# Turnover taxes and innovation

Jing Xing* Katarzyna Bilicka† Xipei Hou‡

**Abstract**

We investigate the impact of tax cascading on innovation activities of both 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. Around half of the R&D investment increase is driven by outsourcing from manufacturing firms. We document that smaller and less innovative manufacturing firms increase outsourcing more, while larger service firms benefit more from the tax reform. Our study provides new evidence on how taxation affects supplier networks and firms' innovation activities.[1]

JEL: H25, H26, O32, D25

Keywords: turnover tax, value-added tax, outsourcing, R&D investment

*Antai College of Economics and Management, Shanghai Jiao Tong University, 1954 Huashan Road, Shanghai 200030, China, jing.xing@sjtu.edu.cn

†Utah State University, NBER, CEPR and Oxford University Centre for Business Taxation, John Huntsman Business School, Logan, United States; kat.bilicka@usu.edu

‡Antai College of Economics and Management, Shanghai Jiao Tong University, 1954 Huashan Road, Shanghai 200030, China, houxipei@sjtu.edu.cn

[1]We would like to thank Wei Cui, Irem Guceri, Jim Hines, Eric Ohrn, Nadine Riedel, Nathan Seegert, Sebastian Siegloch, Martin Simmler and the participants at the CESifo Public Economics Area conference, BUY/Utah Applied Microeconomics Workshop, IEB: Workshop on Economics of Taxation, ZEW Public Finance Conference, European Commission JRC Fiscal Policy Modelling Workshop, IIPF, NTA, and Zurich Public Economics in Developing Countries workshop for their comments. Xing acknowledges financial support from National Natural Science Foundation of China (No. 71903125). All omissions and errors are our own. This paper was previously circulated under the title: "How Distortive Are Turnover Taxes? Evidence from China".

# 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 innovation 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 which 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, R&D, and employment of firms in R&D intensive service industries, based on a sample of Chinese listed firms during 2009-2017.

Our empirical strategy relies on comparing service firms that were directly affected by the reform with manufacturing firms that were *only* affected by the reform through the nature of their purchasing networks. By altering the control group between manufacturing firms that were more or less connected to the service industries, we are also able to recover the effect of the reform on service firms that is due to outsourcing from manufacturing firms. Our key findings are as follows. First, consistent with the hypothesis that removing turnover taxes should replace inefficient vertical integration with outsourcing, we find that treated

service firms increased sales by 11.8% on average relative to a typical manufacturing firm after the B2V reform. This also suggests that turnover taxes suppressed the demand for the 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 15%, relative to manufacturing firms. 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 and employment, of 9% and 5.4% respectively, relative to manufacturing firms, indicating significant scaling effect. We find no significant change for fixed assets investment since our treated service firms mainly produce intangible goods and tend to be R&D intensive. 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 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 products.

We then proceed to investigate how much of this *relative* increase in service firms' R&D investment and employment is due to outsourcing from downstream manufacturing firms, and how much is an additional increase coming from new investment by service firms. Our hypothesis is that manufacturing firms that by nature need more intermediate goods from service firms (i.e. those that are more connected to the service sector) are more likely to increase outsourcing after the B2V reform. In contrast, manufacturing firms that are by nature less connected and use fewer intermediate goods from service industries should be less affected by the B2V reform. Hence, comparing the increase in R&D by service firms relative to that by all manufacturing firms (as in our benchmark estimations) with the increase relative to less connected manufacturing firms should give us a lower bound estimate for the outsourcing effect.

Specifically, we utilize the pre-reform industry-level input-output table for the Chinese economy and calculate the strength of the connection between each manufacturing industry and each service industry. Relative to the less connected manufacturing firms, we find that service firms' R&D investment increased by 4.4% since the B2V reform. This implies that

*at least* 51% (=(9%-4.4%)/9%) of the increase in treated service firms' R&D investment is likely due to outsourcing from more connected manufacturing firms.[2] This magnitude is in line with counterfactual estimates in Gadenne et al. (2019), who show that exempting all firm-to-firm transactions in India from VAT and thereby removing supply chain distortions, reduces upstream segmentation in supply chains by a comparable 50%. Using the same method, we find that at least 22% of the increase in treated service firms' employment is driven by outsourcing from downstream manufacturing firms. We show that these results are robust to alternative measures of connectedness, including the one based on the US industry-level input-output tables and a measure of upstreamness from Antràs et al. (2012).

Next, we examine which manufacturing firms gain from this reform the most. We document a relative slow-down in R&D investment for smaller and less innovative manufacturing firms, relative to larger and more innovative ones, after the B2V reform. This evidence is consistent with the hypothesis that smaller and less innovative manufacturing firms may have been forced to vertically integrate inefficiently before the B2V reform. Consequently, the removal of the turnover tax led these manufacturing firms to outsource more R&D investment.

We further examine which service firms benefit more from the B2V reform. We find that larger treated service firms enjoyed a stronger increase in sales, R&D investment, employment and wages relative to smaller service firms. Larger service firms also enjoy a greater enhancement in the number of new patents following the B2V reform. As such, outsourcing spurred by B2V reform benefits larger service firms, possibly because of their market power and ability to be competitive in this market. We also distinguish between service firms with higher or lower innovation quality. Before the reform, manufacturing firms may purchase from more innovative service firms despite the tax distortion, if the higher quality of their products outweighs the tax costs. Following this, we hypothesize that the reform should have a larger impact on service firms with lower innovation quality, while the impact on more innovative service firms should be limited. While both types of service firms increase sales, R&D investment, and employment after the B2V reform, we find weak evidence that the estimated impact is larger, at least in magnitude, for service firms with relatively lower innovation quality. These results indicate that service firms with lower innovation quality may have been more negatively affected by the turnover tax.

We finish the paper, by exploring alternative explanations for the observed changes in

[2]Using estimates without control variables, we find a smaller magnitude of outsourcing that is around 26%(=20.6%-15.2%/20.6%) .

sales, R&D investment, and employment by service firms. First, we show that our benchmark results are not driven by firms that were more financially constrained, or driven by changes in the tax burden. Second, we show that the reform had a limited impact on goods prices, thereby ruling out the reverse causality channel (Alfaro et al., 2016; Hansen et al., 2022; McGowan, 2017). Finally, we use the service firms in the Business to Consumer (B2C) sector as a placebo group and show no effects of the reform on these industries. 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 upstream 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. Gadenne et al. (2019) explore how the co-existence of turnover tax and VAT in India distorts smaller firms' supply chains. Best et al. (2015) emphasize that turnover taxes reduce evasion, which outweighs the associated production inefficiency.[3] Relative to these previous studies, the reform we analyze affected firms of all sizes from a wide range of industries across the whole country. Hence, the tax cascading we examine potentially created an even larger distortion in the economy. Our study also adds to this strand of literature by showing that as tax capacity for a developing country improves, 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).

Second, we add to the discussion on how government can influence private innovation via 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.[4] Based on our estimation results,

[3]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).

[4]The importance of demand-side policies for innovation has long been recognized (Schmookler, 1962,

we calculate the implied elasticity of R&D investment with respect to increase in sales to be between 0.76 - 0.96, depending on the specification. As a comparison, the estimated elasticity of R&D investment with respect 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 are just as effective as those changing the marginal cost of R&D investment.

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.[5] 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

## 2.1 The reform

China's economic growth traditionally depended on its manufacturing sector, but its service sector and, consequently, innovation driven growth is becoming increasingly important (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-digits level. By 2017, the service sector contributed to more than 50% of the country's GDP. Therefore, policies targeting growth of the service sector are likely a key for 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

1966), but there is limited empirical evidence (Edler and Georghiou, 2007).

[5]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, especially for smaller downstream manufacturing firms.

Starting from 2012, the Chinese government gradually replaced the BT with the VAT. Panel A of Table 1 provides the timeline of the B2V reform. The aim of the reform was to unify the tax treatment for the manufacturing and the service sectors, and to remove distortion and the inefficiency associated with the BT. The transition was made in a revenue-neutral way. Panel B of Table 1 lists the BT rates and the VAT rates for the treated industries. The pilot reform took place in Shanghai on January 1st, 2012 and affected 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 effectively eliminated the BT from the Chinese tax system. In our analysis, we focus on the service industries reformed by 2015. The reform has been hailed as the most important tax reform in China since 1994, involving the countries' two most important taxes (Cui, 2014).

## 2.2 Mechanisms

There are three potential channels through which the Chinese BT, and the elimination of it, can affect the demand and investment decisions for the treated service firms. First, the BT induced manufacturing firms to substitute away from inputs produced by BT-paying service firms. At the extreme, this generated incentives for downstream manufacturing firms to vertically integrate their business and "self-supply". After the unification of the tax system, the demand for upstream service firms will increase directly, as manufacturing firms would have stronger incentives to outsource. This is likely to manifest directly in an increase in sales and an expansion of customer base for service firms. We call this the "outsourcing effect". The increase in sales would likely drive up employment, wages and investment of service firms. Because the service industries we analyze in this paper tend to be R&D intensive, we also expect to observe a higher level of innovation activities after the reform.[6]

Second, as the VAT is imposed on a narrower base, the B2V reform may lower the tax burden for service firms. 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 their tax burden would not increase, in principle. If the reform resulted in a lower tax burden for treated service firms, they may lower price of their products. Consequently, the quantity of goods sold would increase, if demand is elastic. We call this the "direct price effect". A lower tax burden may also relax service firms' financial constraints, leading to more investment and/or employment.

Third, the B2V reform lowered the tax burden of manufacturing firms already purchasing from service firms, since they can now deduct input costs. If a lower tax burden translates into a lower final consumer price, it can lead to a higher demand for products sold by the manufacturer. This may have a cascading effect on the demand for intermediate goods provided by service firms. We call this the "cascading price effect".[7] We explore each of those mechanisms in our analysis.

[6]Table 2 shows that reformed service firms in our sample are almost twice as R&D intensive as listed manufacturing firms, as indicated by the ratio of R&D investment to total assets.

[7]The magnitude of this cascading effect will depend on the pass-through of the VAT to the final consumer. The empirical literature on this subject is mixed, ranging from full pass-through for food and chain restaurants, some pass-through for hairdressers and French restaurant consumers, to no pass-trough for small restaurants (Benzarti and Carloni, 2019; Gaarder, 2018; Harju et al., 2018; Kosonen, 2015).

### 2.3 Contemporary policies

During the analyzed time 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 since 2014. However, this tax incentive only targets non-R&D fixed assets investment. Besides, 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. Since such tax schemes existed well before the B2V reform and apply to firms in all sectors, they are unlikely to threaten our identification strategy. Nevertheless, to address possible confounding effects of these tax incentives, we add firm and time-specific corporate tax rate and subsidies as control variables in our estimations.

## 3 Data and empirical strategy

### 3.1 Data

For empirical analysis, we 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[8], with manufacturing firms that always paid the VAT. Overall, we obtain a balanced sample of 243 service firms and 1,786 manufacturing firms. Table 2 provides summary statistics for key outcome and control variables. Appendix A provides the variable definitions.

There are three reasons why we focus on the sample of listed firms rather than administrative datasets that cover a broader distribution of firms in the population. First, R&D investment in China is concentrated amongst the largest firms. We demonstrate this using an alternative database, the National Tax Survey Data (NTSD) during the same sample period

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

2009-2016. 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). Thus, examining the distribution of R&D activities among NTSD firms should shed light on the distribution in the overall economy. In Figure B1, we show that less than 1% of manufacturing firms in the bottom quintile of the size distribution conduct any R&D investment at all. It is mainly firms in the top quintile of the size distribution that are involved in R&D activities. A similar pattern is found for service firms. In comparison, over 70% of listed firms report R&D investment across all size quintiles. In Table B1, we also show that the average size of listed firms, measured by total assets, is substantially larger than that in the NTSD.[9] Even among the listed firms, we observe a strong positive relationship between firm size and R&D investment. Since R&D investment is mainly conducted by large firms, results based on listed firms should shed light on the overall impact of the B2V reform on R&D activities in the economy.

Second, we observe the quality of innovation activities for the listed firms, such as the number of granted patent applications and patent citations. In contrast, we have no information on patenting activities for firms in the NTSD. Thus, it is useful to examine the sample of listed firms, as analyzing the impact of the B2V reform on the quality of innovation by service firms is an integral part of our study.

Third, we use consolidated financial data for listed firms in our main analysis. In contrast, the NTSD data 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 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 R&D investment by its service subsidiary. This would create a downward bias in the estimated effect 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. Nevertheless, we demonstrate the effects of the reform using the NTSD sample in Table B2 and show the direction of the bias is consistent with our intuition.

[9]The median listed firm in our sample has 3.2 billion RMB total assets, while median firm in NTSD has 10 thousand RMB total assets.

## 3.2 Empirical strategy

We start our analysis by comparing all listed service firms with all listed manufacturing firms before and after the B2V reform, based on a difference-in-differences framework. Service firms were directly affected by the reform through the change in the tax system and hence, they form our treated group. It is worth noting that manufacturing firms may be affected by the reform *indirectly* through their purchasing networks. The removal of tax cascading is likely to lower manufacturing firms' tax burden and encourage them to outsource—both channels may affect manufacturing firms' performance. However, how important these indirect effects are for a given manufacturing firm depends on how exposed it is via its *ex ante* connection with the service sector. In Section 5, we thus use a sub-sample of manufacturing firms that were less likely to be affected by the reform through their supply networks as the alternative control group, and compare the resulting estimates with the benchmark ones.

