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Abstract The impact of China's value-added tax (VAT) reform on enterprise innovation is the result of a combination of tax cuts and various endogenous incentives. In this study, we find evidence that China' s VAT reform largely reduced the tax burden of firms but had a differing impact on the manufacturing and service industries. The tax burden on manufacturing enterprises dropped significantly, but the burden on the service industry did not change markedly. Furthermore, China's VAT reform also had a significant positive impact on corporate innovation in both the service and manufacturing industries. However, these effects were significantly greater on the manufacturing industry. Meanwhile, China's VAT reform did not alleviate the tax burden on all enterprises. For enterprises facing an increased burden of tax, the reform can help stimulate enterprise innovation if the enterprise has sufficient capital, whereas the impact coefficient and significance level are considerably lower than that for enterprises in which the tax burden had reduced. If an enterprise has insufficient capital, VAT reform has little effect on enterprise innovation. Finally, we show that China's VAT reform exerted different influences on the innovation behaviour of heterogeneous enterprises.

Keywords China's VAT reform, Tax Burden, Innovation, Corporate Heterogeneity

JEL Classification H20 · O10 · O31

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1 Introduction

The transition from a business tax to value-added tax (also referred to as 'China's VAT reform') constitutes a major change to China's contemporary taxation system. From January 2012—when the experimental reform began across specific industries in some regions—until May 2016—when the reform was implemented uniformly across all institutions in China—the impact of this reform has emerged gradually. The original intention of this reform was to alleviate the tax burden on enterprises, facilitate the adjustment of the economic structure, and encourage industrial upgradation via tax reform. Taxation reform has often been regarded as an important tool to facilitate economic structure adjustment and industrial upgradation. According to the general principle of economics, adjustment of the economic structure and industrial upgradation cannot be achieved in an arbitrary manner. It must be preceded by the independent innovation of enterprises. China is facing economic difficulties as the economy enters a 'new normal' and the external environment becomes tight; therefore, innovation will be at the heart of the sustainable development of the Chinese economy. The report submitted by the 19th National Congress of the Communist Party of China clearly states that innovation is the primary force guiding development in the country. Therefore, only by stimulating innovation can China's VAT reform facilitate the adjustment of the economic structure and industrial upgradation. In modern society, enterprises experience significant innovation over the course of their existence. Thus, whether China's recent VAT reform stimulates enterprises' innovation, is an important research question.

The correlation between taxes and innovation has previously been studied from the perspective of income tax, as it is convenient to create institutional arrangements that are conducive for innovation by revising income tax. This includes giving pre-tax credit against the cost of innovation and levying a lower tax rate on innovation income. In fact, income tax has been designed along the same lines in many countries. It is generally accepted that offering tax incentives promotes innovation (Atkinson 2007; Ernst et al. 2014; Jolley et al. 2015). Tassey (2007) argues that tax incentives introduced by a government to encourage innovation would fail if other countries implement a bigger preferential tax policy. While he points to conditions under which tax incentives being used to motivate enterprises' innovation would fail in the open economy, he does not deny the overall effectiveness of offering tax incentives to encourage innovation. The aforementioned conclusions are all based on the study of China's income tax. However, there are over 130 countries and regions where VAT is implemented (Keen and Lockwood 2010). Furthermore, the input tax credit of VAT provides the possibility of designing an institution from which innovation could benefit. However, concrete research on the impact of VAT on innovation is considerably lacking. VAT has contributed the most to fiscal revenue since China's tax reform in 1994. On January 1, 2009, China transitioned from a production-type VAT to consumption-type VAT. The VAT transition is considered to play a significant role in promoting the development of high-tech industries (Yu and Jiang 2014), which also implies that the current VAT system theoretically has the genes to stimulate innovation. Before the VAT reform was introduced, VAT exclusively focused on manufacturing, while business tax focused on the service industry. Therefore, VAT reform primarily

focused on the transition of taxation in the service industry from business tax to value-added tax. This transition exerted a lot of influence, attracting attention from Chinese scholars. Before 2017, their research focused on the following aspects: (1) the impact on enterprises' tax burden (Tian and Hu, 2013; Tong et al. 2015); (2) the impact on enterprises' investment behaviour (Yuan et al., 2015); (3) the analysis of the effects of specialisation (Chen and Wang 2016; Fan and Peng 2017); and (4) the impact on income distribution (Ge et al. 2015; Nie et al. 2016). Meanwhile, little work has been published that exclusively studies VAT reform from the perspective of stimulating enterprise innovation. Yuan et al. (2018) analysed the impact of VAT reform on enterprise technology innovation using the service industry as a sample and argued that VAT reform benefits enterprise innovation, due to the reduction in enterprise tax burden. Tan et al. (2017) showed that VAT reform has significantly promoted service enterprises' investment in research and development. According to Wang and Cao (2018), VAT reform significantly inhibits the willingness of service enterprises to engage in innovation. The existing literature on the impact of VAT reform on enterprise innovation is mainly concentrated on the service industry, without sufficient attention paid to manufacturing, and the results are ambiguous, which provides space for further research, as highlighted in this study.

The contributions of this paper are mainly reflected in three aspects: (1) While some recent studies have examined the correlation between VAT and innovation, the study of mainstream tax on innovation is limited to that of income tax. This study analyses the impact of China's VAT reform on innovation and extends the aspects of the study on the correlation between tax and innovation from income tax to commodity tax, while expanding the research scope of taxation. (2) VAT reform is a change to the taxation system that occurred in the service industry, and seems unrelated to manufacturing. Therefore, most existing research only examines the impact of VAT reform on the tax burden on the service industry, but ignores its impact on the tax burden on manufacturing, which leads to the incomplete understanding of the impact of VAT reform on the tax burden on all industries. (3) In existing literature on the correlation between VAT reform, enterprise tax burden, and innovation, VAT reform alleviates enterprise tax burden in order to stimulate innovation. The reduction of enterprise tax burden is viewed as the sole motivation behind innovation. However, we argue that the reduction of enterprise tax burden provides enterprises with the ability to participate in innovation. More importantly, the motivation for innovation attributes to the transformation of internal incentives. The impact of China's VAT reform on enterprise innovation is the result of a combination of tax cuts and various endogenous incentives.

This study establishes the following four main results: first, China's VAT reform significantly reduced the tax burden on manufacturing industries, whereas its effect on service industries was insignificant. Second, China's VAT reform generally reduced the tax burden on enterprises and improved their ability to innovate. More importantly, compared to business tax, VAT has a stronger impact on stimulating the intrinsic and dynamic mechanisms of innovation. The impact of China's VAT reform on corporate innovation is the result of a combination of tax cuts and various endogenous incentives. Third, China's VAT reform did not alleviate the tax burden on all enterprises. For enterprises facing an increased tax burden, the reform can still stimulate enterprise innovation if the enterprise has sufficient capital. However, if the enterprise' s capital is insufficient, VAT reform has little effect on enterprise innovation. Finally, China's VAT reform exerted a differing impact on the incentives for innovation of heterogeneous enterprises.

The remainder of this paper is organised as follows: Section II presents a theoretical model and proposes a research hypothesis. Section III presents the empirical design and data description. Sections IV and V show the results of the empirical analysis. Section VI concludes.

2 Theoretical framework and hypotheses

Maximising profits is the main objective of an enterprise. Reducing the tax burden on enterprises contributes to achieving this. In modern society, innovation is key to determining enterprise survival and development. Reducing the tax burden on enterprises will enhance their ability to engage in innovation. According to this logic, the first step in studying the theoretical impact of China's VAT reform on innovation is to analyse the impact of the reform on the tax burden of enterprises and then explore how this tax burden affects innovation.

2.1 China's VAT Reform and Tax Burden on Enterprises

Before the VAT reform, taxation via business tax covered construction, transportation, post and telecommunications, culture and sports, finance and insurance, entertainment, and other living services. The basis of taxation before the reform was the provision of the turnover of taxable services, the amount of the transfer of intangible assets, and/or the sale of the immovable assets. The tax rate varied from 3% to 20%, according to taxable items, and the tax rate which was at 11% was reduced to 10% in 2019. After the comprehensive experiments of VAT reform, industries on which business tax was levied – except for small-scale taxpayers – no longer pay a full tax on turnover and/or sales. In the early stages of the implementation of the reform, two different categories of the tax rate: 11% and 6%, were imposed on these industries according to different regulations of input tax deduction of different industries. The policymakers regard the VAT reform as tax cuts and require a reduction in the tax burden on all industries after the reform. According to existing institutional arrangements, although the apparent tax rate of VAT is generally higher than the tax rate of business tax, VAT allows the deduction of tax on items purchased, while business tax is a full tax on operating income. Therefore, if the design of the tax rate is reasonable, VAT reform could theoretically fulfil the requirement of tax cuts in the service industry over a short time.

