672
# firms	808	821	821	821	821	811
Mean	3.528	2.617	0.666	3.058	2.858	3.496
Year FE	✓	✓	✓	✓	✓	✓
Firm FEs	✓	✓	✓	✓	✓	✓

Note: This table reports the estimated effects of the B2V reform on treated firms' innovation quality. In Columns 1-4 we consider total patents owned by firms and in columns 5-6 we consider new patent applications. The outcome variable is the number of patents in columns 1 and 5, the number of citations in column 2, the weighted patents in column 3, and the number of citations during the first 5 years since a patent is granted in columns 4 and 6. All outcome variables are in natural logarithms. The treated group consists of listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of less connected manufacturing firms. We define less connected firms according to the median level of connectedness, measured using the 2012 US input-output tables. Standard errors are robust and clustered at the firm level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table 4: Which service firms benefit more?

	(1) Ln(Sales)	(2) Ln(R&D)	(3) Ln(Empl)	(4) Ln(Wage)	(5) Ln(No. of patents)
$\text{Service}_i \times \text{Post}_{i,t}$	0.106	0.077	0.023	0.111**	-0.077
	(0.075)	(0.088)	(0.064)	(0.052)	(0.129)
$\text{Service}_i \times \text{Post}_{i,t}$	0.230**	0.159	0.197**	0.148**	0.451**
$\times \text{Large}_i$	(0.096)	(0.105)	(0.084)	(0.066)	(0.177)
Observations	3851	3851	3847	3840	3538
# firms	847	847	846	846	808
Mean	21.125	17.526	7.554	18.845	3.528

Note: This table reports the estimated effects of the reform for service firms with different sizes. $Large_i$ equals 1 if the treated firm's total assets before the reform (in logs) are above the sample median. We present results for the following outcome variables sales (column 1), R&D expenditures (column 2), number of employees (column 3), wages (column 4),and the number of patents (column 5). In all regressions, we use the sample of listed firms from CSMAR. The treated group consists of listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of less connected manufacturing firms. We define less connected firms according to the median level of connectedness, measured using the 2012 US input-output tables. Standard errors are robust and clustered at the firm level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table 5: Main mechanism: outsourcing

	(1) R&D and technical	(2) IT	(3) cultural and creative	(4) logistics support	(5) tangible movable property leasing	(6) forensic consulting	(7) Total
$\text{Connected}_i \times \text{Post}_{i,t}$	36.174**	1.677*	20.169**	27.713***	2.579*	5.858**	95.890***
	(14.524)	(1.009)	(9.711)	(8.388)	(1.335)	(2.942)	(35.208)
Observations	185282	173148	191593	186304	160385	190091	250292
# firms	65,060	61,078	67,077	65,102	56,339	66,277	85,740
Mean	517.534	25.644	304.628	322.346	27.865	106.937	1624.448
Year FE	✓	✓	✓	✓	✓	✓	✓
Firm FEs	✓	✓	✓	✓	✓	✓	✓

Note: This table reports the estimated effects of the B2V reform on more connected manufacturing plants' R&D outsourcing using the NTSD. The dependent variable is the level of outsourced services across six different categories in columns 1-6, respectively: research and development and technical services, information technology services, cultural and creative services, logistics support services, tangible movable property leasing services, and forensic consulting services. In column 7, we add up outsourcing across all service categories. We estimate the effect of the reform on outsourcing using the OLS estimator. $Connected_i$ is a dummy that equals 1 for manufacturing firms that are more exposed to the service sector. The control group consists of less exposed manufacturing firms. We define less connected firms according to the median level of connectedness, measured using the 2012 US input-output tables. Standard errors are robust and clustered at the firm level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table 6: Effects of the B2V reform on tax burden and product prices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Service firms		**Manufacturing firms**					
	tax/assets	log(price)	tax/assets	log(price)	log(price index)	log(sales)	log(EBT)	log(costs)
$Service_i \times Post_{i,t}$	-0.001	0.017						
	(0.001)	(0.393)						
$MoreConnected_i \times Post_{i,t}$			-0.002***	-0.006	-0.008	0.003	0.079*	-0.048**
			(0.001)	(0.073)	(0.020)	(0.026)	(0.042)	(0.024)
Observations	5342	22160	9961	76445	20	10369	9489	10367
# firms	951	438	1,810	996		1,827	1,807	1,827
Mean	0.031	3.357	0.031	3.012	4.679	21.347	18.734	20.991
Year FE	✓	✓	✓	✓		✓	✓	✓
Firm FEs	✓	✓	✓	✓		✓	✓	✓
Product FEs		✓		✓				