We use the following general specification for estimations:

$$Y_{i,t} = \alpha + \beta \times Service_i \times Post_{i,t} + \delta \times X'_{i,t} + \eta_t + \psi_i + \epsilon_{i,t} \quad (1)$$

where $Y_{i,t}$ is a set of outcome variables at the firm level, which in the baseline specifications includes sales, capital expenditures, customer concentration, $R\&D$ 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 manufacturing industry. 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. $X'_{i,t}$ is a set of firm-level control variables, including size, age, profitability, leverage, the amount of government subsidies and firm specific corporate tax rate; $\eta_t$ is the time fixed effect, $\psi_i$ is a firm-specific fixed effect and $\epsilon_{i,t}$ is the unobserved error term. We cluster standard errors at the firm level.[10] The parameter $\beta$ captures the relative difference in the outcome variables averaged across all service firms compared with manufacturing firms after the reform.

Next, using the event study methodology, we test whether service and manufacturing firms evolve similarly before the reform. To causally identify the effects of the reform on

[10]We test the robustness of this clustering method in Table C5, where we instead cluster the standard errors at the province-industry level.

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 to verify the plausibility of this assumption. We also use this approach to evaluate the speed with which the reform affects our outcome variables. For this purpose, we estimate Equation 2:

$$Y_{i,t} = \alpha + \sum_{\kappa=-3}^{3} \beta_{i,\kappa} 1[t = \kappa] \times Service_i + \delta \times X'_{i,t} + \eta_t + \psi_i + \epsilon_{i,t} \quad (2)$$

where $1[t = \kappa]$ is a set of dummy variables that equals to 1 in each of the $\kappa$ 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 between the two groups in that year relative to year t-1, which we omit from the specification, and which serves as a benchmark. The treatment indicators are binned at endpoints, such that t-3 indicates treatment in year t-3 and all previous years (Fuest et al., 2018; McCrary, 2007). We continue to 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.[11] Second, following Goodman-Bacon (2018), we decompose our estimator into its sources of variation. In Table C1 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).

[11] 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.

# 4 Impact on sales, investment and employment

## 4.1 Baseline estimations

We start our analysis by documenting the changes in sales, customer base, investment, employment, and wages of service firms relative to the sample of all listed manufacturing firms since the B2V reform. We report the results based on Equation 1 in Table 3. In Panel A, we include only firm and year fixed effects and add controls for firm-level characteristics in Panel B. In both panels, the estimated coefficient on sales is positive and highly significant (column 1). With firm-level controls, we find that service firms experienced an 11.8% increase in sales, relative to manufacturing firms, since the B2V reform. Panel A of Figure 1 plots the dynamic changes in sales for the two groups. Each dot in the sub-figure represents the point estimates, $\beta_{i,\kappa}$, based on Equation 2, where we separately estimate the annual coefficients for service and manufacturing firms. 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 the similar rates. Further, the 95% confidence intervals before the reform consistently overlap, suggesting no significant difference between the two groups prior to the reform. Since the year of the B2V reform, we observe a gradual increase in sales for the service firms relative to the manufacturing firms.

In column 2 of Table 3, 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, we use customer concentration as the dependent variable and define it as the logarithm of the ratio of sales to the top five customers to total sales.[12] Column 2 shows that customer concentration declined by 11.5% for service firms after the reform. Panel B of Figure 1 shows no significant difference in the evolution of customer base between service and 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 start outsourcing.

Next, we examine how service firms' investment was affected by the reform. In Table 3, we consider capital expenditures in column 3, and R&D investment in column 4. We

[12] 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.

find that only R&D expenditures increased significantly after the reform for service firms, especially when we control for firm-level characteristics like investment subsidies in Panel B. In Panel C of Figure 1, we document a gradual and statistically significant increase in R&D investment by service firms since the reform relative to manufacturing firms, with no discernible pre-trends.[13] It is not surprising that we observe a greater impact of the B2V reform on treated service firms' R&D expenditures since they are from R&D intensive industries, with R&D expenditures consisting of 71.4% of all expenditures on average (Table 2). According to Panel B of Table 3, service firms increased R&D investment by around 9% (column 4). Based on these results, we can calculate an elasticity of R&D investment with respect to changes in sales to be 0.76 (=9%/11.8% in Panel B). Using results from Panel A of Table 3, we obtain slightly larger elasticity of 0.96 (=25.9%/27.1%). These elasticities are large relative to the literature that estimates the short-run elasticity of R&D investment with respect to changes in the marginal cost, as discussed in the Introduction.

Finally, in columns 5 and 6 in Panel A of Table 3, we show that following the B2V reform, both employment and wages in service firms increased significantly relative to manufacturing firms. The increase in employment is large, 5.4% in magnitude, and remains statistically significant even when we control for firm-level characteristics. Panel D of Figure 1 shows the dynamic effects for employment, while Panel E of Figure 1 shows that on firm wage. These figures provide further evidence that service firms increased employment and wage in response to stronger demand.

## 4.2 Robustness checks

There are two potential concerns about our baseline estimates. First, related to the staggered nature of the reform implementation, the traditional two-way fixed effects estimation may not capture the true effect of the reform, as the already treated units may act as control group in later years. Further, given the heterogeneous implementation across provinces, this may exacerbate the issues. 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, and 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 manufacturing firms, using various estimators that correct for the staggered and heterogeneous

[13] In Panel F, we demonstrate the dynamic estimates for capital expenditures. We show that the positive average effect documented in Panel A, is likely due to large pre-reform trends for service firms, which had lower capital expenditures relative to manufacturing firms.

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 methodologies, we find no significant pre-trends using these corrections.

Second, there could be concerns about the comparability between service and manufacturing firms, since they are from different sectors. To address this concern, we match the service and manufacturing firms in our sample based on observed firm-level characteristics in 2011 using propensity score matching (PSM). Specifically, we match on firm size, age, return on assets (ROA), leverage, the level of subsidies received from the government (in logs), and individual firm-level corporate income tax rate. We describe our matching methodology in more details in Appendix D. We observe that the service firms are comparable with manufacturing firms in terms of firm size, age, financial leverage, and government subsidies even before matching. However, treated service firms appear to be significantly more profitable as reflected by a higher ROA, and also faced a higher corporate income tax rate before matching. The PSM significantly improves the comparability between the two groups, as shown in Table D1. Table D2 reports the estimated effects for our outcome variables based on the matched sample. We find qualitatively similar results to those in Table 3. We also show the dynamic evolution of R&D investment and sales for service and manufacturing firms separately in Figure D1 based on this matched sample.

As a further check, we compare the outcomes of service firms to those of retail firms. Retail firms were subject to the VAT before the B2V reform and have historically relied less on service firms than manufacturing firms, potentially forming a better comparison group that is less affected by outsourcing. We present estimation results similar to the baseline estimations but using retail firms as a control group in Table C2 in the Appendix. We find a similar increase in sales of service firms relative to retail firms as in our baseline estimates. Relative to retail firms, we also observe an increase in R&D among service firms, but the magnitude of the R&D increase is about a third of that in the baseline. Figure C2 in the Appendix shows that while sales evolve similarly between retail and service firms before the B2V reform, the pattern of R&D investment differs substantially between the two groups. Therefore, this result needs to be interpreted with caution.[14]

[14]Note that the sample size of retail firms is small relative to both the service and manufacturing firms, with only around 100 retail firms that report any R&D investment.

## 4.3 Results based on tax returns and aggregated data

Another concern is that listed firms are different from the rest of firms in the economy and that the B2V reform may have affected firms across the size distribution differently. In Appendix B, we show results using the national tax survey data (NTSD) and aggregate data for the software industry to assess whether our baseline results can be generalized. In Table B2, we report the results based on the NTSD. The results suggest that sales of service firms increased by 9.1%, while their R&D increased by 15.7% relative to manufacturing firms in the regressions without control variables. Comparing that with the corresponding baseline estimates, we find roughly a 25% smaller increase in R&D investment for the NTSD firms.[15]

There are two potential explanation for why the estimate for the impact on the intensive margin of R&D based on the NTSD is smaller than our baseline estimate. First, as discussed in Section 3.1, using the NTSD is likely to introduce a downward bias for the effects of B2V reform on R&D investment, since we mix independent service firms with service subsidiaries of manufacturing firms. Second, smaller firms may be less responsive to the B2V reform, because they do not engage in R&D investment as much as larger firms. Consistent with this notion, Figure B2 shows that based on the NTSD, across quintiles of firm size distribution as in 2011, the reaction to the B2V reform is much larger for firms in the top quintile. Despite this difference, the results based on the NTSD are qualitatively consistent with those based on listed firms' data.

To examine whether responses of listed firms could have a material impact on the aggregate economy, we use the software industry as a case study. Specifically, we use aggregated province-industry level data for the software industry from the database WIND. As a comparison, we collect province-industry level aggregate sales for the manufacturing industries in our control group from the statistics yearbooks published by the National Bureau of Statistics. We summarize the results in a dynamic form in Figure B3. We find that the software industry experienced a 30% increase in sales since the B2V reform relative to manufacturing industries. Together with the results from Table 3, these estimates suggest that the B2V reform had a large effect on the treated service industries as a whole, and this effect is not unique to listed firms in our sample.

The analysis in this section indicates that the B2V reform generates a larger impact on larger firms. Since larger firms have greater impact on the aggregate economy, it is

[15]Using the tax returns data also allows us to estimate the effect of the reform on the extensive margin of R&D investment. We are unable to do this in the sample of listed firms, as firms do not report zero R&D in that dataset. We find that following the B2V reform there is a 1.9% increase in the likelihood of doing R&D amongst service firms.

meaningful to examine the consequences of the reform based on the sample of listed firms. In the remainder of the paper, we proceed using just that sample.

# 5 New activities or reallocation?

## 5.1 Inter-industry connection

From policy perspective, an important question is whether the reform spurred new innovation activity or resulted in reallocation of innovation activities from manufacturing firms to service firms. In this section, we shed light on this issue by using a sub-sample of manufacturing firms that rely less on service industries as an alternative control group. Compared with manufacturing firms that rely more on service industries, these firms should be less likely to vertically integrate when facing the tax distortion before the reform, and also less likely to change their outsourcing behavior after the reform. More, if in-house R&D investment and outsourcing are substitutes, we are likely to obtain a smaller change in service firms' R&D investment and employment based on these less-connected manufacturing firms, relative to our baseline estimates. By comparing the estimates using the two alternative comparison groups, we should also be able to examine how much of the changes in service firms' R&D and employment is likely due to outsourcing by manufacturing firms.

We use three measures for inter-industry connectedness. The first measure is based on the industry-level input–output tables published by the National Bureau of Statistics of China for 2012. 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 manufacturing firms into percentile bins and run regressions using the sub-samples of manufacturing firms based on these bins. The second measure of connectedness utilizes that same approach, but instead uses the 2012 industry input-output table from the US Bureau of Economic Analysis (BEA). A concern with using the Chinese input-output table is that it may be endogenous with respect to the reform, as the purchasing ratios could be affected by firms' vertical integration decisions. The BEA data is likely to be more exogenous to Chinese economy and represent the 'true' inter-industrial connectedness. The third 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 that a good has to 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 directly in Antràs et al. (2012).

We run estimations based on Equation 1, where we use service firms as the treated group and change the control group by including different manufacturing firms. We start with the least connected manufacturing firms, which belong to the bottom 30% of the distribution of the shares of goods purchased and sold as to total inter-industry purchases and sales. We then gradually enlarge the control group by including manufacturing firms more connected with the service sector. We visualize the series of point estimates and the associated 95% confidence intervals in Panel A of Figure 2 for R&D investment, and in Panel D for employment. Consistent with our hypothesis, the magnitude of the estimated coefficient is the smallest when we use the sub-sample of least connected manufacturing firms as the comparison group. The magnitude of the estimated coefficient increases when we include more connected manufacturing firms in the comparison group, but not largely so once we pass the 50% cutoff. We find a similar pattern for employment, albeit less pronounced. Note that these coefficients are not statistically significantly different from one another. This is because we include overlapping control groups as we move from left to right of the diagram.

As a further check, in Panels B and E of Figure 2, we cut the full sample of manufacturing firms into two groups: more or less connected based on the median level of inter-industry connection. We then estimate the effect of the reform on R&D and employment of service firms, using the more or less connected manufacturing firms as alternative comparison groups. Across all three measures of connection strength, the pattern is similar—the estimated coefficient is larger when we use the more connected manufacturing firms as the comparison group. We report corresponding coefficient estimates in Table C3. Panel A shows results for R&D investment and Panel B for employment.