Although the existing VAT system design can theoretically reduce the tax burden on the service industry, in the actual operation process, it is very difficult to reduce the tax burden on all enterprises in the service industry. Expenditures of many service enterprises mainly focus on wages, while the proportion of the expenditure on raw materials and fixed assets is not large. Based on the existing regulation of input tax credits under the VAT reform, wages cannot be deducted from input tax, which means that the tax burden on asset-light enterprises will only increase. Of course, asset-light enterprises may assemble all assets for input tax credits at the beginning of the VAT reform in order to receive tax cuts. However, in the long term, their tax burden will still increase due to the lack of raw materials and fixed assets that can be deducted from input tax. By contrast, VAT reform will enhance the tax compliance of enterprises (Mao and Liu 2017). Any evasion of tax in earlier stages will have been set right by the next stage. Therefore, both buying and selling parties will form a mutual supervision relationship, reducing the possibility of tax evasion so that the effective tax rate would correspondingly increase. In other words, while the tax burden of the entire service industry theoretically measured by VAT reform reduces, this does not rule out cases in which the tax paid by some enterprises does not reduce and even increases, considering the characteristics of asset-light

enterprises and the increased tax collection rate. Obviously, since the proportion of asset-light enterprises in the service industry is relatively large, the effect of VAT reform on tax cuts may not be significant for the entire service industry.

Although taxation via VAT is predominant in the service industry, the impact of VAT reform on enterprise tax burden is not limited to only the service industry. Before the VAT reform was introduced, VAT was not levied on the service industry. Advertising or other services purchased by manufacturing entities from the service industry were not eligible for the VAT special invoices by which they could claim input tax credits. After the VAT reform was introduced, however, manufacturing enterprises could obtain input tax credits on advertisements or other services purchased from the service industry. Therefore, VAT reform can potentially reduce the tax burden on manufacturing entities as well. Based on the above reasoning, the first hypothesis of this study is proposed.

Hypothesis 1 *China's VAT reform may significantly reduce the tax burden on manufacturing enterprises, but this reduction is not expected to be significant for enterprises in the service industry. In general, the reform may reduce the tax burden on the full sample enterprises.*

2.2 Enterprise Tax Burden and Innovation

It is widely believed that tax burden has a negative impact on enterprise innovation (Howell, 2016). However, the question is: Is it guaranteed that enterprises will increase investments in innovation so long as the tax burden reduces? Or: Will the increased tax burden decrease enterprises' investment in innovation?

Broadly, if VAT reform reduces the tax burden of enterprises, the after-tax profit of enterprises will increase, which in turn enhances the independent innovation capacity of enterprises. The crux of the matter is the question of whether enterprises would invest additional profits for innovation. Enterprises may face two options: one, additional profit encourage enterprises to innovate using part of their own capital to improve future profitability. Two, if enterprises believe that their existing technology can guarantee stable profits in the long term, they will not have the motivation to spend the additional profit for innovation. This shows that a reduction in the tax burden on enterprises improves the capacity for innovation of enterprises. However, it is not a given that enterprises will engage in innovation.

If the VAT reform increases the tax burden on enterprises, the after-tax profit of enterprises will decrease, which will weaken the independent innovation capacity of enterprises. Will the decline in profits necessarily lead to a reduction in enterprises' innovation activities? For enterprises with relatively sufficient accumulated capital, the decline in profits will increase the pressure of competition, further compelling enterprises to intensify innovation activities. On one hand, under the condition of declining profitability, capital accumulation provides funds for enterprises' innovation activities and on the other hand, it helps enterprises break free of financing constraints by obtaining external support to cover the cost of innovation. However, enterprises without sufficient capital accumulation, while facing the pressure of survival caused by the decline in profits, can neither utilise their own capital to innovate nor break free of the financing constraints to obtain external support for innovation. Therefore, in this case, an increase in the tax burden is harmful for innovation.

The above analysis partially explains the impact of changes in the tax burden of enterprises on

innovation. Furthermore, we raise another question. Regardless of whether VAT reform reduces the tax burden on enterprises, compared to business tax, is the system designed for VAT aptly characterised by motivating innovation?

According to the basic principles of taxation, VAT is levied on the value of goods or services that are provided every time there is a transaction. In Marxist economics, the full value of a product consists of: (V+V+M). Where (V+M) is the added value, C is the consumption of material goods during production, V is the wages, and M is the surplus value. The VAT is the levy on (V+M). After the VAT reform, VAT is levied on both the manufacturing and service industries. In order to accurately define the amount of added value, C includes both the consumption of material goods and all kinds of service consumptions offered by VAT special invoices. In contrast to VAT, business tax is levied on the full amount of operating income: (C+V+M). Therefore, the tax base of business tax is higher than that of VAT, but the business tax rate is generally lower than that of VAT. In the VAT system, 'C' is exempt from tax due to input tax credits. This exemption provides innovation incentives for enterprises. Innovation is an adventure of the cost of material goods and knowledge, including the purchase of raw materials, machinery and equipment, instruments, intellectual capital, and various service expenditures. All inputs that have been listed above fall within the scope of 'C'. The larger the value 'C', the larger is the input tax deducted, and the smaller the amount of VAT actually paid by enterprises. Enterprises that pay VAT will engage in innovation on their own initiative in order to reduce the tax burden. In a business framework, the cost of innovation is not deductible, which means that tax is levied on the full amount of operating income, which is: (C+V+M).

There is no motivation for enterprises to engage in innovation in order to reduce the tax burden. The comparison of the mechanism of taxation between VAT and business tax shows that VAT is more advantageous for providing innovation incentives. The fundamental reason for this is that the input tax credits of VAT enable the government to share the risks of innovation with enterprises, which is missing in the business tax system, even if the business tax rate is lower than the VAT rate. Existing literature provides sufficient evidence that offering tax deductions on enterprises' consumption of fixed assets (new material capital) or the costs of research and development is more effective than reducing the tax rate to encourage enterprise innovation (Shaha, 1995).

Based on the aforementioned analysis, while Hypothesis 1 proposes that the effect of VAT reform on tax cuts for service enterprises is insufficient and, therefore, its impact on improving service enterprise innovation is not obvious, VAT reform may comprehensively improve the innovation of the overall service industry, considering that the system design of VAT is characterised by innovation. The innovation capacity of manufacturing enterprises would improve since VAT reform has a significant effect on tax cuts for manufacturing enterprises. Additionally, VAT reform has inherent innovation incentives. Thus, we can infer that the VAT reform provided significant and positive incentives for improving manufacturing innovation.

Hence, the second hypothesis is proposed.

Hypothesis 2 *China's VAT reform may significantly promote innovation in both service and manufacturing enterprises. This positive incentive for innovation in manufacturing may be greater than that for the service industry.*

Although China's VAT reform may have an incentive effect on enterprises' innovation in general,

for the enterprises that face an increased burden of tax after the reform, their innovation activities may be constrained by their insufficient capital due to a decline in their profit level. Based on the above analysis, the third hypothesis is proposed.

Hypothesis 3 *For enterprises facing an increased burden of tax, VAT reform can still stimulate enterprise innovation if the enterprise has sufficient capital. However, if the enterprise's capital is insufficient, the reform has little effect on enterprise innovation.*

In summary, Hypothesis 1 points to the impact of VAT reform on the tax burden of enterprises. Hypotheses 2 and 3 reveal the possible impact of VAT reform on the innovative behaviour of enterprises. However, an empirical study is needed to test whether the actual situation is consistent with the above hypotheses. Furthermore, this study analyses the impact of the VAT reform on the innovative behaviour of enterprises based on enterprises' heterogeneity in terms of ownership, technology level, and the scale of business.