Note: This table reports the estimated effects of the reform on tax burden and prices for service firms (columns 1 and 2) and on tax burden, prices, sales, profits (proxied by earnings before corporate tax, EBT), and total production costs for more connected manufacturing firms (columns 3-8). The dependent variable is ratio of tax paid (the sum of BT and VAT) to total assets in columns (1 and 3), the logarithm of product price in columns (2 and 4), logarithm of price index in column (5) logarithm of sales in column (6), logarithm of earnings before tax in column (7) and logarithm of total production costs in column (8). In columns 1, 4 and 6-8, we estimate regressions at the firm level, in columns 2 and 4, we estimate regressions at the product level, and in column 5, we estimate the regression at the industry level. In columns 1 and 2 the treated group consists of listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. In columns 3 - 8, the treated group consists of listed firms in more connected manufacturing industries. The control group consists of less-connected manufacturing firms across all specifications. We measure connectedness using the 2012 US input-output tables. The more connected group consists of listed firms in manufacturing industries that are by their business nature more connected to service firms. Standard errors are robust and clustered at the firm level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table 7: Alternative channels: financial constraints and cost of capital

Sample	(1)	(2)	(3)	(4)	(5)	(6)
	Financing constraints				Cost of capital	
	Ln(R&D)	Ln(R&D)	Ln(Empl)	Ln(Empl)	Ln(R&D)	Ln(Empl)
Service$_i$× Post$_{i,t}$	0.225*	0.198*	0.110	0.136	0.153**	0.158**
	(0.114)	(0.112)	(0.067)	(0.090)	(0.074)	(0.063)
Service$_i$× Post$_{i,t}$	0.130	0.134	0.084	0.108		
×*More constrained*$_i$	(0.105)	(0.102)	(0.056)	(0.082)		
Service$_i$× Post$_{i,t}$					0.091	-0.006
×*High labor*$_i$					(0.108)	(0.089)
Year FE	✓	✓	✓	✓	✓	✓
Firm FEs	✓	✓	✓	✓	✓	✓
Observations	2185	2355	3210	3608	3851	3847
# firms	452	497	531	597	847	846
Mean	17.642	17.600	17.634	17.587	17.536	7.554

Note: In this table, we analyze alternative explanations for the effects of the B2V reform. In columns 1-4, we examine the importance of financial constraints on R&D investment (columns 1 and 2) and employment (columns 3 and 4). In columns 1 and 3, $Moreconstrained_i$ equals 1 if the treated firm's dividend payout ratio before the reform is above the sample median. In columns 2 and 4, $More\ constrained_i$ equals 1 if the treated firm's investment rating before the reform is above the sample median. In columns 5-6, we examine the effect of changes in the cost of capital for R&D investment and employment. We interact $Service_i \times Post_{i,t}$ with a dummy $High\ labor_i$, which equals 1 if the ratio of R&D personnel wage to R&D expenditures for firm i is above the median level of all treated firms. The treated group consists of listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of less connected manufacturing firms. We define less connected firms according to the median level of connectedness, measured using the 2012 US input-output tables. Standard errors are robust and clustered at the firm level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

ONLINE APPENDIX—NOT FOR PUBLICATION, June 27, 2024
"How Distortive Are Turnover Taxes? Evidence from China" by Xing, Bilicka, Hou and Raei

A Variable definitions

Sales: firms' sales. Under the BT regime, we subtract the amount of the business tax from sales since the amount of business tax paid was included in the sales figure.
Customer Concentration: the ratio of sales to top 5 customers for each firm divided by the firm's total sales.
Capex: net increase in fixed assets
R&D: firm-level R&D expenditures.
R&D dummy: a dummy that equals to 1 when R&D investment is positive, and 0 otherwise.
Outsourced services: there are six categories of outsourced services, including outsourced R&D and technical services, information technology services, cultural and creative services, logistics support services, tangible mov- able property leasing services, and forensic consulting services. The unit of the outsourced services is 1,000 RMB.
Employment: firm-level annual total employment.
Wage: firm-level annual total wages.
Number of patents (total patents): Number of total patents that a firm owns.
Number of patents (new patents): Number of new patents that a firm apply for in a certain year.
Citations (total patents): The cumulative number of citations over all previous years for a firm's total patents
Weighted patents: Total number of patents that a firm holds weighted by the number of citations that these patents receive.
5-year citations (total patents): Number of citations received in 5 years after application for all patents that a firm owns.
5-year citations (new patents): Number of citations received in 5 years after application for new patents that a firm owns.
Tax: the sum of annual business tax and value-added tax paid by the firm. As Chinese listed firms do not disclose VAT, we follow Fang et al. (2017) to calculate the sum of the two taxes as follows. We first calculate the total turnover tax which is the sum of BT, VAT, and