In Panels C and F in Figure 2, we plot the dynamic evolution of R&D expenditures and employment (in logs) since the B2V reform for service and two types of manufacturing firms, based on the percentage of trading (purchases and sales of intermediate goods) with reformed service industries. For this exercise, we use the cut-off percentage of 80% to obtain a sharper contrast. Here, consistent with previous evidence, we find that more connected manufacturing firms experienced a sharper decline in their R&D investment and employment since the B2V reform. These figures highlight that the larger coefficients obtained when we use more manufacturing firms as the comparison group is driven by a larger decline in R&D investment and employment amongst these firms.[16]

[16]Our analysis includes all affected service firms, which mainly belong to the business-to-business (B2B)

We can further use these estimates to understand the magnitude of potential outsourcing. In Panel A of Table C4, we report regression estimates corresponding to Figure 2 directly. In Panel B of Table C4, we report regression estimates with controls and we use those to calculate the magnitudes of outsourcing. The R&D investment of service firms increases by 9% relative to all manufacturing firms, but only by 4.4% relative to manufacturing firms that are less than 30% connected to service firms. As such, 51% (=(9%-4.4%)/9%) of the relative increase in R&D investment of treated service firms is likely due to reallocation of R&D from more connected manufacturing firms. We can do a similar analysis for employment (Panels C and D of Table C4). We find that, using a full sample of manufacturing firms as the control group, employment of service firms increases by 5.4%. When we limit the comparison group to manufacturing firms that are less than 30% connected to service firms, we find only a 4.2% increase in employment (Panel D, Table C4). This suggests that 22% (=(5.4%-4.2%)/5.4%) of the observed increase in service firms' employment is likely due to reallocation of labor from more connected manufacturing firms.

## 5.2 Testing the assumption

Our analysis in this section relies on the assumption that manufacturing firms that rely less on service industries before the reform are less likely to increase outsourcing after the reform. We do not observe firm-level outsourcing for listed firms. However, we observe plant-level outsourcing of R&D since 2011 in the NTSD. This variable measures the amount of R&D that is contracted by the plant to be done externally. We use the NTSD data to test our conjecture.

In Table 4, we provide descriptive evidence consistent with this assumption. We compute both levels and changes in outsourced R&D based on the NTSD, for sub-samples of more or less connected manufacturing plants, as defined in Section 5.1. Here, we use the top 25th percentile of the distribution of each connectedness measure to obtain a sharper contrast. We show that across the three alternative measures of connectedness, before the B2V reform (as in 2011), manufacturing plants that relied more on service industries were more likely to outsource R&D and also outsourced more R&D than less connected manufacturing plants. Further, more connected manufacturing plants increased outsourced R&D substantially more than less connected manufacturing plants after the B2V reform. In sum, these descriptive

industries. For service firms in business-to-customers (B2C) industries, the outsourcing effect should be limited. We show this is the case in Table C6, where the reform had little effect on B2C firms' sales, capital expenditures, R&D, employment, and wages. This supports our conclusion that outsourcing is the main cause for observed changes in R&D and employment.

statistics based on the NTSD are consistent with our assumption and validate the approach we take.

# 6 Quality of innovation

We show that the B2V reform led to an increase in R&D investment by treated service firms. One 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 greater market demand for service firms, they would have enhanced cash flow and also 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 total number of patents, we use the stock of patents held by each firms 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 citation of 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 5. 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. These evidence suggests that service firms not only increased R&D expenditures, 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.

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 RD, have a higher chance of making major breakthrough discovery. 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).

# 7 Who gains from the reform?

## 7.1 Heterogeneities among manufacturing firms

Our analysis suggests that manufacturing firms increased outsourcing to upstream service firms after the B2V reform. In this section, we examine heterogeneous responses across manufacturing firms with different firm characteristics. We focus on firm size and quality of innovation, both measured before the reform.[17]

We first examine the differences between small and large manufacturing firms. Arguably, larger manufacturing firms may be able to conduct more efficient vertical integration to avoid tax cascading than smaller firms before the reform. Hence, we hypothesize that smaller manufacturing firms should respond to the B2V reform by increasing outsourcing more than larger firms. In Panels A and B in Figure 3, we compare the R&D expenditures and employment between larger and smaller manufacturing firms and add a line showing the evolution of those two outcomes for service firms for comparison. Here, we use the dynamic model, based on Equation 2 where we plot the dynamic evolution of outcomes for each of the three groups of firms separately.We define larger firms as those with above-median total assets before the reform. We plot the estimated coefficients for service firms in red circles, for large manufacturing firms in dark navy triangles, and for small manufacturing firms in light grey diamonds. These plots show that smaller manufacturing firms reduced their R&D expenditures and employment more than larger manufacturing firms following the B2V reform, with no significantly different pre-trend. This finding is consistent with Hansen et al. (2021), who show that smaller manufacturers firms benefit more from the removal of gross receipts tax on marijuana in Washington.

Inefficient vertical integration may also result in poor quality of R&D investment. If such inefficiency is reflected by the quality of innovation before the reform, it is likely that less innovative manufacturing firms would increase outsourcing more than others. We examine this hypothesis in Panels C and D of Figure 3, where we split the full sample of manufacturing firms into two groups based on firms' pre-reform quality of innovation, proxied by the number of patents firms held before the B2V reform. We find that less innovative manufacturing firms did experience a more pronounced slow down in their R&D expenditures and employment after the B2V reform.

Our analysis suggests that smaller and less innovative manufacturing firms outsourced

[17]Note that the correlation between firm size and innovation is 0.14. Hence, in this analysis we examine two very different groups of firms.

more after the B2V reform. As these firms may have been less efficient in innovation activities when the turnover tax was in place, the results indicate that removing tax cascading in the economy likely results in overall efficiency gains for these manufacturing firms.

## 7.2 Which service firms benefit more?

Next, we examine which types of treated service firms benefit most from the B2V reform. We explore heterogeneities in terms of firm size and innovation quality before the reform, similar to the analysis above. The results are reported in Table 6. In Panel A, we show heterogeneities according to the pre-reform firm size, which we measure by the logarithm of total assets. We set a dummy $Large_i$ that is equal to 1 when the firm is above the sample median size. Then, we interact $Large_i$ with $Service_i \times Post_i$ in the DID estimations. In Panel B, we consider heterogeneities across service firms according to their pre-reform quality of innovation, which we measure by the number of patent citations before the reform. We set a dummy $More\ innovative_i$ that is equal to 1 if the treated firm's pre-reform quality of innovation is above the sample median.

In Panel A, we find that larger services firm generally benefit more from the reform. Specifically, the increase in sales, R&D investment, employment, and wages is positive and significant only for larger service firms in the triple DID estimations. We also show that customer concentration only declined for larger service firm, suggesting that they were the ones to have expanded their customer base (column 2). Further, in column 6, we find that larger firms also experienced a significant increase in the quality of innovation after the reform, measured by new patent applications. Overall, results in Panel A indicate that outsourcing spurred by the B2V reform mainly goes to larger service firms, possibly due to their larger market power or their ability to be competitive in this market.[18]

In Panel B, we instead differentiate between more and less innovative service firms. We find suggestive evidence that less innovative service firms benefited more from the reform. Service firms with poorer innovation quality were more likely to be negatively affected by the turnover tax before the reform. In comparison, downstream firms may still purchase intermediate goods from service firms with better innovation quality even with the presence of tax distortion. As such, our hypothesis is that the B2V reform should have a greater impact on service firms with poorer innovation quality. We find a significant increase in sales, R&D investment, employment, and wages for both types of firms, but document a smaller

[18]Note that Hansen et al. (2021) show no heterogeneous size response amongst their upstream firms – cultivators.

magnitude of change for more innovative firms. We also find a significant improvement in the quality of new patents for less innovative firms, reflected by a higher number of citations. Note that the only significant difference between less and more innovative firms is in terms of sales, but the direction of the triple interaction coefficients implies smaller effects for more innovative firms. These results imply that the turnover tax likely hurt the less innovative service firms to a larger extent before the reform.

# 8 Alternative explanations

In this section, we discuss 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.

## 8.1 The role of financial constraints

We start by looking at the role that the 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 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 6, where we interact $Service \times Post$ with dummies $More\ constrained_i$ to indicate firms with above dividend payout ratio (columns 1 and 3) and firms with above median investment rating (columns 2 and 4), both before the reform. We do so for both R&D investment and employment as outcome variables. In all columns, we find that the estimated coefficients on the interaction terms are statistically insignificant for both outcome variables. This result implies that the increase in service firms' R&D investment and employment is unlikely to be driven by liquidity improvement.

## 8.2 Changes in the cost of capital

Next, we consider the importance of cost of capital, since the B2V reform could have lowered the cost of capital for investment for service firms. This is because before the reform, service firms could not deduct input costs associated with R&D investment under the BT, but can deduct those after switching to the VAT. However, if most of the R&D expenditures are in the form of wages, the reform should have limited impact on the cost of capital for R&D investment, since wages are not deductible when calculating either the BT or the VAT.[19] 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. Further, if capital and labor are substitutes, this may affect price of labor as well.

To examine the importance of this 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.[20] On average, more than 70% of R&D expenditures went into wage. This suggests that the majority of the R&D expenditures for a typical service firm was not deductible against the VAT after the B2V reform. We then construct an indicator variable called "High labor ratio", which equals 1 if the ratio of R&D personnel wage to total R&D expenditures is above 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.

## 8.3 Price changes

A third potential mechanism through which demand for service firms may increase is a lower product price. This may occur, if the B2V reform reduced service firms' tax burden and hence, production costs. While the B2V is portrayed by the government as a tax reducing policy reform (Cui, 2014), it remains controversial whether firms' tax burden actually

[19] 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).

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

declined after the B2V.[21] In column 7 of Table 7, we calculate firms' tax burden as the ratio of total BT and VAT paid scaled by firms' total assets.[22] Conceptually, more connected manufacturing firms may also experience a reduction in tax burden after the B2V reform. Therefore, in column 7, we include as a comparison group only manufacturing firms in industries that are less that 50% connected with service industries. We find no evidence that service firms experienced a significant reduction in their tax burden after the B2V reform, relative to this sub-group of manufacturing firms. Thus, our benchmark results are unlikely to be driven by this direct price effect.

On the other hand, manufacturing firms already purchasing intermediate goods from service industries should experience a reduction in their tax burden after the B2V reform, since they now can claim deduction on such input purchases. This reduction in manufacturing firms' tax burden may lead to a lower price of the final product, possibly generating higher demand for both downstream manufacturing firms and upstream service firms. Our data does not provide product-level price information and hence, we rely on the average price indices for manufacturing industries across years. We calculate the price index separately for more connected manufacturing industries that were more affected by the B2V reform through their purchasing network and for those less affected manufacturing industries. In column 8 in Table 7, we compare the producer price indices for those two groups of manufacturing firms directly. We find no evidence that these price indices change significantly after the B2V reform, suggesting limited impact on producer prices within the few years since the reform. Hence, the cascading price channel is also unlikely to drive our benchmark results.

## 8.4 Relabeling

Alternatively, firms could manipulate their financial statements, for example by relabeling, to qualify for certain tax benefits. Given the wide range of R&D tax incentives available during our sample period that we discuss in Section 2.3, the observed increase in service firms' R&D investment may be caused by relabeling (Chen et al., 2021). 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. More, if service firms did increase relabeling since the B2V reform for other unknown reasons, we should find a significant reduction in their non-R&D invest-

[21] 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*.

[22] The results are consistent if we use a natural logarithm of the total BT and VAT as a dependent variable.

ment after the reform. As Table 3 shows, if anything, there is an increase in service firms' non-R&D capital expenditures. All of these suggest that the increase in R&D investment by service firms is unlikely to be caused by relabelling.

# 9 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, likely as downstream manufacturing firms increased outsourcing. Such reallocation increases economic efficiency and improves the quality of innovation.

We can use back of the envelope calculations to quantify the size of the distortion created by vertical integration. The total R&D spending of manufacturing firms in 2011 in our data was 48 billion RMB. This means that the reform increased the relative R&D spending of service firms by between 4.3 billion and 9.8 billion RMB (top estimates). Half of this increase in R&D was due to outsourcing from downstream manufacturing firms based on our estimates. Assume that manufacturing firms' outsourcing decision is balanced between tax considerations and production efficiency, this implies that the distortion created by turnover taxes before the B2V reform was between 2.15 and 4.9 billion RMB of R&D. This is between 0.3-0.8% of the total capital expenditures of those manufacturing firms in 2011.

This paper improves our understanding of the negative impact of turnover taxes imposed on business inputs, 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.[23] 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.

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

# References


Agrawal, A., Rosell, C. and Simcoe, T. (2020). Tax Credits and Small Firm R&D Spending, *American Economic Journal: Economic Policy* **12**(2): 1–21.

Akcigit, U., Grigsby, J., Nicholas, T. and Stantcheva, S. (2018). Taxation and innovation in the 20th century, *Working Paper 24982*, National Bureau of Economic Research.

Alfaro, L., Conconi, P., Fadinger, H. and Newman, A. F. (2016). Do prices determine vertical integration?, *The Review of Economic Studies* **83**(3 (296)): 855–888.

Antràs, P., Chor, D., Fally, T. and Hillberry, R. (2012). Measuring the upstreamness of production and trade flows, *American Economic Review* **102**(3): 412–16.

Balasubramanian, N. and Sivadasan, J. (2011). What Happens When Firms Patent? New Evidence from U.S. Economic Census Data, *The Review of Economics and Statistics* **93**(1): 126–146.

Benzarti, Y. and Carloni, D. (2019). Who really benefits from consumption tax cuts? evidence from a large vat reform in france, *American Economic Journal: Economic Policy* **11**(1): 38–63.

Best, M. C., Brockmeyer, A., Kleven, H. J., Spinnewijn, J. and Waseem, M. (2015). Production versus revenue efficiency with limited tax capacity: theory and evidence from pakistan, *Journal of political Economy* **123**(6): 1311–1355.

Bloom, N., Griffith, R. and Van Reenen, J. (2002). Do R&D tax credits work? Evidence from a panel of countries 1979-1997, *Journal of Public Economics* **85**(1): 1–31.