3 Empirical Design and Summary Statistics

3.1. Institutional Background

VAT was first introduced in China in 1979 and experienced two stages of reformation over the course of the following 14 years. In December 1993, the 'Provisional Regulations on Value-Added Tax of the People's Republic of China' were promulgated, showing that VAT achieved the indigenised transformation of the tax scope and rate. China's turnover tax system had long-established a stable situation in which VAT and business tax were levied in parallel. While VAT is levied on most goods and processing, repair, and replacement services, business tax is levied on most labour services, immovable property, and intangible assets. Furthermore, the two taxes are quite different in terms of how they are levied. VAT is levied on the added value realised by a taxpayer or tax unit during production activities. On the other hand, business tax is levied based on the turnover of the taxpayer or the tax unit. This means that if a manufacturer purchases services, business tax invoices are not deductible. Thus, double tax will be levied on commodities and services produced by the manufacturer, which goes against the concept of healthy and rapid development of enterprises. In this regard, the State Council promulgated a pilot programme to replace business tax with VAT, proposing the guiding ideology of establishing and improving a taxation system that is conducive to scientific development, economic restructuring, and the development of the modern service industry. The reform started from the '1+6'[①] industries in the pilot regions and then extended throughout the whole state to clear obstacles for the healthy development of the modern service industry[②]. As time progressed, VAT has been implemented throughout the country since the second half of 2013. Since January 2014, the national railway transportation and postal industry have also joined the VAT reform. Telecommunications were also included in the nationwide VAT reform. The remaining service industries implemented the transition

[①] The '1+6' industries actually covers a transportation sector and some of the modern services sector, they are: land transport, water transport, air transport, pipeline transport, research and development and technical services, information technology services, cultural and creative services, logistics support services, tangible chattel leasing services, certification consulting services.

[②] The reform pilot areas and time are: Shanghai (January 2012), Beijing (September 2012), Jiangsu and Anhui (October, 2012), Fujian and Guangdong (November 2012), Tianjin, Zhejiang and Hubei (December 2012).

from business tax to VAT in May 2016.

3.2 Difference-in-Difference Model Specification

The process of VAT reform provides a good basis for the adoption of the difference-in-difference (DID) model. There are two fundamental requirements for the application of the DID model. First, an external policy shock is required. Second, it is necessary that this shock influences some parts of social samples, but not the others, or else the impact is very small. The VAT reform perfectly fits these two requirements. Business tax levied on some portions of the service industry transitioned to VAT at some point in time. At this point, VAT reform occurred in some pilot regions rather than nationwide. In most of the empirical research on VAT reform, DID and DDD are widely used to evaluate the effects of VAT reform. The above analysis shows that inter-industry interaction between the service and manufacturing industries is very lively, and all upstream, midstream, and downstream industries are influenced by the VAT reform. Therefore, the second requirement will fail if we assume that industries in which reform took place are the treatment group and other industries are the control group. This raises the issue that industries in non-pilot regions will be added to the treatment group, which may overestimate the impact of the VAT reform. Additionally, as shown in the above analysis, manufacturing is influenced by VAT reform. Therefore, manufacturing enterprises are not qualified as a control group.

It is more suitable to use the pilot service industries and manufacturing industries in provinces and regions where the reform was implemented as the treatment group, and to use other service industries that were not part of the pilot and all industries in provinces and regions excluded from the reform as the control group. The reason for this is that there is often a cluster effect in the development of industries. Enterprises in the same region are even more closely connected. While the development of industries in different provinces or regions has a certain interaction, the interactive activities between industries in different provinces or regions are much less than the connected activities between the manufacturing and service industries in the same province or region. Additionally, the pilot provinces and regions are in coastal regions. Many of them are geographically close to each other and can be viewed as a whole (such as the Beijing – Tianjin area, Yangtze River Delta area, etc.) to minimise the deviation of the setting of the DID model.

For a given enterprise i in the industry j, in fiscal year t and the region k, we consider the following empirical specification:

$$Taxburden_{i,j,t,k} = \alpha_0 + \beta_1 Treat_{i,j,k} * Time_t + \beta_2 Treat_{i,j,k} + \beta_3 Time_t + \gamma_1 X_{i,j,t,k} + \eta_i + \mu_j + \delta_t + \tau_k + \varepsilon_{i,j,t} \quad (1)$$

$$Innovation_{i,j,t,k} = \alpha_0 + \beta_1 Treat_{i,j,k} * Time_t + \beta_2 Treat_{i,j,k} + \beta_3 Time_t + \gamma_1 X_{i,j,t,k} + \eta_i + \mu_j + \delta_t + \tau_k + \varepsilon_{i,j,t} \quad (2)$$

where $Taxburden$ represents the tax burden on enterprises, $Innovation$ represents the level of innovation, $Treat$ represents the provinces (regions) where reforms took place and industries reformed (including local manufacturing), $Time$ represents the exact time of implementation of the VAT reform, and X represents other control variables influencing the tax burden and the innovation level of enterprises. Dummies η_i represents individual effects, dummies μ_j represents industry effects, dummies δ_t represents the time effects and dummies τ_k represents regional effects; $\varepsilon_{i,j,t}$ represents residuals.

For the two dummy variables representing the VAT reform, $Treat$e equals 1 if the enterprise is

in the pilot service industry and in the province where the reform took place; otherwise it equals 0. However, the value of $Time$ needs to be explained. While the nine pilot provinces started reforming in 2012, Shanghai was the only region where the reform was implemented in January 2012 and the other regions actually started from the second half of the year. The effects of the reform may not be obvious in 2012. Therefore, the reform timing of Shanghai was set to be 2012. For other regions, the reform timing was set to 2013. The dummy variable $Time$ equals 1 for the year of the implementation of VAT reform and afterwards, and 0 for the year before that.

3.3 Variable and Descriptive Statistics

Tax burden: two types of enterprise tax burden measures have been discussed in the literature. The first is the ratio of tax rate to operating income and the second is the ratio of tax rate to net profit (Devereux, 2003; Søresen, 2004; Μουρίκης, 2016; Mascagni and Mengistu, 2016). These two measures have little statistical difference. However, from the enterprise's actual burden point-of-view, the latter plays a better role in measuring the enterprise's tax burden. Operating income is a summary of the enterprise's business scale, whereas net profit reflects the profitability and future development scope of enterprises. Therefore, the ratio of tax rate to net profit is more appropriate for measuring the enterprise's tax.

In this study, we use the enterprise's tax burden as the dependent variable. Considering that the financial statements of listed companies only record three categories—business tax and surcharges, income tax expenses, and taxes payable—further calculations are required to obtain the turnover tax (VAT and business tax), which is the target of our analysis. The total tax burden is the sum of the turnover and income taxes. The income tax burden is calculated in a more uniform manner. Income tax burden = (income tax expenses – deferred income taxes) / net profit. There are large differences in the calculation of turnover tax. The existing estimation methods are generally based on cash flows for the year. However, some scholars point out that the turnover tax also concerns the same issue of deferral as income tax. In other words, turnover tax that should have been paid in the current year may actually be paid in the next year due to the issue of tax deferral, introducing a bias into the calculation based on the data of the current year. Therefore, in line with the research of Cao and Li (2016), we adopt the following method to calculate the turnover tax burden: (1) if there is a single additional charge of educational expenses, the expense is directly divided by 3%; (2) if additional charges of educational expense are calculated by multiple expense rates, local additional charges of the expense are divided by 2%; (3) if both the additional charges of the educational expense and the local additional charges are calculated by multiple expense rates, urban maintenance and construction tax is divided by the corresponding single tax rate; and (4) if all three of the above are calculated according to the multiple expense rates, the educational sur-tax is used; (5) turnover tax burden equals the calculated turnover tax divided by the net profit; while the sum of the turnover tax burden and the ratio of income tax to the net profit is the overall enterprise tax burden.

Innovation: Two types of innovation measures have been used in the literature: the enterprise's investment in research and development, and the number of applications for patents (Greunz 2004; Wang and Tsai 2009). Being limited by availability, our empirical study adopts research and development as the variable of innovation measure.

Based on empirical evidence, the tax burden and innovation activities of enterprises are influenced by the following categories of company-level control variables (Stickney and Mc Gee

1982；Spooner 1986; Atrostic and Nunns, 1991; Kiburi et al., 2018): (1) enterprise asset scale, *Lcapital*, which is defined as the logarithm of enterprise total assets and expected to have a negative impact on enterprise tax burden and a positive impact on innovation; (2) financial leverage, *Lev*, which is measured by the ratio of total liabilities to total assets and is expected to have a positive impact on tax burden and a negative impact on innovation; (3) the density of inventory, *Hasset*, which is defined as the ratio of net inventories to total assets and is expected to have a positive impact on tax burden and a negative impact on innovation; (4) the intensity of tangible assets, *PPE*, which is measured by the ratio of net fixed assets to total assets, and the intensity of intangible assets *Intang*, which is measured by the ratio of net intangible assets to total assets, and both are expected to have a negative impact on tax burden and a positive impact on innovation; (5) investment gains, *Eqinc*, which is defined as the ratio of investment gains to total assets and is expected to have a negative impact on tax burden and a positive impact on innovation; (6) price earing ration, *ROA*, which is measured by the ratio of net profit to total assets and is expected to have a negative impact on tax burden and a positive impact on innovation; (7) enterprise business scale, *Loperation*, which is defined as the algorithm of enterprise operating revenue and is expected to have an ambiguous impact on tax burden and a positive impact on innovation; (8) market competitiveness of products, *Sfin*, which is defined as the ratio of annual selling expenses to operating revenue and is expected to have an ambiguous impact on tax burden and a negative impact on innovation; (9) the growth of enterprises, *Tobin Q value*, which is defined as the ratio of total market value of listed companies to total assets and is expected to have a negative impact on tax burden and a positive impact on innovation; (10) previous period loss, *Loss*, which equals to 1 if the net profit for the previous period is negative and/or 0 otherwise. The loss for the previous period could be used to offset the payable tax for the current period; therefore, it is expected to have a positive impact on tax burden and a negative impact on innovation.