consumption tax paid. We then subtract the amount of disclosed consumption tax paid from the total turnover tax. Total turnover tax is not directly disclosed. However, additional tax and fees are calculated based on the amount of turnover tax paid. Specifically, the education supplementary tax is 3% of the turnover tax, the local education supplementary tax is 2% of the turnover tax, and the urban construction tax is 5% or 7% of the turnover tax for firms in the urban areas. We follow the following three steps to obtain turnover tax paid: 1) for companies disclosing the federal education supplementary tax, we set the turnover tax to be the federal education supplementary tax divided by 3%; 2) for companies only disclosing the local education supplementary tax, we set the turnover tax to be the local education supplementary tax divided by 2%; and 3) for other companies, we use the urban construction tax divided by 6% to calculate the amount of the turnover tax.

Price: export price at the firm-product level, provided by the Chinese Customs Trade Statistics.

Price index: manufacturing industry price index, provided by the National Bureau of Statistics of China.

Size: the natural logarithm of firms' total assets.

Age: current year minus the year of firm establishment.

ROA: net profit divided by total assets.

Leverage: total debt divided by total assets.

Subsidy: the natural logarithm of all subsidies received from the government.

CIT: firm and year-specific nominal corporate income tax rate.

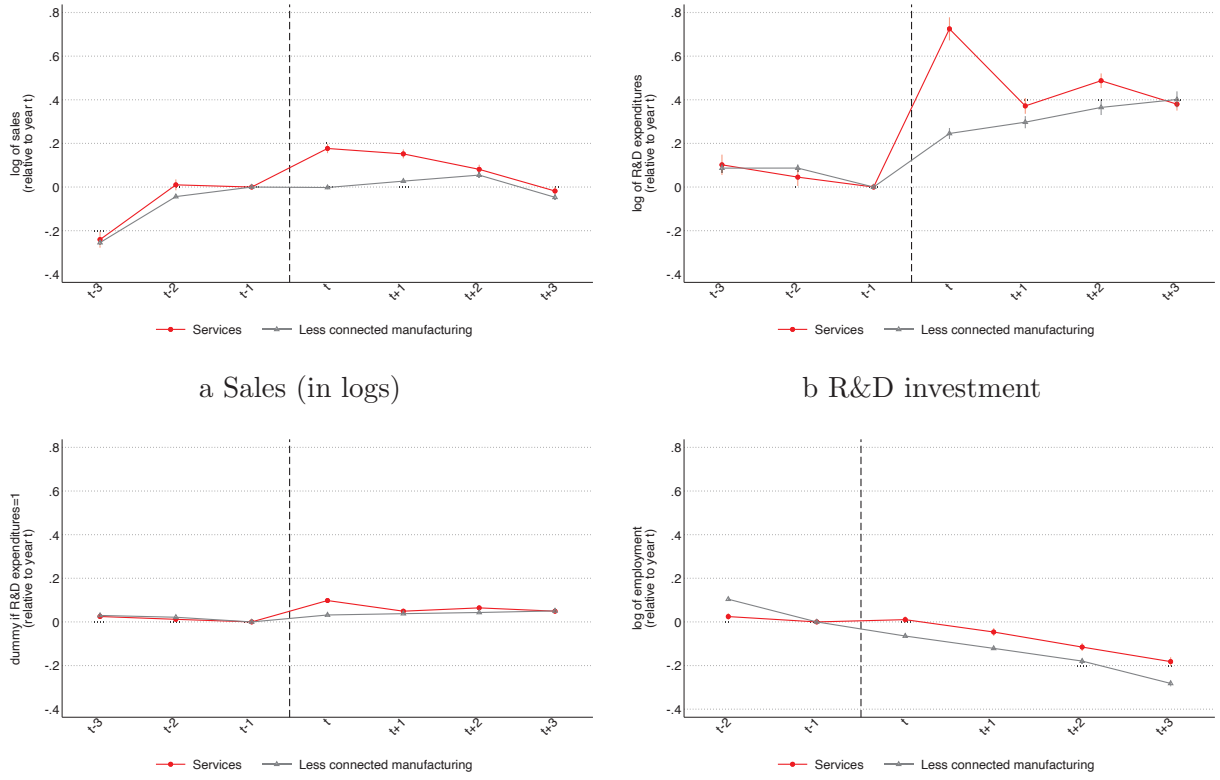
B Results based on the tax survey

Table B1: Impact of the B2V reform on firm performance: evidence from tax returns