Borusyak, K. and Jaravel, X. (2021). Revisiting event study designs.

Callaway, B. and Sant'Anna, P. H. (2020). Difference-in-differences with multiple time periods, *Journal of Econometrics* .

Chen, Z., Liu, Z., Suárez Serrato, J. C. and Xu, D. Y. (2021). Notching r&d investment with corporate income tax cuts in china, *American Economic Review* **111**(7): 2065–2100.

Coase, R. (1937). *The Nature of the Firm*.

Cui, W. (2014). China's business-tax-to-vat reform: An interim assessment, *British Tax Review* **5**: 617–641.

Cui, W., Hicks, J. and Xing, J. (2022). Cash on the table? imperfect take-up of tax incentives and firm investment behavior, *Journal of Public Economics* **208**: 104632.

Cui, W., Wei, M., Xie, W. and Xing, J. (2021). Corporate tax cuts for small firms: What do firms do?, *Working Paper 9389*, CESifo Working Paper Series.

de Chaisemartin, C. and D'Haultfoeuille, X. (2020). Difference-in-Differences Estimators of Intertemporal Treatment Effects, *Papers 2007.04267*, arXiv.org.

Doraszelski, U. and Jaumandreu, J. (2013). R&d and productivity: Estimating endogenous productivity, *Review of Economic Studies* **80**(4): 1338–1383.

Ebrill, M. L. P., Keen, M. M. and Perry, M. V. P. (2001). *The modern VAT*, International Monetary Fund.

Edler, J. and Georghiou, L. (2007). Public procurement and innovation–Resurrecting the demand side, *Research Policy* **36**(7): 949–963.

Einiö, E. (2014). R&D Subsidies and Company Performance: Evidence from Geographic Variation in Government Funding Based on the ERDF Population-Density Rule, *The Review of Economics and Statistics* **96**(4): 710–728.

Fan, Z. and Liu, Y. (2020). Tax compliance and investment incentives: firm responses to accelerated depreciation in china, *Journal of Economic Behavior & Organization* **176**: 1–17.

Fang, H., Bao, Y. and Zhang, J. (2017). Asymmetric reform bonus: The impact of VAT pilot expansion on China's corporate total tax burden, *China Economic Review* **46**(S): 17–34.

Fuest, C., Peichl, A. and Siegloch, S. (2018). Do Higher Corporate Taxes Reduce Wages? Micro Evidence from Germany, *American Economic Review* **108**(2): 393–418.

Gaarder, I. (2018). Incidence and Distributional Effects of Value Added Taxes, *The Economic Journal* **129**(618): 853–876.

Gadenne, L., Nandi, T. and Rathelot, R. (2019). Taxation and Supplier Networks: Evidence from India, *CEPR Discussion Papers 13971*, C.E.P.R. Discussion Papers.

Goodman-Bacon, A. (2018). Difference-in-differences with variation in treatment timing, *Working Paper 25018*, National Bureau of Economic Research.

Griliches, Z. and Mairesse, J. (1991). R&d and productivity growth: comparing japanese and us manufacturing firms, *Productivity growth in Japan and the United States*, University of Chicago Press, pp. 317–348.

Guceri, I. and Liu, L. (2019). Effectiveness of Fiscal Incentives for R&D: Quasi-experimental Evidence, *American Economic Journal: Economic Policy* **11**(1): 266–291.

Hall, B. H. (1993). R&d tax policy during the 1980s: Success or failure?, *Tax Policy and the Economy* **7**: 1–35.

Hall, B. H. and Mairesse, J. (1995). Exploring the relationship between r&d and productivity in french manufacturing firms, *Journal of econometrics* **65**(1): 263–293.

Hall, B. and Van Reenen, J. (2000). How effective are fiscal incentives for R&D? A review of the evidence, *Research Policy* **29**(4-5): 449–469.

Hansen, B., Miller, K. S. and Weber, C. (2021). Vertical integration and production inefficiency in the presence of a gross receipts tax, *Technical report*, National Bureau of Economic Research.

Hansen, B., Miller, K. and Weber, C. (2022). Vertical integration and production inefficiency in the presence of a gross receipts tax, *Journal of Public Economics* **212**: 104693.

Harju, J., Kosonen, T. and Skans, O. N. (2018). Firm types, price-setting strategies, and consumption-tax incidence, *Journal of Public Economics* **165**: 48–72.

Hasan, I. and Tucci, C. L. (2010). The innovation–economic growth nexus: Global evidence, *Research policy* **39**(10): 1264–1276.

Kogan, L., Papanikolaou, D., Seru, A. and Stoffman, N. (2017). Technological Innovation, Resource Allocation, and Growth*, *The Quarterly Journal of Economics* **132**(2): 665–712.

Kosonen, T. (2015). More and cheaper haircuts after vat cut? on the efficiency and incidence of service sector consumption taxes, *Journal of Public Economics* **131**: 87–100.

Liu, Y. and Mao, J. (2019). How Do Tax Incentives Affect Investment and Productivity? Firm-Level Evidence from China, *American Economic Journal: Economic Policy* **11**(3): 261–291.

Lokshin, B. and Mohnen, P. (2013). Do R&D tax incentives lead to higher wages for R&D workers? Evidence from The Netherlands, *Research Policy* **42**(3): 823–830.

Mansfield, E. (1980). Basic research and productivity increase in manufacturing, *The American Economic Review* **70**(5): 863–873.

McCrary, J. (2007). The effect of court-ordered hiring quotas on the composition and quality of police, *American Economic Review* **97**(1): 318–353.

McGowan, D. (2017). Digging Deep to Compete: Vertical Integration, Product Market Competition and Prices, *Journal of Industrial Economics* **65**(4): 683–718.

Naritomi, J. (2019). Consumers as tax auditors, *American Economic Review* **109**(9): 3031–72.

Phillips, A. and Ibaid, M. (2019). The impact of imposing sales taxes on business inputs, *Ernst and Young LLP and the Council on State Taxation, Washington DC* .

Pomeranz, D. (2015). No taxation without information: Deterrence and self-enforcement in the value added tax, *American Economic Review* **105**(8): 2539–69.

Rao, N. (2016). Do tax credits stimulate rd spending? the effect of the rd tax credit in its first decade, *Journal of Public Economics* **140**: 1 – 12.

Schmookler, J. (1962). Economic Sources of Inventive Activity, *The Journal of Economic History* **22**(1): 1–20.

Schmookler, J. (1966). Invention and Economic Growth.

Smart, M. and Bird, R. M. (2009). The impact on investment of replacing a retail sales tax with a value-added tax: Evidence from canadian experience, *National Tax Journal* **62**(4): 591–609.

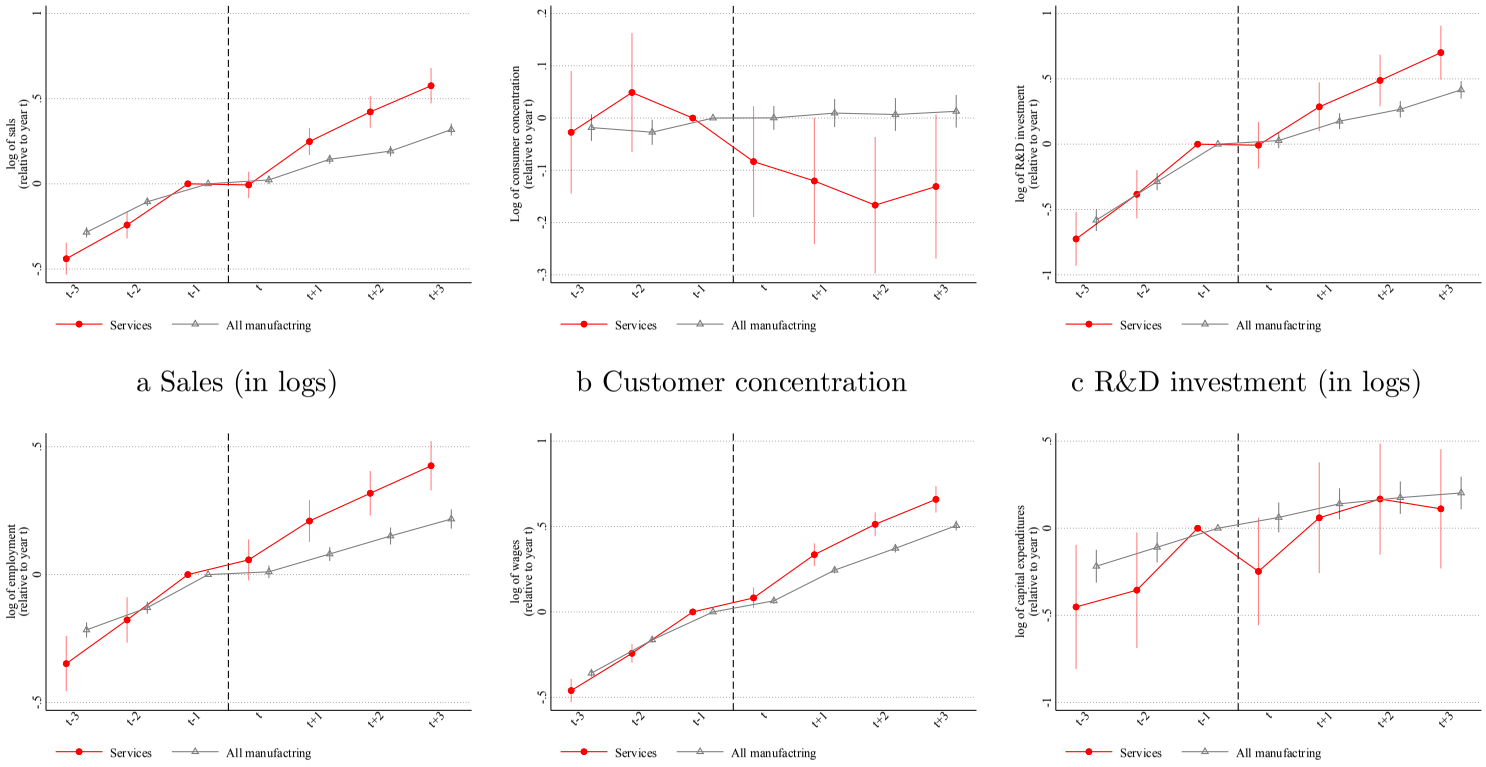
Sun, L. and Abraham, S. (2020). Estimating dynamic treatment effects in event studies with heterogeneous treatment effects, *Journal of Econometrics* .

Waseem, M. (2019). Information, Asymmetric Incentives, or Withholding? Understanding the Self-Enforcement of Value-Added Tax, *Technical report*.

Williamson, O. E. (1971). The Vertical Integration of Production: Market Failure Considerations, *American Economic Review* **61**(2): 112–123.

Zilibotti, F. (2017). Growing and Slowing Down Like China, *Journal of the European Economic Association* **15**(5): 943–988.

Figure 1: Dynamic effects of the B2V reform.

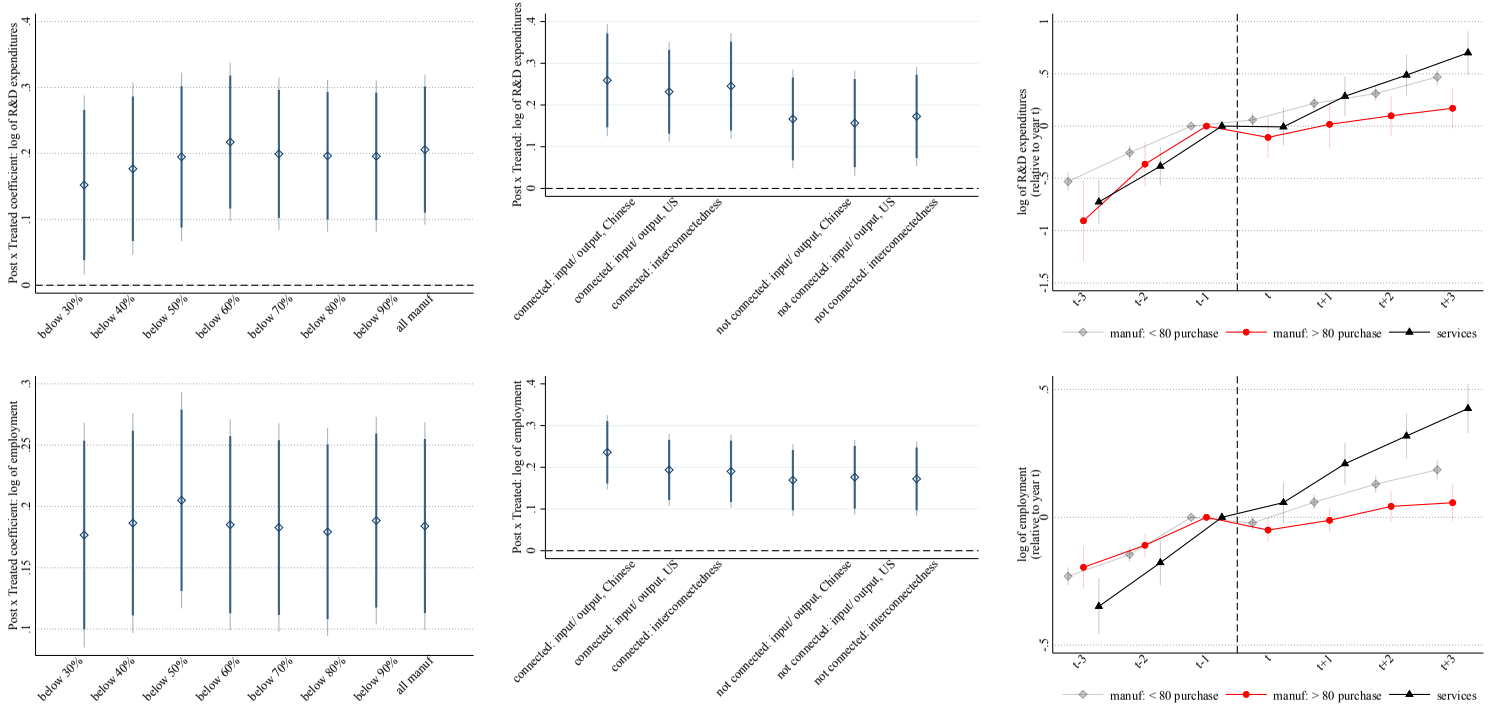



a Sales (in logs) b Customer concentration c R&D investment (in logs)

d Employment (in logs) e Ln(Wage) f Ln(Capex)