3.4. Data Sources and Descriptive Statistics

In this study we focus on companies listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange. According to the definition of variables and availability, we use the CSMAR and Wind datasets for the period of 2004 – 2016. The division of industry is based on the National Economic Industrial Classification issued by the statistical bureau. The definitions and sources of the variables are shown in Table 1.

Table 1 Variable definitions and sources

Variable	Definition	Sources
Taxburden	Enterprise tax burden: (tax paid-tax refunds received) / net profit	CSMAR
Innovation	Innovation level: Enterprise research & development expenses / operating revenue	Wind
Lcaptial	Enterprise asset scale: logarithm of enterprise total assets	CSMAR
Loperation	Enterprise business scale: logarithm of enterprise operating revenue	CSMAR
Lev	Financial leverage: total liabilities / total assets	CSMAR
Hasset	The density of inventory: net inventories / total assets	CSMAR
PPE	The intensity of tangible assets: net fixed assets / total assets	CSMAR
Intang	The intensity of intangible assets: net intangible assets / total assets	CSMAR
Eqinc	Investment gains: investment gains / total assets	CSMAR

ROA	Price earnings ratio: net profit / total assets	CSMAR
Sfin	Market competitiveness of the products: annual selling expenses / operating revenue	CSMAR
Q-value	The growth of enterprise: total market value of listed companies / total assets	CSMAR
Loss	Previous period loss: 1, if the net profit for the previous period is negative; 0, otherwise.	CSMAR

According to the reasonability, we drop ST firms - firms characterised by negative revenue and non-positive proportion tangible assets, and firms characterised by negative payment. Removing these abnormal values contributes to the robustness of our results. Our final sample consist of 3111 unbalanced firm-level panel data. The descriptive statistics of the variables are shown in Table 2.

Table 2 Descriptive statistics

Variable	Unit	Mean	Standard error	Minimum	Maximum
Taxburden	%	1.13	2.52	-12.10	19.62
Innovation	%	0.12	0.20	0.02	0.83
Lcaptial	-	21.74	1.36	18.81	26.71
Loperation	-	21.18	1.53	16.70	25.41
Lev	%	0.51	1.84	-0.19	142.72
Hasset	%	0.17	0.16	0.00	0.94
PPE	%	0.24	0.18	0.00	0.97
Intang	%	0.04	0.06	0.00	0.90
Eqinc	%	0.01	0.03	-0.15	0.18
ROA	%	0.14	0.27	-1.13	2.01
Sfin	%	5.81	5.41	0.00	19.45
Q-value	%	1.88	1.43	0.61	6.31
Loss	-	0.02	0.15	0.00	1.00

Table 3 lists the correlation coefficients between the main variables of Equation (1). Owing to space constraints, the coefficients between the variables of the other equations are not reported here. We find that the correlation between control variables is less than 0.5, and the correlation coefficients between most control variables and two dependent variables, i.e., the tax burden (*Taxburden*) and innovation (*Innovation*), are significant at 5%. To a certain extent, it shows that the selected control variables satisfy internal validity and there is no serious multicollinearity between the variables.

Table 3 Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Taxburden	1.00	-0.01	0.28	0.24	0.14	0.02	-0.06	0.14	**-0.65**	**-0.06**	-0.25	0.00
Lcaptial	-0.06	1.00	0.68	0.41	0.10	0.03	-0.05	0.10	0.08	-0.20	-0.51	-0.01
Loperation	0.14	0.71	1.00	0.36	0.13	0.11	-0.03	0.19	**-0.40**	-0.17	-0.39	-0.04
Lev	0.16	0.43	0.37	1.00	0.30	0.06	-0.09	0.02	-0.32	-0.23	-0.56	0.07
Hasset	0.13	0.10	0.07	0.31	1.00	-0.32	-0.16	-0.04	-0.17	0.05	-0.18	**0.01**
PPE	0.03	0.01	0.09	0.05	-0.34	1.00	0.22	-0.04	-0.17	-0.12	-0.14	0.02

Intang	**-0.01**	-0.06	-0.08	-0.04	-0.20	0.09	1.00	-0.03	-0.00	0.11	0.10	**0.01**
Eqinc	0.19	-0.04	0.06	**0.01**	-0.04	-0.05	-0.03	1.00	-0.09	**-0.01**	-0.06	-0.01
ROA	-0.18	0.09	-0.35	-0.06	-0.02	-0.12	0.02	-0.00	1.00	0.09	0.30	-0.03
Sfin	-0.00	**-0.20**	-0.12	-0.15	-0.02	-0.07	0.02	0.05	-0.00	1.00	0.24	-0.03
Q-value	-0.13	-0.46	-0.41	-0.48	-0.19	-0.17	0.04	-0.03	0.15	0.04	1.00	-0.02
Loss	0.03	-0.03	-0.05	0.07	0.02	0.02	0.02	0.02	0.03	-0.02	**0.01**	1.00

Note: The upper part of the table represents the Spearman correlation coefficients and the lower part of the table shows the Pearson correlation coefficients. The bolded values show that the confidence level of correlation coefficient is lower than 5%, and the rest indicates that the correlation is statistically significant at 1%.

4 China's VAT Reform Tax Cut Effect and Innovation Effect

4.1 The Effect of China's VAT Reform on Tax Cuts

We control for time fixed effects, regional fixed effects, and industry fixed effects and adopt clustered standard errors at the firm level in order to reduce the margin for error. The results of the same are shown in Table 4. According to the above analysis, the proportion of the consumption of fixed assets and raw materials to service enterprises' expenditures is relatively small, while labour costs such as wages, that are not deductible from input tax, and are a bulk of the enterprise's expenditure. Suppose a service enterprise on which the rate of enterprise tax levied increases from 3% to 11% (the VAT of service enterprises at the beginning of VAT reform), it will have to pay higher tax unless its input tax accounts for close to 8% of the total operating income. It can be seen that it is not an easily achievable target which is needed to reduce the enterprise's tax burden through VAT reform, especially for enterprises with a high proportion of human capital. This means that whether an enterprise's tax reduces after VAT reform depends on whether the enterprise could obtain enough input tax credits. The situation is quite different for manufacturing entities. Manufacturing always levied VAT before VAT reform was implemented nationwide across China. After that, in addition to input tax credits of standard fixed assets and raw materials, the original purchase service that was not deductible can also be deducted by VAT special invoice so that the enterprise's tax burden declines. Columns (1) and (2) in Table 4 represent the regression results of samples of the service and manufacturing industry, respectively. The VAT reform coefficient of the service industryis negative but insignificant. The manufacturing coefficient is -0.1733 and significant at the 1% confidence level, indicating that the VAT reform significantly reduced the tax burden on the manufacturing sector. None of the existing literature provides a special or specific study on the impact of VAT reform on the tax burden of the manufacturing sector. Hence, Hypothesis 1 (as declared in this study) is supported.

Furthermore, we conduct a quantitative test on the entire population to explore the overall effects of tax cuts. Column (3) shows that the overall effects of tax cuts induced by VAT reform are significantly negative. The implementation of the policy reduced the tax burden on the whole population by 0.2110%.

An important premise of the DID model is that both treatment and control groups have similar trends. The estimation would be higher if the trends were different. Therefore, this study adopts two methods for robustness testing: first, we assume a linear time trend and then introduce multiple provincial fixed effects, industrial fixed effects, and time fixed effects in order to examine the

common trend assumption (Angrist and Pischke 2015). The significance of this method is that the intersection of regions, industries, and time, represents a common time trend in clusters of enterprises classified by industries, and the conclusion is that policy changes affect the development of the pilot enterprises and is supposed to be consistent with the estimation of the previous regression as discussed in detail above. Without this common time-trend, the impact of policy changes on the treatment group would show a relatively large bias. In other words, the impact of VAT reform on tax cuts would greatly deviate from the conclusion of the previous method.