	(1) Ln(Sales)	(2) R&D expend.	(3) R&D expendit.	(4) R&D dummy	(5) Ln(Empl)
Service$_i$× Post$_{i,t}$	0.075***	73.245***	0.155***	0.019***	0.068***
	(0.011)	(12.664)	(0.016)	(0.002)	(0.007)
Observations	382017	382017	382017	382017	382017
# firms	143,518	143,518	143,518	143,518	143,518
Mean	9.635	500.287	0.953	0.121	3.902
Year FE	✓	✓	✓	✓	✓
Plant FEs	✓	✓	✓	✓	✓

Note: This table reports the difference-in-differences estimated effects of the B2V reform on treated service firms' sales (column 1), level of R&D expenditures (columns 2 and 3), the extensive margin of conducting any R&D investment (column 4), and number of employees (column 5) based on the NTSD. In column 2, we use OLS to estimate the effect of the reform on R&D expenditures, while in column 3, we use the Poisson estimator. The treated group consists of all firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of less connected manufacturing firms. We define less connected firms according to the median level of connectedness, measured using the 2012 US input-output tables. Standard errors are robust and clustered at the firm level. In each specification, we include firm and year fixed effects. Standard errors are robust and clustered over firm. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Figure B1: Dynamic effects of the B2V reform: evidence from tax returns



a Sales (in logs)

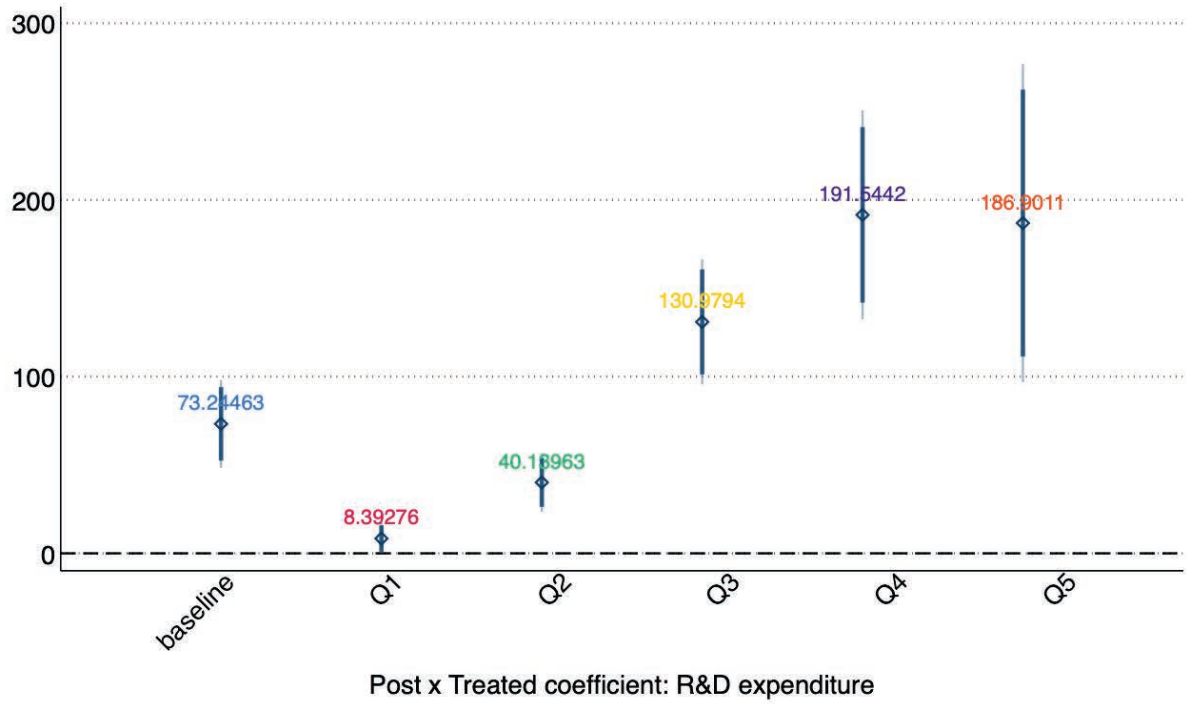
b R&D investment

c R&D dummy

d Employment (in logs)

Note: This figure reports the dynamic effects of the reform on sales (panel a), R&D expenditures (panel b), number of employees (panel c), R&D dummy (panel d), capital expenditures (panel e), and tax burden (panel f). We use year t=-1 as the benchmark. For each outcome variable, we plot the estimated difference in that outcome between each year and the benchmark year, for the treatment (red filled dots) and control groups (grey hollow diamonds), up to three years before and three years after the reform. We control for year and firm-level fixed effects when estimating these differences. The vertical bars represent the 95% confidence intervals. The treated group consists of listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of less connected manufacturing firms. We define less connected firms according to the median level of connectedness, measured using the 2012 US input-output tables. Standard errors are robust and clustered at the firm level.