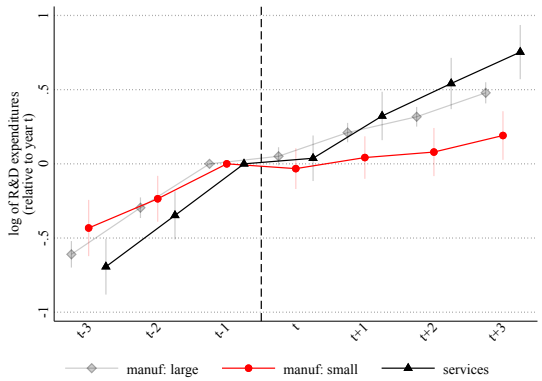
Note: This figure reports the dynamic effects of the reform on sales (panel a), customer concentration (panel b), R&D expenditures (panel c), number of employees (panel d), wages (panel e), and capital expenditures (panel f). We use year t=-1 as the benchmark. For each outcome variable, we plot the estimated 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: Outsourcing from manufacturing firms: heterogeneity in terms of inter-industry connectedness

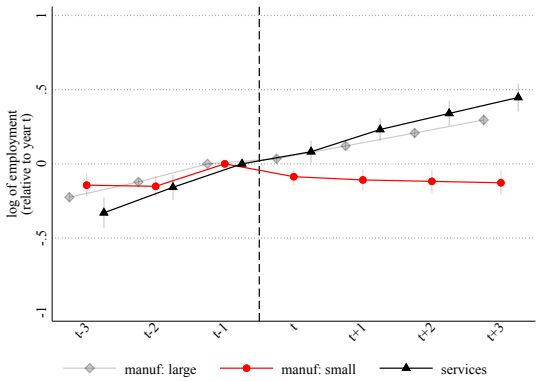



Note: This figure summarizes how changing the control group affects baseline estimates for R&D investment (Panels a-c at the top) and employment (Panels d-f at the bottom). In Panels a and d, we plot DID estimates for the effect of the B2V reform on R&D investment and employment. As we move from the right-end to the left-end of the x-axis, we restrict the sample of manufacturing firms to be those less connected using 2012 Chinese industrial input-output tables. In Panels b and e, we split manufacturing firms into those more or less connected according to the median of an indicator for connectedness, based on: the 2012 Chinese input-output tables; the 2012 US input-output tables; a measure of industry upstreamness from Antràs et al. (2012). In Panels c and f, we plot the dynamic DID estimates where we split firms into 80%+ connected and $< 80\%$ connected. We use year t=-1 as the benchmark. In all specifications, we control for year and firm-level 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 all listed manufacturing firms. Standard errors are robust and clustered at the firm level. Each dot represents the point estimate and the vertical bars represent the 95% confidence intervals. Corresponding estimations are reported in Tables C4 and C3 in the Appendix.

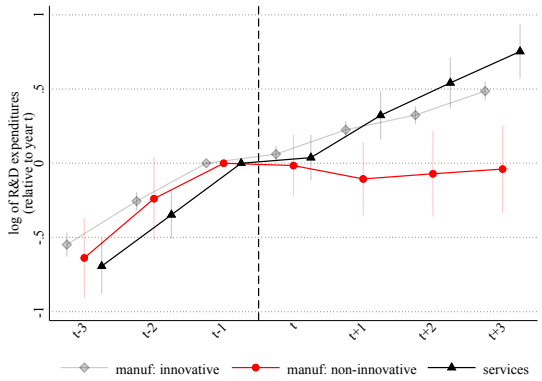
Figure 3: Outsourcing from manufacturing firms: heterogeneity in terms of other firm traits



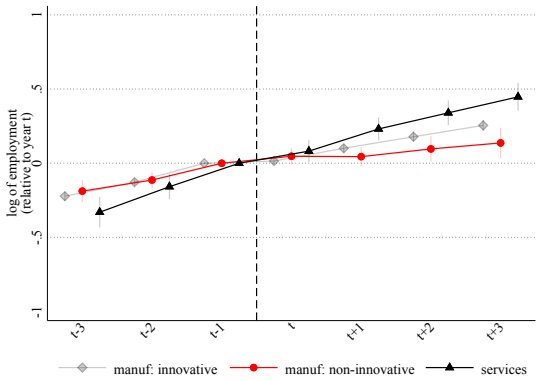

a Large versus small manufacturing firms




b Large versus small manufacturing firms




c More versus less innovative manufacturing firms




d More versus less innovative manufacturing firms

Note: These figures plot the dynamic effects of the reform on R&D expenditures (Panels a and c) and employment (Panels b and d). 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. We split control group according to size in Panels a and b, and according to pre-reform quality of innovation in Panels c and d. Large firms are those reporting above-median total assets before the reform. More innovative firms are those reporting above-median number of patents before the reform. We control for year and firm-level fixed effects when estimating these differences. The vertical bars represent the 95% confidence intervals. The services group consists of listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. Standard errors are robust and clustered at the firm level. In Table C7 we report corresponding coefficients from the simple difference-in-differences framework in which we compare manufacturing firms of different sizes and innovation quality.

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[24] |
|---|---|---|
| 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%[25] |
| 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.

Table 2: Descriptive statistics of key variables.

| | (1) All | (2) Control | (3) Treated | (4) diff | (5) t-test |
|---|---|---|---|---|---|
| Ln(Sales) | 21.184 | 21.235 | 20.782 | 0.453*** | 4.327 |
| Ln(Conctr) | 3.197 | 3.201 | 3.156 | 0.046 | 0.760 |
| Ln(Capex) | 18.336 | 18.358 | 18.135 | 0.223 | 1.252 |
| Ln(R&D) | 17.175 | 17.172 | 17.197 | -0.026 | -0.236 |
| R&D intensity | 0.024 | 0.023 | 0.039 | -0.016*** | -5.388 |
| R&D investment in all investment | 0.407 | 0.374 | 0.714 | -0.340*** | -6.503 |
| Ln(Empl) | 7.435 | 7.455 | 7.268 | 0.187* | 1.889 |
| Ln(Wage) | 18.649 | 18.635 | 18.773 | -0.138 | -1.613 |
| Patents owned | 3.139 | 3.218 | 2.166 | 1.052*** | 8.481 |
| Nb of citations | 1.689 | 1.746 | 1.150 | 0.596*** | 4.535 |
| Cit weighted nb patents | 0.693 | 0.687 | 0.776 | -0.089 | -1.626 |
| Pat owned: 5 year citation count | 2.076 | 2.137 | 1.500 | 0.637*** | 4.048 |
| Patent applications | 2.513 | 2.581 | 1.875 | 0.705*** | 4.438 |
| Pat appl: 5 year citation count | 3.332 | 3.423 | 2.512 | 0.911*** | 4.304 |
| Ln(Tax) | 17.749 | 17.772 | 17.552 | 0.220** | 2.272 |
| Tax/Assets | 0.030 | 0.031 | 0.022 | 0.009*** | 7.072 |
| Age | 12.903 | 12.992 | 12.226 | 0.767** | 2.100 |
| Size | 21.737 | 21.744 | 21.689 | 0.055 | 0.554 |
| ROA | 0.050 | 0.048 | 0.065 | -0.017*** | -4.908 |
| Leverage | 0.414 | 0.423 | 0.348 | 0.076*** | 4.700 |
| Subsidy | 15.924 | 15.928 | 15.894 | 0.034 | 0.273 |
| CIT | 0.188 | 0.188 | 0.193 | -0.006 | -1.553 |

Note: This table reports summary statistics of key variables for the control group and the treated group for a period before the reform (2009-2011). 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. 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 listed manufacturing firms.

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

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

Table 3: 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) |
|---|---|---|---|---|---|---|
| **Panel A: No controls** | | | | | | |
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.271*** | -0.152*** | 0.115 | 0.206*** | 0.217*** | 0.180*** |
| | (0.047) | (0.033) | (0.098) | (0.058) | (0.047) | (0.042) |
| Observations | 19,760 | 18,744 | 15,271 | 13,346 | 21,007 | 20,951 |
| # firms | 2,755 | 3,318 | 3,608 | 3,144 | 2,980 | 2,986 |
| Mean | 21.288 | 3.210 | 18.438 | 17.620 | 7.557 | 18.905 |
| **Panel B: Including controls** | | | | | | |
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.118*** | -0.115*** | -0.020 | 0.090** | 0.054* | 0.034 |
| | (0.025) | (0.029) | (0.082) | (0.042) | (0.029) | (0.024) |
| Observations | 18,008 | 16,150 | 13,375 | 12,822 | 17,992 | 17,953 |
| # firms | 2,627 | 2,849 | 3,136 | 2,997 | 2,629 | 2,632 |
| Mean | 21.303 | 3.184 | 18.514 | 17.615 | 7.667 | 19.008 |
| 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). In Panel A, we present results with firm and year fixed effects, and in Panel B, we add firm-level control variables, including firm size, age, returns on assets (ROA), leverage, subsidy and firm-specific and time-varying nominal corporate income tax rate. 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 all listed manufacturing firms. Standard errors are robust and clustered at the firm level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table 4: R&D outsourcing patterns: more and less connected manufacturing plants.

| | (1) above 75th percentile | (2) below 25th percentile | (3) diff | (4) t-stat |
|---|---|---|---|---|
| **Panel A: using Chinese input-output tables** | | | | |
| Ln(Outsourced R&D) | 2.846 | 2.434 | 0.412 | 1.638 |
| Outsourced R&D/ assets | 0.005 | 0.004 | 0.001 | 0.785 |
| Pr(Outsourced R&D>0) | 0.362 | 0.302 | 0.059** | 1.994 |
| $\Delta Outsourced\ R\&D$ | 5,066.674 | -312.796 | 5,379.469 | 0.597 |
| $\frac{\Delta' Outsourced\ R\&D}{Initial\ outsourced\ R\&D}$ | 54.082 | 13.132 | 40.950** | 2.052 |
| **Panel B: using US input-output tables** | | | | |
| Ln(Outsourced R&D) | 2.845 | 2.028 | 0.817*** | 5.601 |
| Outsourced R&D/ assets | 0.005 | 0.003 | 0.002*** | 3.875 |
| Pr(Outsourced R&D>0) | 0.360 | 0.261 | 0.099*** | 5.618 |
| $\Delta Outsourced\ R\&D$ | 5,167.070 | 4,012.293 | 1,154.777 | 0.376 |
| $\frac{\Delta' Outsourced\ R\&D}{Initial\ outsourced\ R\&D}$ | 59.196 | 27.576 | 31.621 | 1.115 |
| **Panel C: using Fally's upstreamness** | | | | |
| Ln(Outsourced R&D) | 2.512 | 2.270 | 0.242* | 1.664 |
| Outsourced R&D/ assets | 0.004 | 0.003 | 0.001 | 1.201 |
| Pr(Outsourced R&D>0) | 0.323 | 0.286 | 0.037** | 2.108 |
| $\Delta Outsourced\ R\&D$ | 4,305.165 | 4,930.687 | -625.522 | -0.212 |
| $\frac{\Delta' Outsourced\ R\&D}{Initial\ outsourced\ R\&D}$ | 65.097 | 17.542 | 47.556* | 1.762 |

Note: This table shows descriptive statistics for outsourced R&D of manufacturing plants using tax returns data (NTSD). In Panel A, as a measure of connectedness we use the 2012 Chinese input-output tables; in Panel B, we use the 2012 US input-output tables; in Panel C, we use a measure of industry upstreamness from Antràs et al. (2012). We compare firms in the top and bottom 25th percentile of the distribution of these measures, respectively in columns 1 and 2. Column 3 shows the difference between the two, while column 4 the t-statistics test. Ln(Outsourced R&D) is the amount of outsourced R&D (in logs) in 2011. $\frac{Outsourced\ R\&D}{assets}$ is outsourced R&D in 2011, scaled by total assets in that year. Pr(Outsourced R&D>0) measures the percentage of firms in total firms that outsourced any R&D in 2011. $\Delta Outsourced\ R\&D$ is measured as a difference between the level of outsourced R&D in 2014 and 2011, while $\frac{\Delta' Outsourced\ R\&D}{Initial\ outsourced\ R\&D}$ is the accumulated change in outsourcing is the sum of outsourcing between 2012 and 2014 minus outsourcing in 2011 scaled by outsourcing in 2011.