As shown in Column (4), the coefficient of VAT reform remains approximately the same, indicating that the tax cut is not the result of other different trends. Therefore, the result is robust. The second method is to use the hypothesis test to examine whether both the treatment and control groups have the same trend. The time trend will naturally appear in the model with sufficient control variables. However, it is impossible to control all variables influencing the result in reality. The solution is to assume that both the treatment and control groups are indeed consistent before the implementation of the new policy. There will not be significant differences between the treatment control group if VAT reform occurred a few years before.

We assume that the VAT reform occurred in 2011. Time equals 1 if the year is 2011 and 2012 and 0 for other years before 2011 with other variables controlled in the same way (considering that the reform in Shanghai occurred in 2012, we removed Shanghai from the sample of this regression for simplification). The result is shown in Column (5) that the coefficient is insignificant. This verifies that the treatment and control groups have the same time trend before the reform.

Table 4 The effect of China's VAT reform on the burden of the corporate tax

Variable	Dependent variable: the burden of the corporate tax				
	Service industry	Manufacturing	Total sample	Total sample	Total sample
	（1）	（2）	（3）	（4）	（5）
*Treat*Time*	-0.1086	-0.1733**	-0.2110***	-0.2083**	-0.1081
	(0.2165)	(0.0841)	(0.0819)	(0.0865)	(0.1008)
Time	0.1644	0.4023	0.2842	0.3311	-0.3340**
	(0.2832)	(0.2904)	(0.1940)	(0.2277)	(0.1382)
Treat	-0.4632	-0.6427	-0.6135*	-0.6309	-0.5561
	(0.6635)	(0.4183)	(0.3686)	(0.3974)	(0.4179)
Lcaptial	-1.0843***	-0.9705***	-0.9334***	-0.9468***	-1.0461***
	(0.1286)	(0.0793)	(0.0669)	(0.0679)	(0.0805)
Loperation	0.7528***	0.7429***	0.6899***	0.6988***	0.7620***
	(0.1085)	(0.0622)	(0.0543)	(0.0549)	(0.0633)
Lev	1.2430***	1.1532***	1.1169***	1.1053***	1.0099***
	(0.4064)	(0.1983)	(0.1741)	(0.1773)	(0.2113)
Hasset	0.6748	0.0221	0.4840	0.4695	0.6954*
	(0.4635)	(0.4151)	(0.2944)	(0.2972)	(0.3980)
PPE	1.1795***	0.3097	0.5629***	0.5726***	0.5813**
	(0.4151)	(0.2276)	(0.2000)	(0.2058)	(0.2564)
Intang	0.6548	2.6313***	1.8636***	1.9787***	2.2150***
	(0.8154)	(0.7693)	(0.5292)	(0.5421)	(0.6801)

Eqinc	7.3847***	9.4146***	9.0135***	8.9111***	8.0943***
	(2.2254)	(1.7480)	(1.3869)	(1.4098)	(1.5781)
ROA	-0.3329	-0.0037	-0.2086*	-0.2143*	-0.2514*
	(0.2178)	(0.1400)	(0.1198)	(0.1208)	(0.1453)
Sfin	0.0007	-0.0081	-0.0044	-0.0047	-0.0056
	(0.0091)	(0.0070)	(0.0050)	(0.0051)	(0.0066)
Q-value	-0.1561***	-0.1567***	-0.1179***	-0.1197***	-0.1466***
	(0.0537)	(0.0260)	(0.0233)	(0.0235)	(0.0296)
Loss	-0.0547	0.2050	0.1662	0.1642	0.1047
	(0.2105)	(0.1333)	(0.1136)	(0.1153)	(0.1349)
Cons	8.8377***	6.1024***	6.3879***	6.5366***	7.1968***
	(1.3123)	(0.8327)	(0.7030)	(0.7238)	(0.8568)
Time fixed effects	Yes	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
District*time*industry	No	No	No	Yes	Yes
R-squared	0.220	0.168	0.182	0.189	0.192
Observations	4539	11884	16423	16423	11145

Notes: The value in the parentheses is the standard deviation of robustness. Asterisks *, **, and ***, indicate statistical significance at the 10%, 5%, and 1% levels in this paper.

4.2 The Effect of China's Tax Reform on Innovation

Based on our theoretical analysis, VAT is the tax on the added value of products, and business tax is the tax on the operating income. The primary difference between the two is whether input tax is deductible. The deductible input tax includes the costs of raw materials, machinery and equipment, intellectual capital, and various service expenditures, that are essential inputs for innovation. The higher the degree of enterprise innovation, the greater the proportion of increase in added value of the output. However, a high degree of innovation brings with it a high demand for both physical capital and intangible services. Innovation has always been an adventure involving many uncontrollable factors. Not every innovation investment manages to obtain sufficient returns (Domar and Musgrave 1944; Feng and Liu 2017). In cases that business tax is levied, if the innovation is successful, the profits generated by innovation could be enough to cover its costs. However, if enterprises fail in their innovation investment, in addition to a loss in potential profits, enterprises are not able to claim tax deduction on the amount that is invested. Considering the mechanism of business tax, enterprises are more prone to reduce innovation investment to avoid the risk of failure. Therefore, business tax does not encourage innovation. On the contrary, VAT promotes innovation for the sole reason that most of the cost of innovation is deductible except for wages and the government shares the risks of innovation with enterprises.

Next, we test the above inference using an empirical analysis. Table 5 shows the impact of VAT reform on enterprise innovation. Columns (1) and (2) in Table 5 represent the regression results of the service industry and manufacturing, respectively, showing that the coefficients of both industries are significantly positive and the effects of innovation incentives for manufacturing are larger than those for the service industry. This conclusion is in line with reality. In actual social activities, the technological innovation of manufacturing has always been in the main position, and innovation

activities of the service industry are relatively less. Thus, Hypothesis 2 (as declared in this study) is supported.

Furthermore, Column (3) shows the results for the whole population with a coefficient of 0.029, which is significant at the 1% confidence level, which demonstrates that VAT reform promotes enterprise innovation as a whole.

However, it is worth noting that VAT reform is proven to reduce enterprise tax burden as a whole, which indicates an increase in profits of enterprises and an improvement in the ability of enterprises to innovate. Hence, the question arises: does the increase in profits due to the decline in tax burden give rise to innovation? Or does VAT reform provide inherent innovation incentives?

The specific design is as follows: (1) we judge whether enterprise tax burden increases from weather. The enterprise's overall tax burden has increased for two consecutive years; (2) and we calculate the average research and development investment of each industry in the previous year according to the national industry code and then compare the undistributed profit of the enterprise for the previous year with the average research and development investment of the industry. We define enterprises with larger share of undistributed profits as those with sufficient funds. If the undistributed profit of enterprises is smaller, we consider them as enterprises with insufficient funds. We then re-examine the impact of VAT reform on enterprise innovation with distinguished groups of enterprises. The results are listed in Columns (5) and (6) of Table 5.

If the enterprise tax burden increases, the impact of VAT reform on innovation is still significant and positive when the enterprise has sufficient capital. However, the coefficient is significantly smaller, and the significance is reduced. This shows that an increased tax burden due to VAT reform reduces profits of some enterprises. This decline in profit hinders innovation. Profiting from the enterprises' sufficient own capital, VAT reform still induces the effect of innovation incentive. (2) If the enterprise's tax burden increases, the impact of VAT reform on innovation is positive but insignificant when the enterprise has insufficient capital. This shows that adequate profits of enterprises play an important role in encouraging innovation. Additionally, it provides empirical evidence of the incentive mechanism of VAT for enterprise's innovation activities. Otherwise, if the enterprise's tax burden increases, VAT reform should have a negative impact on innovation activities when the enterprise does not have sufficient capital. Thus, Hypothesis 3 (as declared in this study) is supported.