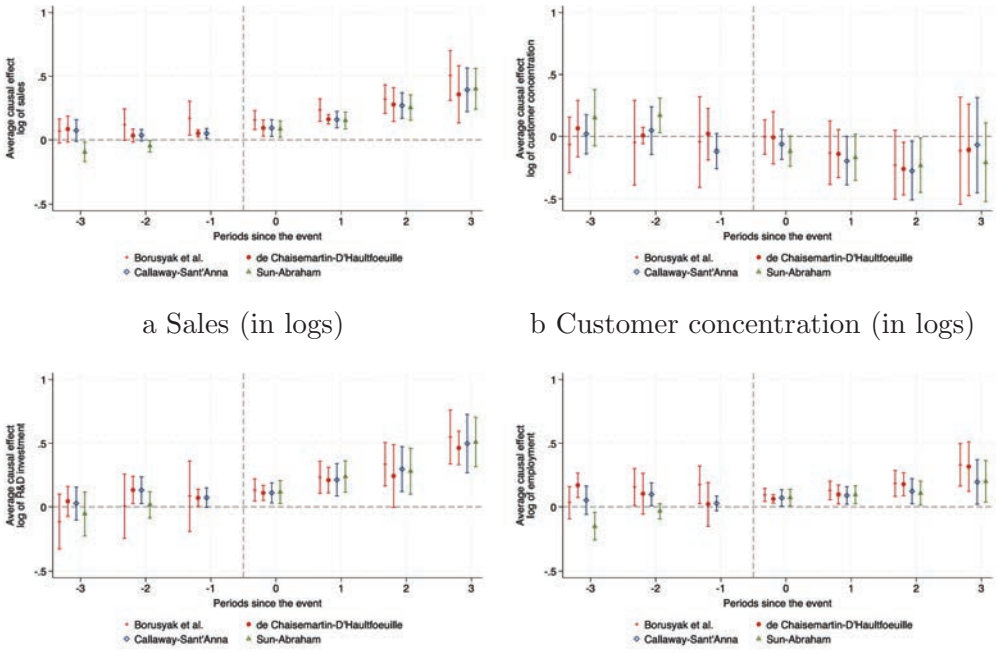
Figure B2: Distribution of the estimated effects of the B2V reform across firm size quintiles.



Note: This figure plots the distribution of the estimates effects of the B2V reform on service firms R&D across size quintiles based on the NTSD. We define size quintiles using total assets distribution as in 2011. The treated group consists of all firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of less connected manufacturing firms. We define less connected firms according to the median level of connectedness, measured using the 2012 US input-output tables. Standard errors are robust and clustered at the firm level.

C Additional figures and tables

Figure C1: Dynamic effects of the B2V reform: staggered DID corrections.



a Sales (in logs)