Table 5: 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 |
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.268*** | 0.140 | 0.155*** | 0.252** | 0.285** | 0.484*** |
| | (0.080) | (0.104) | (0.038) | (0.118) | (0.123) | (0.150) |
| Observations | 12,451 | 12,652 | 10,774 | 12,652 | 12,684 | 12,180 |
| # firms | 2,206 | 2,292 | 2,575 | 2,292 | 2,268 | 2,388 |
| Mean | 3.992 | 3.048 | 0.875 | 3.312 | 2.879 | 2.678 |
| 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 all listed manufacturing firms. Standard errors are robust and clustered at the firm level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table 6: Which service firms benefit more?

| | (1) Ln(Sales) | (2) Ln(Conctr) | (3) Ln(R&D) | (4) Ln(Empl) | (5) Ln(Wage) | (6)) Ln(No. of new patents) |
|---|---|---|---|---|---|---|
| **Panel A: pre-reform size** | | | | | | |
| $\text{Service}_i \times \text{Post}_{i,t}$ | -0.050 | 0.072 | -0.001 | -0.061 | 0.033 | -0.093 |
| | (0.091) | (0.111) | (0.101) | (0.081) | (0.062) | (0.370) |
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.507*** | -0.290** | 0.321** | 0.364*** | 0.280*** | 0.769* |
| $\times$ $\text{Large}_i$ | (0.111) | (0.121) | (0.125) | (0.096) | (0.077) | (0.400) |
| **Panel B: pre-reform quality of innovation** | | | | | | |
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.593*** | -0.136 | 0.446*** | 0.254* | 0.322*** | 0.879*** |
| | (0.135) | (0.126) | (0.128) | (0.136) | (0.100) | (0.300) |
| $\text{Service}_i \times \text{Post}_{i,t}$ | -0.299** | -0.032 | -0.240 | -0.026 | -0.080 | -0.019 |
| $\times$ $\text{More innovative}_i$ | (0.148) | (0.134) | (0.147) | (0.143) | (0.109) | (0.367) |
| Observations | 13,346 | 12,664 | 13,346 | 13,336 | 13,295 | 12,180 |
| # firms | 2,340 | 2,326 | 2,340 | 2,340 | 2,336 | 2,147 |
| Mean | 21.221 | 3.207 | 17.620 | 7.649 | 18.993 | 3.704 |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm FEs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Note: This table reports the estimated effects of the reform for services firms with different characteristics. In Panel A, we show results for small and larger firms, in Panel B for more and less innovative firms, both prior to the reform. In Panel A, $Large_i$ equals 1 if the treated firm's total assets before the reform (in logs) is above the sample median. In Panel B, *More innovative* equals 1 if the treated firm's pre-reform quality of innovation is above the sample median. We measure the quality of innovation by the number of patent citations before the reform. We present results for the following outcome variables sales (column 1), customer concentration (column 2), R&D expenditures (column 3), number of employees (column 4), wages (column 5), and number of new patents (column 6). All outcome variables are in 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 all listed manufacturing 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, cost of capital, price effects

| Sample | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Financing constraints | | | | Cost of capital | | Price effect | |
| | Ln(R&D) | Ln(R&D) | Ln(Empl) | Ln(Empl) | Ln(R&D) | Ln(Empl) | Tax/Assets | Ln(Price) |
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.161 | 0.243** | 0.179** | 0.144* | 0.269*** | 0.265*** | -0.001 | -0.008 |
| | (0.123) | (0.111) | (0.089) | (0.087) | (0.090) | (0.063) | (0.001) | (0.020) |
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.224 | 0.073 | 0.066 | 0.138 | | | | |
| $\times More\ constrained_i$ | (0.142) | (0.136) | (0.104) | (0.103) | | | | |
| $\text{Service}_i \times \text{Post}_{i,t}$ | | | | | -0.022 | -0.067 | | |
| $\times High\ labor_i$ | | | | | (0.136) | (0.098) | | |
| Year FE | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Firm FEs | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Observations | 6,560 | 7,172 | 6,554 | 7,166 | 13,346 | 13,336 | 5,746 | 20 |
| # firms | 951 | 1,060 | 951 | 1,060 | 2,340 | 2,340 | 1,027 | |
| Mean | 17.798 | 17.744 | 17.798 | 17.744 | 17.620 | 7.649 | 0.031 | |

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. In column 7, we examine changes in treated firms' tax burden, which is the ratio of tax paid (the sum of BT and VAT) to total assets. 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 listed manufacturing firms in columns 1-6, and consists of less connected manufacturing firms in column 7. In column 8, we examine changes in industry-level price indices (in logs) for manufacturing industries that are exposed to the B2V reform to different degrees. Service dummy in column 8 is 1 when a manufacturing industry has a high purchasing ratio from service industries. Standard errors are robust and clustered at the firm level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

# Appendices

## 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 RD investment is positive, and 0 otherwise.
**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.
**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.
**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.

# B How representative are the listed firms?

One may be concerned about how representative the listed firms are. To attenuate concerns that our main results come from a selected sample of firms and do not represent the population of firms in China, we do two things. First, we present results using the universe of Chinese tax returns between 2009 - 2016. Then we examine effect of the reform using aggregated province-industry level data.

## B.1 Evidence from tax returns data

In this section, we compare R&D investment across size distributions in the listed firm sample and the NTSD. We report the results in Table B1. Table B2 presents results using the populations of tax returns in China for years 2009 -2016. We consider the effects of the reform on sales, R&D, capital expenditures, employment, tax burden, and the amount of outsourced R&D. We do not have data on customer concentration or wages for non-listed firms. We ensure that for sales, R&D, capital expenditures and employment, we consider the same sample of firms. In Table B2, we present results with firm and year fixed effects only. These are analogous to results in Panel A in Table 3.

Table B1: R&D investment across firm size quintiles: comparison between listed firms and tax returns data

| | (1) Q1 | (2) Q2 | (3) Q3 | (4) Q4 | (5) Q5 |
|---|---|---|---|---|---|
| **Panel A: Tax returns data** | | | | | |
| Ln(R&D) | 0.276 | 0.689 | 1.126 | 1.599 | 1.281 |
| R&D expenditures | 8 | 48 | 156 | 443 | 581 |
| Pr($R\&D > 0$) | 0.025 | 0.055 | 0.082 | 0.110 | 0.085 |
| Ln(Total assets) | 12 | 15 | 16 | 18 | 20 |
| Total assets | 374 | 3,223 | 11,783 | 48,947 | 1,402,885 |
| Observations | 137,407 | 94,583 | 101,960 | 94,307 | 126,580 |
| **Panel B: Listed firms** | | | | | |
| Ln(R&D) | 16.946 | 17.664 | 18.117 | 18.286 | 17.739 |
| R&D expenditures | 31,475 | 64,129 | 134,201 | 186,632 | 206,364 |
| Pr($R\&D > 0$) | 0.824 | 0.861 | 0.793 | 0.681 | 0.626 |
| Ln(Total assets) | 20.279 | 21.133 | 21.730 | 22.434 | 23.862 |
| Total assets | 689,339 | 1,530,000 | 2,780,000 | 5,680,000 | 34,000,000 |
| Observations | 383 | 363 | 338 | 416 | 543 |

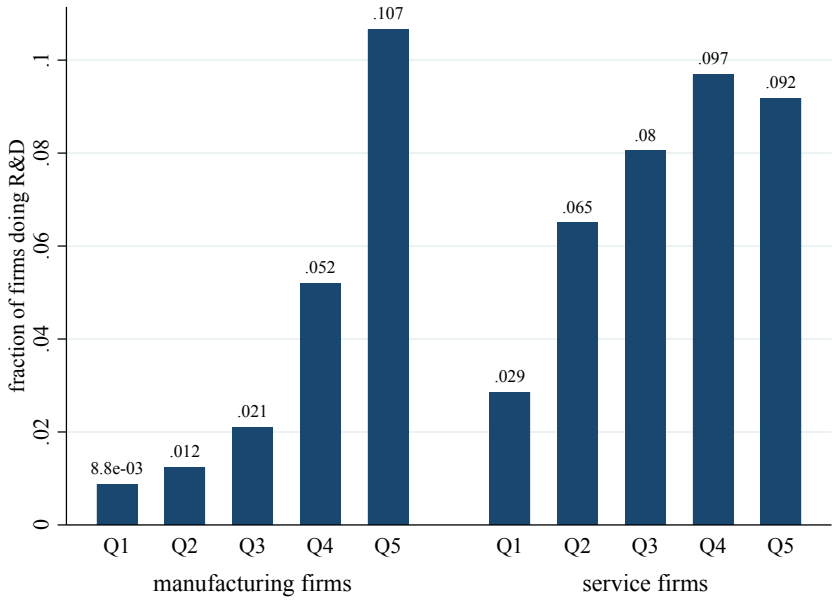
Note: This Table reports the average R&D and firm size across firm size quintiles. Here, we only report results for service firms. Panel A reports these statistics using the tax returns data, while Panel B uses the sample of listed firms. R&D expenditures and total assets are both in thousands of RMB. Pr($R\&D > 0$) is the percentage of firms in each size quintile that report positive R&D expenditures. The sample period is 2009 - 2016.

Table B2: Impact of the B2V reform on firm performance: evidence from tax returns

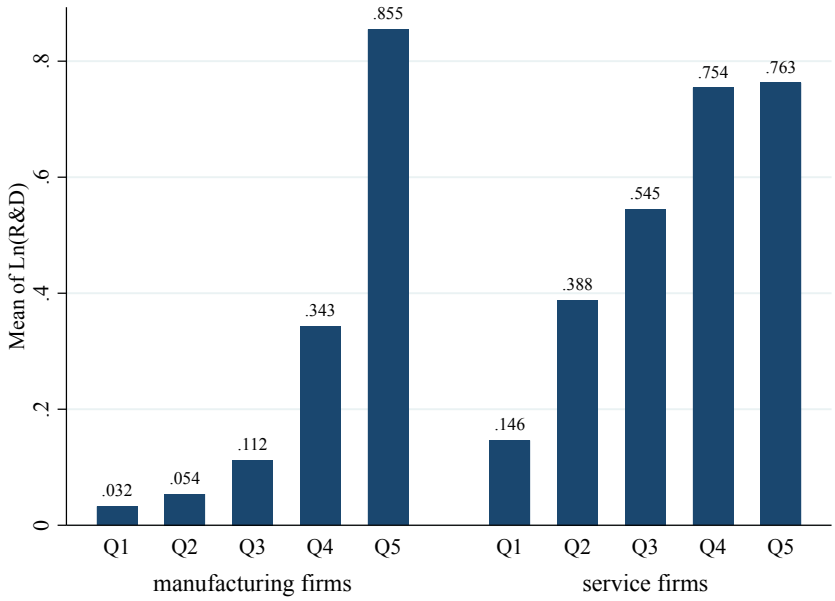
| | (1) Ln(Sales) | (2) Ln(Capex) | (3) Ln(R&D) | (4) R&D dummy | (5) Ln(Empl) | (6) Tax/Assets |
|---|---|---|---|---|---|---|
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.091*** | 0.184*** | 0.157*** | 0.019*** | 0.044*** | -0.005*** |
| | (0.010) | (0.022) | (0.013) | (0.002) | (0.006) | (0.001) |
| Observations | 998,718 | 998,718 | 998,718 | 998,718 | 998,718 | 992,476 |
| # firms | 391,131 | 391,131 | 391,131 | 391,131 | 391,131 | 388,535 |
| Mean | 9.926 | 3.646 | 0.535 | 0.073 | 3.704 | 0.068 |

Note: This table reports the difference-in-differences estimated effects of the B2V reform on treated service firms' sales (column 1), capital expenditures (column 2), R&D expenditures (column 3), the extensive margin of conducting any R&D investment (column 4), number of employees (column 5), and tax burden defined as total turnover and VAT tax scaled by total assets (column 6), based on the NTSD. 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 all manufacturing firms. 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: R&D investment by firm size quintile in the NTSD