Table 5 The effect of China's tax reform on innovation

Variable	Dependent variable：innovation				
	Service industry	Manufacturing	Total sample	Sufficient fund	Insufficient fund
	(1)	(2)	（3）	(5)	(6)
*Treat*Time*	0.0191**	0.0466***	0.0290***	0.0224*	0.0013
	(0.0082)	(0.0099)	(0.0085)	(0.0122)	(0.0328)
Time	-0.0184*	-0.0130	-0.0300*	-0.0431*	0.0291
	(0.0094)	(0.0259)	(0.0179)	(0.0238)	(0.0911)
Treat	0.0290*	0.0064	0.0176	0.0017	-0.0065
	(0.0153)	(0.0195)	(0.0170)	(0.0267)	(0.0277)
Lcaptial	0.0022	0.0192***	0.0120***	0.0117**	0.0176**
	(0.0034)	(0.0038)	(0.0030)	(0.0052)	(0.0087)

Loperation	-0.0112***	-0.0240***	-0.0193***	-0.0270***	-0.0030
	(0.0021)	(0.0025)	(0.0019)	(0.0038)	(0.0042)
Lev	-0.0166	-0.0615***	-0.0534***	-0.0041	0.0139
	(0.0133)	(0.0143)	(0.0115)	(0.0215)	(0.0266)
Hasset	-0.0249**	0.0107	-0.0329**	-0.0567**	0.0210
	(0.0124)	(0.0254)	(0.0163)	(0.0260)	(0.0427)
PPE	-0.0019	0.0564***	0.0514***	0.0095	-0.0449
	(0.0143)	(0.0177)	(0.0137)	(0.0215)	(0.0401)
Intang	-0.0272	0.0121	0.0394	0.0510	0.0063
	(0.0348)	(0.0438)	(0.0337)	(0.0573)	(0.0721)
Eqinc	-0.1226***	-0.2507***	-0.1961***	0.0072	-0.0111
	(0.0402)	(0.0507)	(0.0379)	(0.0171)	(0.1100)
ROA	-0.0084	-0.0386***	-0.0334***	-0.0946***	-0.0310**
	(0.0062)	(0.0103)	(0.0064)	(0.0182)	(0.0133)
Sfin	0.0010*	0.0010*	0.0008*	0.0009	0.0000
	(0.0005)	(0.0005)	(0.0004)	(0.0007)	(0.0010)
Q-value	0.0004	-0.0081***	-0.0052***	-0.0029	-0.0050
	(0.0024)	(0.0020)	(0.0017)	(0.0029)	(0.0053)
Loss	0.0026	-0.0078	-0.0070	-0.0014	0.0098
	(0.0054)	(0.0069)	(0.0054)	(0.0102)	(0.0150)
Cons	0.5876***	0.1092	0.1734***	0.5977***	-0.2558
	(0.0656)	(0.0695)	(0.0571)	(0.0908)	(0.2254)
Time fixed effects	Yes	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
District*time*industry	Yes	Yes	Yes	Yes	Yes
R-squared	0.157	0.312	0.240	0.273	0.269
Observations	4299	10152	14451	4864	502

5 Extended Analysis Based on Enterprise Heterogeneity

According to the theoretical analysis mentioned above, China's VAT reform naturally has an infernal impetus mechanism to encourage innovation. In other words, an enterprise that benefits from a reduced tax burden will impress upon its ability to conduct further research, development, and innovation. Therefore, in general, all enterprises with reduced tax burden will be motivated by the VAT reform to engage in innovation. Under this premise, the incentive effect of China's VAT reform on heterogeneous enterprises' innovation activity is unobservable. On the other hand, the innovation ability of enterprises whose tax burden increases will be weakened. The impact of China's VAT reform on innovation activity of those enterprises is still inconclusive. Considering the above analysis, the following discussions about the heterogeneity in enterprises' characteristics are based on the condition that the tax burden of enterprises increases:

5.1 Impact of China's VAT Reform on Innovation of Enterprises with Heterogeneous Property Rights

State-owned enterprises and private enterprises have completely different motivations for tax avoidance. For state-owned enterprises, the government is both the owner of the property and the collector and manager of tax as well. The government can levy taxes on enterprises by political power and divide the after-tax profits of the enterprises according to its ownership. Purely from the perspective of interests, there is not much difference between paying taxes to and turning over profits to the state. Therefore, as compared to private enterprises, state-owned enterprises have fewer motivations for tax avoidance (Bradshaw and Liao, 2012). VAT reform impacts the tax burden on all enterprises. Considering that enterprises of different property rights do not respond to the tax burden in the same way, in this paper we explore how state-owned enterprises and private enterprises perform under the condition of innovation incentives induced by VAT reform. We construct the interaction between VAT reform and enterprises of different property rights, in order to observe the innovation performance of private, central and local state-owned enterprises during the period of VAT reform. Following a structure similar to the above analysis, we focus on the cases in which the tax burden on enterprises increases and examine the innovation performance of enterprises with different property rights under conditions with and without sufficient own funds.

In Table 7, Soe1 - Soe3 are dummy variables representing private, central state-owned, and local state-owned enterprises, respectively. Results show that when enterprises have sufficient personal funds and when the tax burden increases, innovation incentive of VAT reforms on private enterprises is significantly greater than that on state-owned enterprises. When enterprises have insufficient funds, the innovation incentive of VAT reform on private enterprises is insignificant and/or smaller than that on state-owned enterprises. This indicates that the innovation motivation of private enterprises is higher than that of state-owned enterprises. Additionally, it infers that when compared with state-owned enterprises, private enterprises face stronger budget constraints and are considerably more difficult to obtain external financial support in case of having insufficient funds. Even if private enterprises have motivations for innovation, their innovation activities are severely restricted by insufficient funds. The reason that state-owned enterprises are grouped into central state-owned and local state-owned enterprises is because the objective functions of these two types of enterprises are totally different under the background of fiscal decentralisation which leads to distinct choices made by them. For central state-owned enterprises, when the tax burden increases and enterprises have sufficient funds, the impact of VAT reform on innovation is insignificantly smaller than on the combination of private and local state-owned enterprises. Distinguishing private enterprises from local state-owned enterprises, in this study we find that the impact of VAT reform on innovation motivations for central state-owned enterprises is smaller than that for private enterprises, but larger than that of local state-owned enterprises. When enterprises do not have sufficient funds, the impact of VAT reform on innovation incentives for central state-owned enterprises is insignificantly smaller than that of the combination of the other two types. Distinguishing private enterprises from local state-owned enterprises is the impact of VAT reform on innovation incentives for central state-owned companies is larger than that of private enterprises and smaller than that of local state-owned enterprises. For local state-owned enterprises, when the tax burden increases and enterprises have sufficient funds, the impact of VAT reform on innovation incentives is significantly smaller than that of the other two types of enterprises (regardless of

whether they are combined or separate). When enterprises do not have sufficient funds, the impact of VAT reform on innovation incentives for local state-owned enterprises is insignificantly larger than that of the other two types (regardless of whether they are combined or separate). Under the condition of availability of sufficient funds, all central state-owned, local state-owned, and private enterprises are capable of innovating, but the magnitudes of their motivations for innovation are different. Since private enterprises face the most grievous survival crisis, VAT reform has the strongest impact on innovation incentives for them. Central state-owned companies also have strong motivations for innovation in order to fulfil the tasks of national development strategy and accomplish their missions entrusted by the state. Local state-owned enterprises are motivated to innovate to satisfy the demand of local government revenues. Therefore, when enterprises have sufficient personal funds and VAT reform provides motivations for innovation, they will engage in innovation as much as possible. Central state-owned enterprises would increase investments in innovation. While local state-owned enterprises would increase their innovation activities, the fact that they have sufficient funds shows that they are able to satisfy the local government's demands for revenues. Consequently, the innovation activities of local state-owned enterprises are less than those of central state-owned enterprises and private enterprises. In this case, VAT reform has the strongest impact on innovation incentives for private enterprises. Its impacts on central state-owned enterprises and local state-owned enterprises rank second and third, respectively. If enterprises do not have sufficient funds, private enterprises particularly are unable to innovate. Compared to private enterprises, the situation is relatively easier for central state-owned enterprises to obtain external funding for innovation. Additionally, the innovation activities of central state-owned enterprises face fewer restrictions. If local state-owned enterprises have insufficient funds, they fail to satisfy the government's demand for revenue. They may be strongly motivated by the local government's pressure to pass performance evaluation. Meanwhile, local government will try to help enterprises attract external funding for innovation. Conclusively, when enterprises have insufficient funds, VAT reform has the strongest impact on innovation incentives for local state-owned enterprises. Its impacts on central state-owned enterprises and private enterprises rank second and third, respectively.