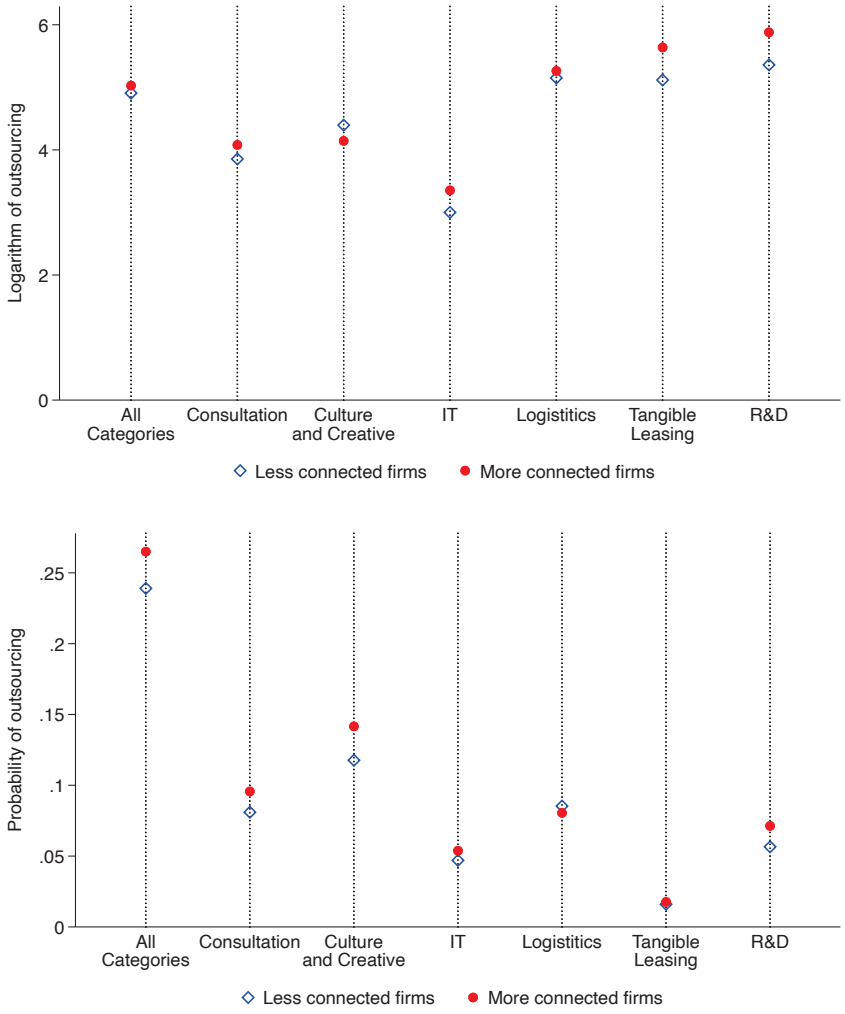
b Customer concentration (in logs)

c R&D investment (in logs)

d Employment (in logs)

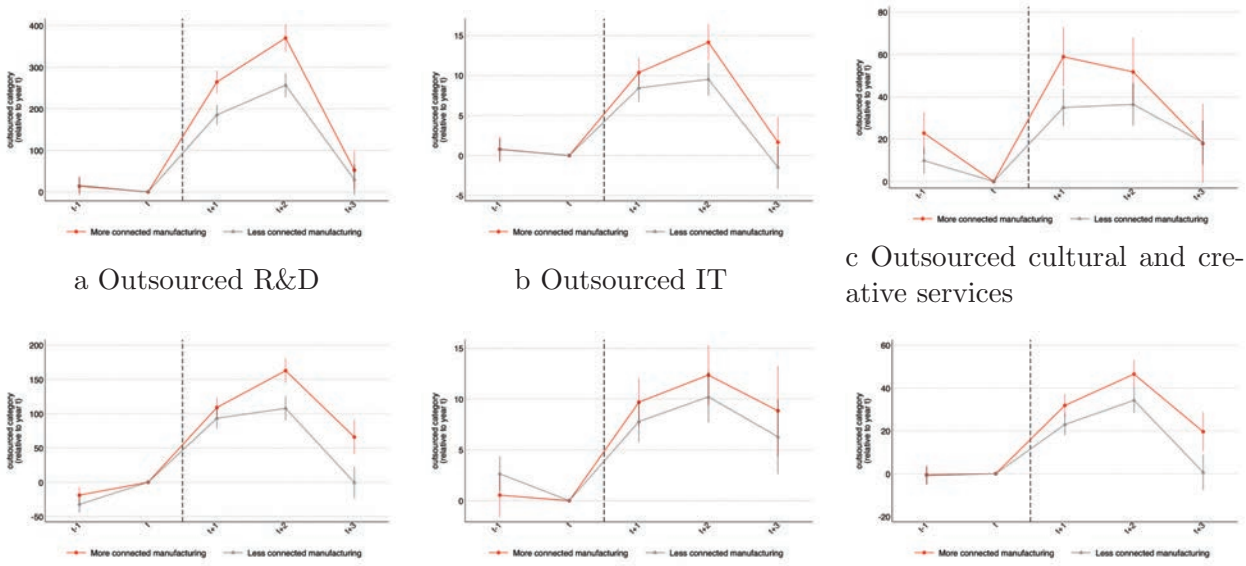
Note: This figure reports the dynamic effects of the B2V reform on treated firms' sales (Panel a), customer concentration (Panel b), R&D expenditures (Panel c), and number of employees (Panel d). All panels include the event study coefficient plots for treated firms relative to those in the control group from 3 years before the reform to 3 years after the reform. Each dot represents the coefficient estimate using different methodologies, while each vertical line represents the associated 95% confidence intervals. We control for year and firm-level fixed effects when estimating these differences. The treated group consists of listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of less connected manufacturing firms. We define less connected firms according to the median level of connectedness, measured using the 2012 US input-output tables. Standard errors are robust and clustered at the firm level.