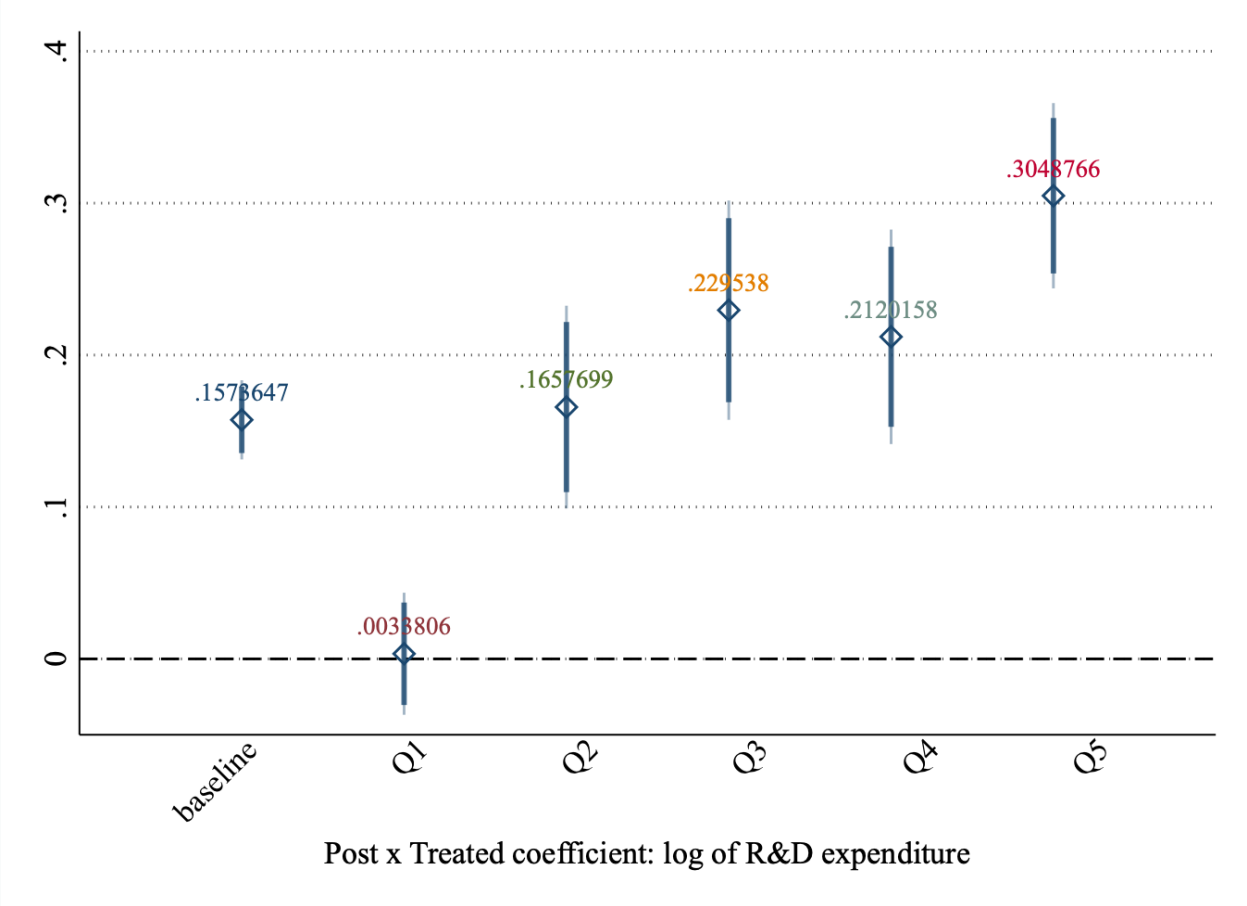

a % of firms making R&D investment




b Ln(R&D)

Note: This figure illustrates R&D investment across firms of different sizes in the NTSD, based on data in 2011. In Panel A, we plot the share of firms in total firms making any R&D investment across the size quintiles, for the treatment and control groups seperately. In Panel B, we plot the average of R&D investment (in logs) across size quintiles.

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. We present estimates without control variables here. 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 all manufacturing firms. Standard errors are robust and clustered at the firm level.

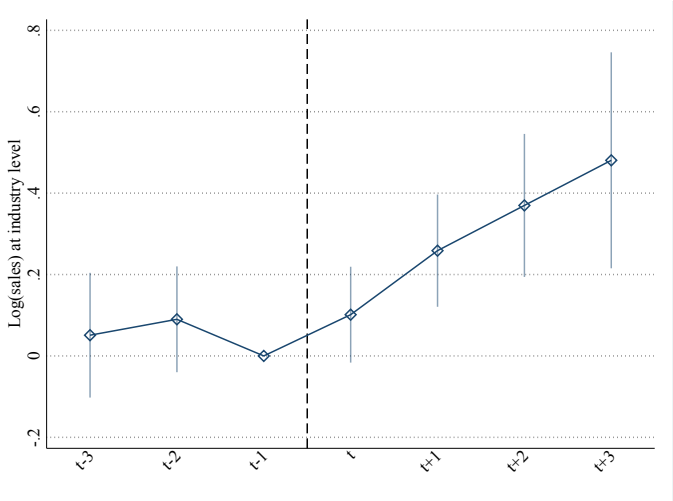
## B.2 Industry level results

Second, we use aggregated province-industry level data for the software industry obtained from the database WIND.[26] Over 80% of our treated firm-year observations come from the software industry. Thus, analyses based on the software industry at the province level should shed some light on whether the increase in sales documented among listed software firms can be also found at the aggregate level. As a comparison, we collect province-industry level aggregate sales for the manufacturing industries in our control group from the statistics yearbooks published by the National Bureau of Statistics.

We find that the software industry experienced a 30% increase in sales since the B2V reform relative to manufacturing industries in the control group. This effect is statistically significant at the 1 percent level, with a p-value of 0.007. The sample we have includes 605 observations. We present the dynamic evolution of these changes in Figure B3. Our findings are consistent with the positive effect of the B2V reform we find on firm-level sales in Table 3. Together with the results from Table 3, these estimates suggest that the B2V reform created a positive demand shock for the treated service industries as a whole, and this effect is not unique to listed firms in our sample.

[26] We did not find aggregate sales at the province level for other treated industries, as the Chinese official statistics usually focus on the manufacturing sector and do not provide information on the service industries.

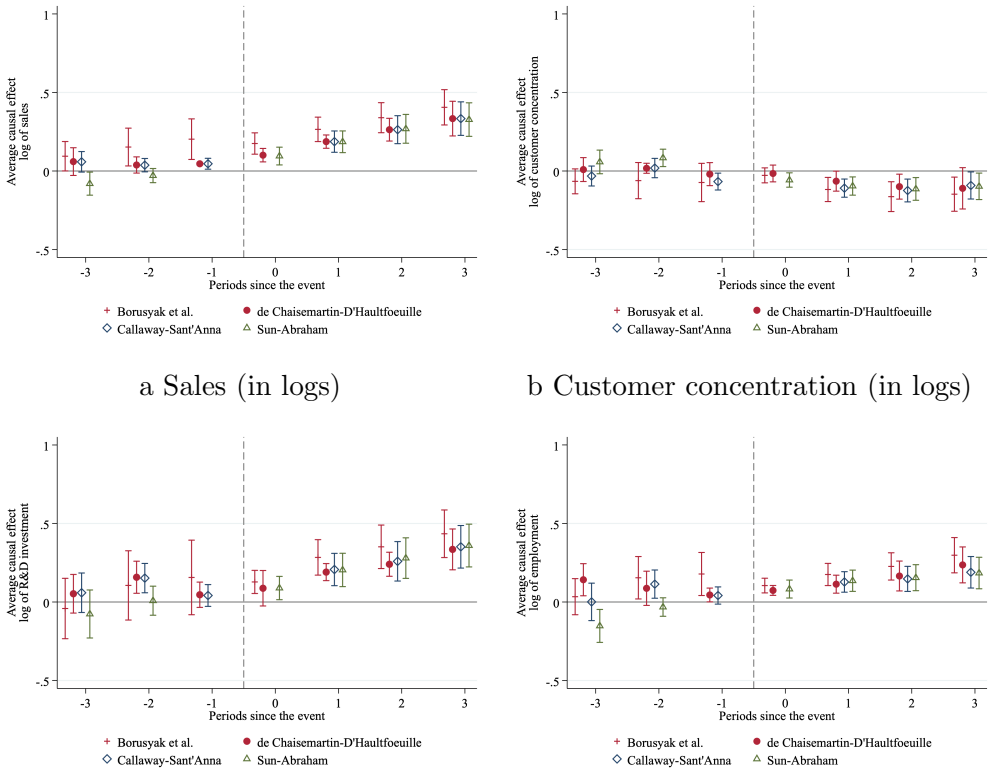
Figure B3: Dynamic effects of the B2V reform on the software industry




Note: This figure reports the dynamic effects of the reform on sales of the software industry at the province level. We plot the event study coefficient for the software industryrelative to the manufacturing industries, at each province level, from 3 years before the reform to 3 or more years after the reform. Each dot represents the coefficient estimate, while each vertical line represents the 95% confidence intervals. We control for year and province-level fixed effects when estimating these differences. Standard errors are robust and clustered at the province level.

# C Additional figures and tables

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




a Sales (in logs)

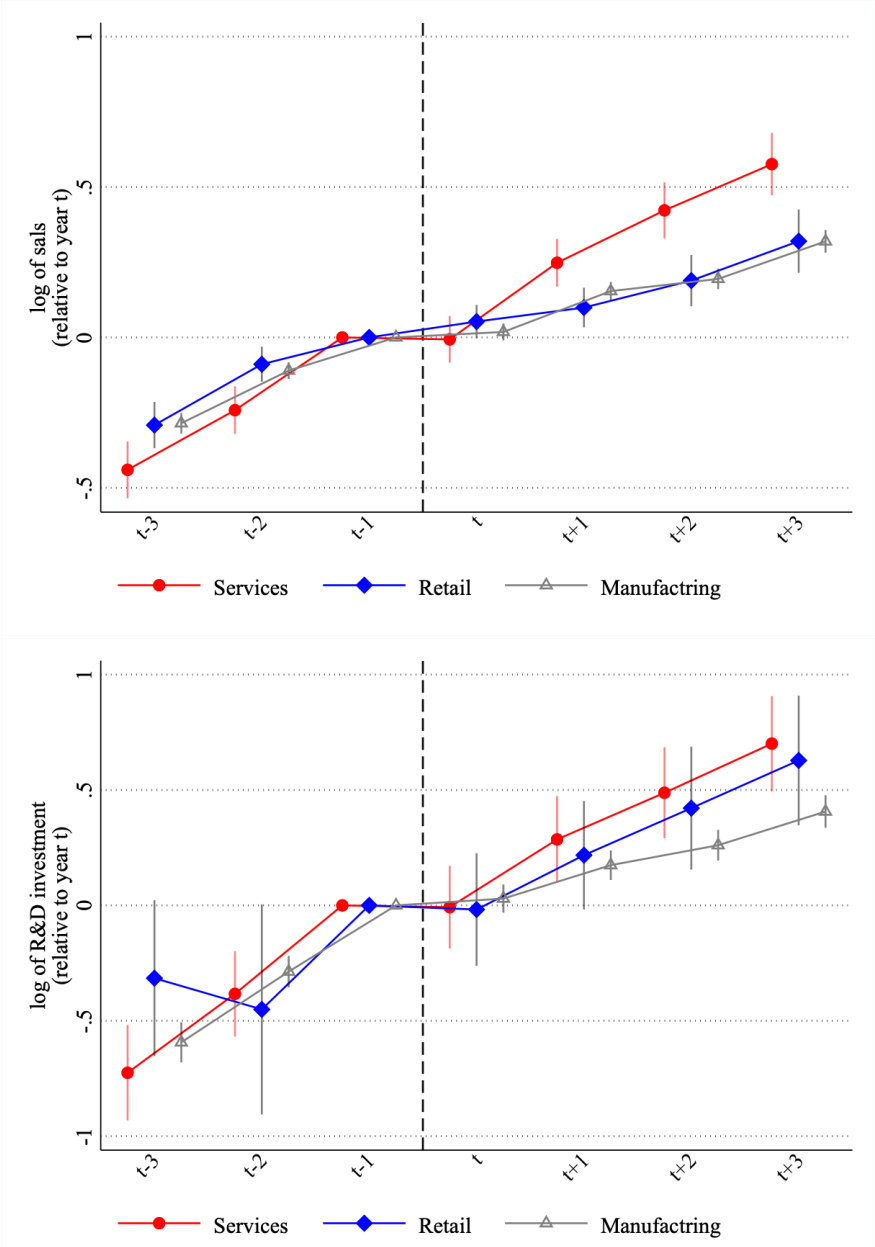
b Customer concentration (in logs)

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 or more 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 all listed manufacturing firms. Standard errors are robust and clustered at the firm level.

Figure C2: Using retail firms as the alternative control group




Note: This figure reports the dynamic effects of the B2V reform on sales (Panel a) and R&D expenditures (Panel b), when we use different firms as the alternative control group. 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 group (red filled dots), the baseline control group (grey hollow diamonds), and an alternative control group of retail firms (blue filled 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 baseline control group consists of all manufacturing firms. Standard errors are robust and clustered at the firm level.

Table C1: 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 all listed manufacturing firms. In the decomposition, we include year fixed effect, but no controls. Standard errors are robust and clustered at the firm level.