Table 6 The impact of China's VAT reform on innovation of enterprises with heterogenous property rights

	(1)	(2)	(3)	(4)	(5)	(6)
	Sufficient fund	Insufficient fund	Sufficient fund	Insufficient fund	Sufficient fund	Insufficient fund
	Innovation	*Innovation*	*Innovation*	*Innovation*	*Innovation*	*Innovation*
*Treat*Time*Soe1*	0.0315**	-0.0611				
	(0.0139)	(0.0464)				
Soe1	0.0019	-0.0229*				
	(0.0074)	(0.0120)				
*Treat*Time*Soe2*			-0.0094	-0.0352		
			(0.0204)	(0.0347)		
Soe2			0.0115	0.0108		
			(0.0088)	(0.0201)		
*Treat*Time*Soe3*					-0.0317**	0.0716

					(0.0152)	(0.0495)
Soe3					-0.0082	0.0170
					(0.0070)	(0.0121)
*Treat*Time*	0.0030	0.0293	0.0226*	0.0049	0.0306**	-0.0350
	(0.0153)	(0.0499)	(0.0124)	(0.0333)	(0.0127)	(0.0264)
Time	-0.0401*	0.0036	-0.0435*	0.0263	-0.0399*	-0.0020
	(0.0240)	(0.0981)	(0.0238)	(0.0916)	(0.0240)	(0.0993)
Treat	0.0046	-0.0139	0.0053	-0.0059	0.0062	-0.0142
	(0.0266)	(0.0320)	(0.0267)	(0.0281)	(0.0270)	(0.0299)
Lcaptial	0.0098*	0.0153*	0.0089*	0.0172**	0.0096*	0.0159*
	(0.0052)	(0.0087)	(0.0052)	(0.0087)	(0.0052)	(0.0087)
Loperation	-0.0244***	-0.0036	-0.0250***	-0.0035	-0.0245***	-0.0030
	(0.0038)	(0.0043)	(0.0038)	(0.0043)	(0.0038)	(0.0043)
Lev	-0.0022	0.0131	-0.0027	0.0141	-0.0018	0.0131
	(0.0215)	(0.0260)	(0.0215)	(0.0267)	(0.0215)	(0.0260)
Hasset	-0.0602**	0.0254	-0.0609**	0.0212	-0.0603**	0.0290
	(0.0260)	(0.0422)	(0.0260)	(0.0417)	(0.0259)	(0.0418)
PPE	0.0057	-0.0452	0.0043	-0.0455	0.0057	-0.0447
	(0.0216)	(0.0390)	(0.0216)	(0.0403)	(0.0215)	(0.0389)
Intang	0.0445	-0.0009	0.0512	0.0068	0.0470	0.0019
	(0.0569)	(0.0716)	(0.0573)	(0.0719)	(0.0569)	(0.0727)
Eqinc	-0.2208***	-0.0383	-0.2240***	-0.0081	-0.2190***	-0.0363
	(0.0661)	(0.1089)	(0.0665)	(0.1097)	(0.0662)	(0.1076)
ROA	-0.0880***	-0.0272**	-0.0894***	-0.0317**	-0.0881***	-0.0275**
	(0.0185)	(0.0128)	(0.0186)	(0.0134)	(0.0184)	(0.0127)
Sfin	0.0010	-0.0000	0.0011	0.0000	0.0010	0.0001
	(0.0007)	(0.0010)	(0.0007)	(0.0010)	(0.0007)	(0.0010)
Q-value	-0.0039	-0.0037	-0.0034	-0.0055	-0.0040	-0.0035
	(0.0029)	(0.0052)	(0.0029)	(0.0054)	(0.0029)	(0.0052)
Loss	-0.0007	0.0071	-0.0011	0.0091	-0.0007	0.0079
	(0.0102)	(0.0149)	(0.0102)	(0.0152)	(0.0102)	(0.0148)
Cons	0.0000	-0.1570	0.6162***	-0.2357	0.5911***	-0.1956
	(0.0000)	(0.2338)	(0.0911)	(0.2300)	(0.0906)	(0.2307)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
District*time*District	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.7410	0.2658	0.2731	0.2690	0.2741	02648
Observations	4864	502	4864	502	4864	502

5.2 The Impact of China's VAT Reform on Innovation of Enterprises with Heterogeneous Scales

The study of the relationship between business scale and innovation can be traced back to Adam Smith's work on the division of labour. It refers to the evolution from conventional separate production to the unified division of labour and co-operation, which could be classified as institutional innovation. In Schumpeter's (1942) innovation theory, the larger the enterprise size, the more concentrated the resource endowment, and the soil that fosters innovation is more mature. Broadly, large enterprises have more advantages in terms of economies of scale, capital flow, and financing capabilities, when compared to small enterprises. Therefore, the motivation of large enterprises for innovation usually lasts longer. Contemporarily scholars regard mobilise-scale as a control variable influencing innovation without considering how VAT reform influences innovation of enterprises of different scales. Therefore, this study introduces enterprise scales as a variable to examine the impact of VAT reform on innovation. Since this study uses data from listed companies, if enterprises are segregated by their operating income, all enterprises targeted are big enterprises will be done without clarification on differing sizes. This study examines the impact of an enterprise's scale on innovation conducted by comparing the interaction effect of VAT on enterprises in the top 5%, based on operating income and the effect on enterprises in the bottom 5%, based on operating income. In this study we define the dummy variable of enterprise-scale Size 1 as 1 if the enterprise is in the top 5% of its industry and 0 otherwise. The dummy variable Size 2 equals 1 if the enterprise is in the bottom 5% of its industry and 0 otherwise. Under the condition that the enterprise tax burden increases, we analyse enterprises both with and without sufficient personal funds. The results are shown in Table 6. The results of the enterprises in the top 5% are listed in Columns (1) and (2), and the results of the enterprises in the bottom 5% are listed in Columns (3) and (4).

The coefficient of enterprises in the top 5% of enterprise-scale is positive but insignificant if the enterprises have sufficient personal funds. However, the coefficient of enterprises in the bottom 5% of enterprise-scale is insignificant and negative. This shows that if the enterprises have enough funds, big enterprises are more capable of organising innovation activities as compared to small enterprises, and VAT reform does not have significantly differing impacts on innovation incentives on different sizes of enterprises. However, if the enterprises do not have sufficient funds, both sizes of enterprises show significant negative effects, but VAT reform has a more negative influence on small enterprises. In other words, under conditions of increased enterprise tax burden and insufficient funds, VAT reform does not benefit the innovation of enterprises either at the top or in the bottom of industries. For enterprises in the top 5%, which is the top of the pyramid, VAT reform has certain incentives to increase enterprises investments in innovation, but the increases in investments will undoubtedly expand the enterprise's scale, which would lead to diseconomies of scale. Under the condition of availability of insufficient funds, diseconomies of scale may even have a stronger constraint on the innovation incentives generated by VAT reform, resulting in the innovation incentives for enterprises in the top 5% being significantly smaller than incentives for enterprises in the middle 90%. For enterprises in the 5% bottom, there is no concern of diseconomies of scale. However, compared to big enterprises, small enterprises are under a stronger budget constraint and face much more difficulties in attracting external funds. Without sufficient funds, these enterprises are not able to increase investment in innovation. Then, the impact of VAT reform on innovation

would be out of the question. Therefore, the impact of VAT reform on enterprises' innovation at the 5% bottom is significantly smaller than that of enterprises in the middle 90% and enterprises in the top 5%.

Table 7: The impact of China's VAT reform on innovation of enterprises with heterogenous scales

	Sufficient fund	Insufficient fund	Sufficient fund	Insufficient fund
	(1)	(2)	(3)	(4)
	Innovation	*Innovation*	*Innovation*	*Innovation*
*Treat*Time *size1*	0.0156	-0.0665*		
	(0.0282)	(0.0394)		
Size1	0.0232**	-0.0349		
	(0.0107)	(0.0219)		
*Treat*Time *size2*			-0.0112	-0.0951**
			(0.0176)	(0.0397)
Size2			0.0272***	0.0122
			(0.0091)	(0.0268)
*Treat*Time*	0.0205*	0.0037	0.0238*	0.0095
	(0.0123)	(0.0336)	(0.0126)	(0.0341)
Time	-0.0463**	0.0266	-0.0437*	0.0217
	(0.0235)	(0.0921)	(0.0239)	(0.0928)
Treat	0.0043	-0.0079	0.0041	-0.0068
	(0.0266)	(0.0283)	(0.0264)	(0.0275)
Lcaptial	0.0079	0.0185**	0.0086*	0.0185**
	(0.0053)	(0.0085)	(0.0052)	(0.0090)
Loperation	-0.0270***	-0.0011	-0.0294***	-0.0039
	(0.0039)	(0.0041)	(0.0043)	(0.0049)
Lev	-0.0024	0.0133	-0.0007	0.0145
	(0.0215)	(0.0265)	(0.0215)	(0.0267)
Hasset	-0.0606**	0.0179	-0.0616**	0.0218
	(0.0259)	(0.0429)	(0.0260)	(0.0428)
PPE	0.0067	-0.0480	0.0042	-0.0452
	(0.0214)	(0.0404)	(0.0214)	(0.0404)
Intang	0.0519	0.0033	0.0510	0.0085
	(0.0570)	(0.0730)	(0.0568)	(0.0726)
Eqinc	-0.2247***	-0.0105	-0.2261***	-0.0172
	(0.0663)	(0.1100)	(0.0661)	(0.1103)
ROA	-0.0908***	-0.0287**	-0.0930***	-0.0325**
	(0.0188)	(0.0131)	(0.0193)	(0.0140)
Sfin	0.0010	0.0001	0.0010	0.0001
	(0.0007)	(0.0009)	(0.0007)	(0.0010)
Q-value	-0.0035	-0.0048	-0.0036	-0.0050
	(0.0029)	(0.0053)	(0.0029)	(0.0053)
Loss	-0.0016	0.0098	-0.0013	0.0083
	(0.0102)	(0.0150)	(0.0102)	(0.0150)