Figure C2: R&D outsourcing patterns: more and less connected manufacturing plants.



Note: This table shows descriptive statistics for outsourced categories of manufacturing plants using tax returns data (NTSD). We measure connectedness using the 2012 US input-output tables and compare firms in the top (connected) and bottom (unconnected) 50th percentile of the distribution of this measure, respectively in columns 1 and 2. Column 3 shows the difference between the two, while column 4 the t-statistics test. For each category of outsourced services, we present results showing the logarithm of the outcome in 2011, the percentage of firms in total firms that outsourced this particular service in 2011 using Pr(category>0), and the level of each category in 2011.

Figure C3: Mechanism: outsourcing.



a Outsourced R&D

b Outsourced IT

c Outsourced cultural and creative services

d Outsourced logistics

e Outsourced tangible leasing

f Outsourced consultation

Note: These figures plot the dynamic effects of the reform on different categories of outsourcing using NTSD data. We use the year before the B2V reform (t=-1) as the benchmark. For each outcome variable, we plot the estimated difference in that outcome between each year and the benchmark year, for the treatment (red filled dots) and control groups, up to three years before and three years after the reform. Treated group is more connected manufacturing firms, while control group is less connected manufacturing firms. We measure connectedness using the 2012 US input-output tables. We control for year and firm-level fixed effects when estimating these differences. The vertical bars represent the 95% confidence intervals. Standard errors are robust and clustered at the firm level. We report corresponding coefficients from the simple difference-in-differences framework in Tables 5.

Table C1: Descriptive statistics of key variables.

	(1) Total	(2) Services	(3) More conn manuf	(4) Less conn manuf
Ln(sales)	21.140	20.776	21.277	21.261
ln(Consumer concentration)	0.243	0.463	0.617	0.184
ln(capex)	18.350	18.052	18.362	18.441
ln(R&D)	17.169	17.289	17.266	17.135
R&D intensity	0.025	0.040	0.024	0.021
R&D investment in all investment	0.428	0.739	0.393	0.351
R&D to sales ratio	0.047	0.083	0.047	0.037
log(employees)	7.505	7.272	7.522	7.583
Ln(wage)	18.689	18.789	18.712	18.656
patents owned	2.913	2.159	3.372	3.064
nb of citations	1.646	1.183	1.786	1.771
cit weighted nb patents	0.433	0.357	0.479	0.454
pat owned: 5 year citation count	2.064	1.548	2.188	2.204
patent applications	2.601	1.981	2.609	2.770
pat appl: 5 year citation count	3.430	2.657	3.419	3.650
Tax burden	17.907	17.584	17.793	18.012
tax/ total assets	0.032	0.022	0.030	0.035
Age	12.320	12.083	13.076	12.398
Size	21.692	21.706	21.786	21.687
ROA	0.054	0.064	0.047	0.051
Leverage	0.376	0.334	0.437	0.390
Subsidy	15.897	15.995	16.042	15.866
CIT	0.180	0.192	0.190	0.175
Firms	825	205	1050	620

Note: This table reports summary statistics of key variables for the treated group and the control group for a period before the reform (2009-2011). The treated group consists of listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of less connected manufacturing firms. Full sample includes both treated and control groups. For each variable, we conduct the t-test on the null hypothesis that the mean values are equal between the treated and the control groups. The associated T-statistics is reported in the last column. R&D intensity is measured by the ratio of R&D expenditures to total assets. All investment is the sum of R&D expenditures and capital expenditures. All other variables are defined in Appendix A.

Table C2: Goodman Bacon decomposition

Dep Var.		Timing groups	Never treated	Overall coefficient
Ln(Sales)	Coefficient	-0.032	0.252	0.249***
	Weights	0.010	0.990	
Ln(Conctr)	Coefficient	-0.054	0.009	-0.155***
	Weights	-0.156	0.990	
Ln(Capex)	Coefficient	-0.354	0.100	0.095
	Weights	0.010	0.989	
Ln(R&D)	Coefficient	-0.091	0.007	0.191**
	Weights	0.195	0.989	
Ln(Empl)	Coefficient	0.084	0.203	0.202***
	Weights	0.010	0.990	
Ln(Wage)	Coefficient	0.034	0.010	0.164***
	Weights	0.165	0.990	

Note: This table decomposes the overall effect of the reform using the Goodman Bacon decomposition, based on a balanced data during 2009-2016. This limits the number of observations, relative to the benchmark results, which is necessary to perform the decomposition. We report the estimated effects of the reform on treated firms' sales, customer concentration, capital expenditures, R&D, employment and wages. The treated group consists of listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of less connected manufacturing firms. We define less connected firms according to the median level of connectedness, measured using the 2012 US input-output tables. In the decomposition, we include year fixed effect, but no controls. Standard errors are robust and clustered at the firm level.