Table C2: Impact of the B2V reform on firm performances: using retail firms as the alternative control group

| | (1) Ln(Sales) | (2) Ln(Conctr) | (3) Ln(Capex) | (4) Ln(R&D) | (5) Ln(Empl) | (6) Ln(Wage) |
|---|---|---|---|---|---|---|
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.262*** | -0.338*** | 0.076 | 0.062 | 0.164*** | 0.223*** |
| | (0.058) | (0.106) | (0.113) | (0.130) | (0.062) | (0.047) |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm FEs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 4,674 | 3,671 | 3,961 | 1,848 | 5,931 | 5,922 |
| # firms | 636 | 660 | 702 | 351 | 783 | 783 |
| Mean | 21.412 | 0.404 | 17.985 | 17.531 | 7.249 | 18.809 |

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). In Panel A, we present results with firm and year fixed effects, and in Panel B, we add firm-level control variables, including firm size, age, returns on assets (ROA), leverage, subsidy and firm-specific and time-varying nominal corporate income tax rate. 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 all listed manufacturing firms. Standard errors are robust and clustered at the firm level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

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

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | More onnected | | | Less connected | | |
| | Input-output | | | Input-output | | |
| | Chinese | US | Upstreamness | Chinese | US | Upstreamness |
| **Panel A: Impact on R&D expenditures** | | | | | | |
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.259*** | 0.232*** | 0.245*** | 0.167*** | 0.157** | 0.173*** |
| | (0.068) | (0.061) | (0.065) | (0.060) | (0.064) | (0.061) |
| Observations | 3,232 | 5,267 | 4,167 | 5,362 | 4,116 | 5,219 |
| **Panel B: Impact on employment** | | | | | | |
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.236*** | 0.194*** | 0.190*** | 0.169*** | 0.176*** | 0.172*** |
| | (0.045) | (0.044) | (0.045) | (0.044) | (0.046) | (0.046) |
| Observations | 4,882 | 7,486 | 9,857 | 7,694 | 9,122 | 6,758 |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm FEs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Note: This table reports the estimated effects of the reform on R&D expenditures and employment (both in logs) across various control group thresholds. In Panel A, we report estimates for R&D expenditures and in Panel B, we report estimates for employment. In columns 1-3 we include as control group only manufacturing firms that are more connected with service firms. In columns 4-6 we include as control group only manufacturing firms that are less connected with service firms. In each case, we split firms according to the median level of connectedness, measured using: the 2012 industry input-output tables from Chinese Statistical office (columns 1, 4); the 2012 industry input-output tables from US Bureau of Economic Analysis (columns 2, 5); and a measure of industry upstreamness from Antràs et al. (2012) (columns 4, 6). 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: Outsourcing: robustness using different control groups

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Panel A: Ln(R&D) without controls** | | | | | | | |
| | (1) below 30% | (2) below 40% | (3) below 50% | (4) below 60% | (5) below 70% | (6) below 80% | (7) below 90% |
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.152** | 0.177*** | 0.195*** | 0.217*** | 0.199*** | 0.196*** | 0.196*** |
| | (0.069) | (0.067) | (0.065) | (0.061) | (0.059) | (0.059) | (0.059) |
| Observations | 3,130 | 3,522 | 4,011 | 5,511 | 6,972 | 7,396 | 7,608 |
| **Panel B: Ln(R&D) with controls** | | | | | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.044 | 0.047 | 0.060 | 0.087** | 0.081* | 0.079* | 0.081* |
| | (0.048) | (0.047) | (0.046) | (0.044) | (0.043) | (0.042) | (0.042) |
| Observations | 3,090 | 3,479 | 3,965 | 5,442 | 6,889 | 7,309 | 7,518 |
| Controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Panel C: Ln(Employment) without controls** | | | | | | | |
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.177*** | 0.186*** | 0.205*** | 0.185*** | 0.183*** | 0.179*** | 0.189*** |
| | (0.047) | (0.046) | (0.045) | (0.044) | (0.043) | (0.043) | (0.043) |
| Observations | 4,797 | 5,359 | 5,976 | 8,000 | 9,827 | 10,361 | 10,756 |
| **Panel D: Ln(Employment) with controls** | | | | | | | |
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.042 | 0.048 | 0.063** | 0.053* | 0.056* | 0.058* | 0.062** |
| | (0.032) | (0.031) | (0.031) | (0.030) | (0.029) | (0.029) | (0.029) |
| Observations | 4,797 | 5,359 | 5,976 | 8,000 | 9,827 | 10,361 | 10,756 |
| Controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm FEs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Note: This table reports the estimated effects of the reform on R&D expenditures and employment across various control groups. In Panels A and B, we report estimates for R&D expenditures, and in Panels C and D we report estimates for employment. In Column 1, we include only manufacturing firms from industries that sell (or purchase) less than 30% of their output to (or from) affected service firms in the control group. Moving to the right, we increase the ratio by 10 percentage points in each column. Firm controls include size, age, returns on assets (ROA), leverage, subsidy and firm-specific and time-varying nominal corporate income tax rate. We define each of those variables in Appendix A. Standard errors are robust and clustered at the firm level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table C5: 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) |
|---|---|---|---|---|---|---|
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.273** | -0.149*** | 0.122 | 0.205** | 0.215** | 0.177 |
| | (0.085) | (0.030) | (0.085) | (0.071) | (0.080) | (0.100) |
| Observations | 18,919 | 16,966 | 13,929 | 8,545 | 18,912 | 18,857 |
| # firms | 2,647 | 2,910 | 3,209 | 3,419 | 2,652 | 2,650 |
| Mean | 21.270 | 3.193 | 18.498 | 17.513 | 7.632 | 18.965 |
| 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 all listed manufacturing firms. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table C6: The impact of the reform on B2C firms

| | (1) Ln(Sales) | (2) Ln(Capex) | (3) Ln(R&D) | (4) Ln(Empl) | (5) Ln(Wage) |
|---|---|---|---|---|---|
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.155 | -0.309 | 0.000 | -0.080 | -0.006 |
| | (0.103) | (0.280) | (0.176) | (0.118) | (0.089) |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm FEs | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 6,140 | 4,891 | 6,140 | 6,135 | 6,130 |
| # firms | 976 | 945 | 976 | 976 | 975 |
| Mean | 21.267 | 18.507 | 17.668 | 7.699 | 19.014 |

Note: This table reports the estimated effects of the B2V reform for a sub-sample of treated firms in B2C industries (including transportation services, culture and entertainment, and commercial services). We consider the following outcomes: sales (column 1), capital expenditures (column 2), R&D expenditures (column 3), number of employees (column 4) and wages (column 5). The control group consists of all listed manufacturing firms. Standard errors are robust and clustered at the firm level.

Table C7: Heterogeneous impact of the B2V reform on manufacturing firms' R&D investment and employment.

| | (1) Ln(R&D) | (2) Ln(Empl) | (3) Ln(R&D) | (4) Ln(Empl) |
|---|---|---|---|---|
| $\text{Large}_i \times$ post | 0.087** | 0.160*** | | |
| | (0.037) | (0.027) | | |
| More $\text{innovative}_i \times$ post | | | 0.327*** | 0.054* |
| | | | (0.101) | (0.032) |
| Year FE | ✓ | ✓ | ✓ | ✓ |
| Firm FEs | ✓ | ✓ | ✓ | ✓ |
| Observations | 9,800 | 16,065 | 9,800 | 16,065 |
| # firms | 1,883 | 2,385 | 1,883 | 2,385 |
| Mean | 17.563 | 7.553 | 17.563 | 7.553 |

Note: This table reports the estimated effects of the B2V reform on manufacturing firms' R&D investment (columns 1 and 3) and employment (column 2 and 4). In this table, we *only* include manufacturing firms. The first two columns examine heterogeneity of the response in terms of firm size, where we compare large manufacturing firms with small manufacturing firms. The last two columns examine heterogeneity of the response in terms of firms' innovation quality, where we compare more innovative manufacturing firms with less innovative manufacturing firms. We define large firms as those with above-median total assets before the reform, and more innovative firms as those with above-median patents before the reform. The standard errors are robust and clustered at the firm level. Standard errors are robust and clustered over firm. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

# D Propensity score matching

We use propensity score-matching to construct the alternative treated and control groups, based on the observed firm-level characteristics including firm size, age, ROA, leverage, the level of subsidies received from the government (in logs), and individual firm-level corporate income tax rate. All these covariates are measured in 2011 before the implementation of the B2V reform. First, we estimate the following probit model:

$$Service_i = \alpha_0 + \alpha_1 \times X_i^{'} + \epsilon_i \tag{3}$$

where $Service_i$ equals 1 if firm i belongs to the selected service industry treatment group, and 0 when it is a selected manufacturing firm with weak links to service industry. $X_i^{'}$ is a vector of firm-level characteristics. $\epsilon_i$ is the error term. The predicted probabilities from this regression — propensity scores — are used to construct the matched sample of service and manufacturing firms. We use kernel matching, which assigns inverse probability weights to control group observations. Table D1 reports the means of key variables for the treatment and the control groups before and after our matching procedure, together with a pairwise t-test and the bias reduction that results from matching.

Table D1: Matching properties

| Variable | Group | Treated | Control | t-test | % bias | % bias reduction |
|---|---|---|---|---|---|---|
| Size | Unmatched | 21.689 | 21.579 | 1.23 | 8.5 | |
| | Matched | 21.678 | 21.667 | 0.09 | 0.9 | 90 |
| Age | Unmatched | 12.226 | 12.339 | -0.3 | -2.2 | |
| | Matched | 12.175 | 12.239 | -0.12 | -1.2 | 43.6 |
| ROA | Unmatched | 0.065 | 0.045 | 4.92*** | 38.2 | |
| | Matched | 0.066 | 0.068 | -0.32 | -2.8 | 92.5 |
| Leverage | Unmatched | 0.348 | 0.397 | -2.93 | -21.8 | |
| | Matched | 0.345 | 0.347 | -0.1 | -1 | 95.6 |
| Subsidy | Unmatched | 15.894 | 15.962 | -0.56 | -4.1 | |
| | Matched | 15.894 | 15.943 | -0.29 | -3 | 27.9 |
| CIT | Unmatched | 0.193 | 0.174 | 5.71*** | 39.7 | |
| | Matched | 0.192 | 0.189 | 0.55 | 5.7 | 85.8 |

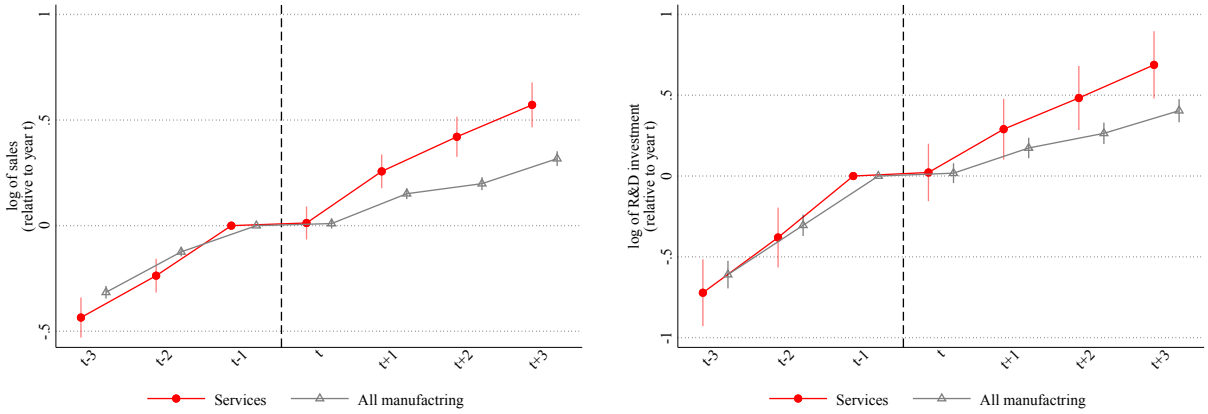
Note: This table reports the matching properties for the list of matching variables we use. % bias reduction is calculated as (% bias of unmatched sample-% bias of matched sample)/(% bias of unmatched sample). For variable definitions, see Appendix A.

Table D2: Difference-in-differences estimations based on the matched sample

| | (1) Ln(Sales) | (2) Ln(Conctr) | (3) Ln(Capex) | (4) Ln(R&D) | (5) Ln(Empl) | (6) Ln(Wage) |
|---|---|---|---|---|---|---|
| **Panel A: No controls** | | | | | | |
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.223*** | -0.127*** | 0.073 | 0.227*** | 0.173*** | 0.127*** |
| | (0.043) | (0.033) | (0.097) | (0.069) | (0.044) | (0.039) |
| Observations | 16,565 | 14,712 | 12,769 | 11,016 | 16,568 | 16,516 |
| # firms | 1,144 | 1,255 | 1,407 | 1,049 | 1,147 | 1,146 |
| Mean | 21.372 | 3.168 | 18.544 | 17.687 | 7.710 | 7.710 |
| **Panel B: Including controls** | | | | | | |
| $\text{Service}_i \times \text{Post}_{i,t}$ | 0.099*** | -0.100*** | -0.080 | 0.067 | 0.055* | 0.021 |
| | (0.024) | (0.031) | (0.087) | (0.057) | (0.031) | (0.026) |
| Observations | 15,645 | 13,931 | 12,188 | 10,643 | 15,631 | 15,596 |
| # firms | 1,139 | 1,274 | 1,395 | 1,045 | 1,141 | 1,139 |
| Mean | 21.408 | 3.157 | 18.558 | 17.682 | 7.754 | 7.754 |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm FEs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Note: This table reports the estimated effects of the reform on the treated firms' sales, customer concentration, capital expenditures, R&D investment, employment and wage based on a matched sample. We use kernel propensity score matching to match firms based on firm-level information in 2011. In Panel A, we present results with firm and year fixed effects, and in Panel B, we add firm control variables. Firm controls include size, age, returns on assets (ROA), leverage, subsidy and firm-specific and time-varying nominal corporate income tax rate. The treated group consists of matched listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of matched listed manufacturing firms. Standard errors are robust and clustered at the firm level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Figure D1: Matched sample: dynamic estimation results




Note: This figure reports the dynamic estimation results for the impact of the reform on sales (panel a) and R&D expenditures (panel b), based on the matched sample. 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 service firms (red filled dots) and manufacturing firms (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 matched listed firms in service industries moving from BT to VAT by 2015, as outlined in Table 1. The control group consists of matched manufacturing firms. Standard errors are robust and clustered at the firm level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.