Cons	0.0000	-0.3091	0.0000	-0.2513
	(0.0000)	(0.2158)	(0.0000)	(0.2291)
Time fixed effects	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
District*time*industry	Yes	Yes	Yes	Yes
R-squared	0.274	0.270	0.275	0.266
Observations	4864	502	4864	502

5.3 The Impact of China's VAT Reform on Enterprises' Innovation with Heterogeneous Levels of Technology

In order to encourage the rapid development of high-tech industries, the Chinese government has identified high-tech enterprises since 1991 in China. Ones that have been certified by the government as high-tech enterprises could benefit from a series of preferential policies covering finance, taxation, and trade. Compared to high-tech enterprises, non-high-tech enterprises obtain much less favourable offers. Naturally, it is generally accepted that high-tech enterprises are more capable and motivated to participate in innovation activities than non-high-tech enterprises. Although China's VAT reform has inherent qualities encouraging innovation, it is imperative to further clarify that the impact of the reform on the innovation activities of enterprises are at different levels of technology development.

In view of this, this study examines the impact of China's VAT reform on enterprise innovation with another heterogeneity in enterprise characteristics, whether the enterprise is high-tech or not. As shown in Columns (1) and (2) in Table 7, the proxy variable of a high-tech enterprise is Technology, which equals 1 if the enterprise is a high-tech and 0 otherwise. The results show that if an enterprise has sufficient capital, the impact of VAT reform on high-tech enterprises' motivation for innovation is significantly higher than that of non-high-tech enterprises. However, if the enterprise's own capital is insufficient, the impact of VAT reform on the innovation of high-tech enterprises is significantly smaller than that on enterprises without high-tech technologies. The explanation for this is that innovation activities of high-tech enterprises are more constrained by funds than non-high-tech enterprises, and therefore, high-tech enterprises' demand for capital investment is larger. China's VAT reform increases the tax rate; however, it increases input tax credit of enterprises. The high investment in high-tech enterprises contributes to the increased tax credit, and high taxation increases the responsibility of the government to share risks (Feng and Liu 2017). Therefore, if the enterprise has sufficient capital, the impact of the VAT reform on high-tech enterprises' motivation for innovation is significantly larger than that on non-high-tech enterprises. If the enterprise's capital is insufficient, the innovation ability of high-tech enterprises is much more seriously restrained compared to non-high-tech enterprises. For high-tech enterprises, insufficient funds fail to satisfy the high demand for investment for innovation activities, which on the one hand limits innovation activities and, on the other hand, reduces the VAT input tax credit such that

enterprises would take more risks of innovation. For non-high-tech enterprises, the demand for funds for innovation activities is relatively low. Therefore, a lack of funds has a smaller negative effect on the innovation activities of non-high-tech enterprises. Conclusively, if the enterprise's own capital is insufficient, China's VAT reform has a much smaller impact on innovation incentives for high-tech enterprises.

Table 8 The impact of China's VAT reform on innovation of enterprises with heterogenous levels of technology

Variable	Sufficient fund	Insufficient fund
	(1)	(2)
*Treat*Time *Tech*	0.0975***	-0.0897**
	(0.0218)	(0.0383)
Technology	0.0021	0.0054
	(0.0106)	(0.0241)
*Treat*Time*	0.0086	0.0081
	(0.0123)	(0.0339)
Time	-0.0386	0.0226
	(0.0239)	(0.0923)
Treat	0.0046	-0.0067
	(0.0268)	(0.0279)
Lcaptial	0.0087*	0.0181**
	(0.0052)	(0.0089)
Loperation	-0.0253***	-0.0026
	(0.0038)	(0.0043)
Lev	-0.0050	0.0138
	(0.0214)	(0.0263)
Hasset	-0.0530**	0.0200
	(0.0255)	(0.0430)
PPE	0.0088	-0.0464
	(0.0214)	(0.0411)
Intang	0.0507	0.0063
	(0.0570)	(0.0727)
Eqinc	-0.2183***	-0.0120
	(0.0655)	(0.1131)
ROA	-0.0876***	-0.0302**
	(0.0184)	(0.0131)
Sfin	0.0010	0.0001
	(0.0007)	(0.0010)
Q-value	-0.0030	-0.0048
	(0.0029)	(0.0053)
Loss	-0.0024	0.0088
	(0.0101)	(0.0151)
Cons	0.0000	0.0000
	(0.0000)	(0.0000)

Time fixed effects	Yes	Yes
District fixed effects	Yes	Yes
Industry fixed effects	Yes	Yes
District*time*industry	Yes	Yes
R-squared	0.2836	0.2675
Observations	4864	502

6 Conclusions

This study analyses the impact of China's VAT reform on industrial tax burden and innovation activities of enterprises using the data of listed enterprises over the period 2004 – 2016. Our analysis obtains the following main results:

(1) China's VAT reform mostly reduced the tax burden on enterprises, but its impact on both manufacturing and service industries is different. While tax burden on manufacturing entities reduced significantly, the reduction effect of tax burden on the service industry was rather insignificant.

(2) China's VAT reform also had a significant positive impact on corporate innovation for both the service industry and manufacturing entities, but these effects were significantly greater on manufacturing.

(3) China's VAT reform did not alleviate the tax burden on all enterprises. For enterprises facing an increased burden of tax, the reform can still encourage enterprise innovation if it has sufficient capital, whereas the impact coefficient and significant level reduced significantly compared to enterprises which have the burden of tax reduced. If an enterprise's capital is insufficient, VAT reform has little effect on enterprise innovation.

(4) Under the condition that an enterprise has sufficient capital, there was no significant difference in the impacts of the VAT reform on different scale enterprises' motivation for innovation. However, under the condition that an enterprise's personal capital is insufficient, the impact on enterprises at the bottom 5% of firm-scale is significantly lower than the impact on those in the middle 90% of firm-scale, and the impact is considerably absent on enterprises in the top 5%.

(5) Under the condition that an enterprise has sufficient capital, compared with the enterprises without high technologies, the impact of the VAT reform on high-tech enterprises' motivation for innovation is significantly larger. However, under the condition that an enterprise's capital is insufficient, the impact of VAT reform is significantly smaller for high-tech firms.

Our results underscore the impact of China's VAT reform on corporate innovation is the result of a combination of tax cuts and endogenous incentives. While on the one hand, China's VAT reform generally reduced the tax burden on enterprises and then enhanced their innovation capacity, on the other hand, it changed the incentive system, providing enterprises with motivation for innovation. Therefore, it is necessary to continue to improve the current VAT system after the completion of the comprehensive experiments of China's VAT reform.

From a broader perspective, the government should actively promote tax and fee cuts in order to stimulate further innovation. Currently, VAT accounts for more than 40% of China's total tax revenue. In this context, VAT does is undoubtedly the key point of tax cuts to reduce the tax burden

of enterprises by reducing the tax category and lowering the tax rate.

Our results also highlight that China's VAT reform reduced the tax burden on manufacturing entities significantly, but the reduction effect on the service industry was rather insignificant. The main explanation for this is that VAT reform alleviated the tax burden of some service industries, whereas it increased the burden of service industries characterised as an asset-light model. Therefore, in addition to the manufacturing and transportation industries, VAT cuts should also pay attention to the service industry, especially the asset-light ones, to improve the impact of VAT cuts on innovation.

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