Table C3: Robustness: different measures for inter-industry connection strength

	(1) Ln(Sales)	(2) Ln(Conctr)	(3) Ln(Capex)	(4) Ln(R&D)	(5) Ln(Empl)	(6) Ln(Wage)
Panel A: Chinese input-output tables						
$\text{Service}_i \times \text{Post}_{i,t}$	0.277***	-0.072**	0.180	0.214***	0.224***	0.134***
	(0.046)	(0.031)	(0.114)	(0.075)	(0.045)	(0.038)
Observations	4296	3820	3163	2912	4293	4287
Mean	21.156	3.057	18.426	17.515	7.612	18.908
Panel B: Upstreamness						
$\text{Service}_i \times \text{Post}_{i,t}$	0.185***	-0.091***	0.082	0.166***	0.184***	0.115***
	(0.044)	(0.030)	(0.108)	(0.060)	(0.043)	(0.037)
Observations	8848	8671	7252	5870	9811	9790
Mean	21.257	3.195	18.514	17.573	7.626	18.876
Year FE	✓	✓	✓	✓	✓	✓
Firm FEs	✓	✓	✓	✓	✓	✓

Note: This table reports the estimated effects of the B2V reform on treated service firms' sales (column 1), customer concentration (column 2), capital expenditures (column 3), R&D expenditures (column 4), number of employees (column 5) and wages (column 6). We define each of those variables in Appendix A. The treated group consists of listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of less-connected manufacturing firms. We define less connected firms according to the median level of connectedness, measured using: the 2012 industry input-output tables from Chinese Statistical office (Panel A); and a measure of industry upstreamness from Antràs et al. (2012) (Panel B). In each specification, we include industry and year fixed effects. Standard errors are robust and clustered at the firm level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table C4: Impact of the B2V reform on firm performances: clustering robustness

	(1) Ln(Sales)	(2) Ln(Conctr)	(3) Ln(Capex)	(4) Ln(R&D)	(5) Ln(Empl)	(6) Ln(Wage)
$\text{Service}_i \times \text{Post}_{i,t}$	0.219**	-0.073***	0.048	0.183**	0.174**	0.106
	(0.080)	(0.020)	(0.109)	(0.076)	(0.062)	(0.090)
Observations	5597	4996	4212	3851	5591	5584
# firms	667	934	881	847	967	967
Mean	21.245	3.055	18.504	17.526	7.627	18.896
Year FE	✓	✓	✓	✓	✓	✓
Firm FEs	✓	✓	✓	✓	✓	✓

Note: Note: This table reports the estimated effects of the reform on sales (column 1), customer concentration (column 2), capital expenditures (column 3), R&D expenditures (column 4), number of employees (column 5) and wages (column 6), where we cluster the standard errors at the province-industry level. We present results with firm and year fixed effects. The treated group consists of listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of less connected manufacturing firms. We define less connected firms according to the median level of connectedness, measured using the 2012 US input-output tables. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table C5: Outsourcing: Poisson estimations

	(1) R&D and technical	(2) IT	(3) cultural and creative	(4) logistics support	(5) tangible movable property leasing	(6) forensic consulting	(7) All
connected × post=1	0.052*	0.072*	0.007	0.061**	0.124**	0.064**	0.006
	(0.027)	(0.040)	(0.027)	(0.026)	(0.050)	(0.027)	(0.020)
Observations	185282	173148	191593	186304	160385	190091	250292
# firms	65,060	61,078	67,077	65,102	56,339	66,277	85,740
Year FE	✓	✓	✓	✓	✓	✓	✓
Firm FEs	✓	✓	✓	✓	✓	✓	✓

Note: This table reports the estimated effects of the B2V reform on more connected manufacturing plants' R&D outsourcing using tax returns data (NTSD). The dependent variable is the level of outsourcing across 6 different categories in columns 1-6 respectively: research and development and technical services, information technology services, cultural and creative services, logistics support services, tangible movable property leasing services, and forensic consulting services. In column (7), we add up outsourcing across all categories. We use Poisson regressions to estimate the effect of the reform. We estimate the effects of B2V on a subsample of standalone firms. The treated group consists of listed firms in more connected manufacturing industries. The control group consists of less connected manufacturing firms. We define less connected firms according to the median level of connectedness, measured using the 2012 US input-output tables. Standard errors are robust and clustered at the firm level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.