# "Chip War" Enlightenment: The Effect of Value-added Tax on Investment and Research and Development of High-tech Enterprises

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*In the trade war between China and the United States, the competitive position of high-tech industries has become increasingly prominent. We examine how high burden of China's value-added tax (VAT) in high-tech industry affects firms' investment, R&D, and innovation. Study shows that: (1) the reduction of VAT tax burden significantly promoted business investment, R&D investment and technological innovation; (2) the "deductible" and "return" policies also significantly increased such activities (3) among the "chip" firms, the reduction of VAT has a significant positive effect on business investment; but its impact on technological innovation and R&D expenditure is not significant.*

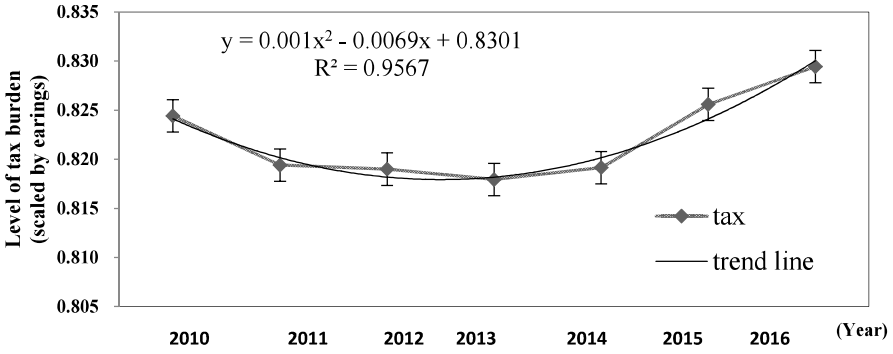
*Keywords: Value-added tax, high-tech enterprises, R&D investment*

## INTRODUCTION

After the Sino-US trade war broke out, the United States banned the production of spare parts and technical service support to ZTE. The "film war" has aroused widespread concern among taxpayers, who believe that China's tax policy lacks effective incentives for high-tech enterprises, and the most controversial issue is that it accounts for about 56% -81% of the tax burden of high-tech enterprises. (VAT as a percentage of total tax). From the "value-added tax transition" in 2009 to the "business-to-business-increase" policy in August 2013, high-tech enterprises can enjoy preferential policies for input tax deduction for purchased equipment and materials, avoiding repeated taxation of enterprises, while also enjoy VAT refund for self-produced software. The refund is based on Ministry of Finance and State Administration of Taxation [2008] No.1 document that provides "software manufacturing enterprises implement the policy of VAT and immediate refund". However, after the introduction of the "business-to-business-increase" policy, the value-added tax burden of the high-tech industry dropped slightly in 2014, and then it rose again (see Figure 1). Due to the limitations of their own funds and scale, high-tech enterprises will inevitably have a negative impact on the value of their investment. In addition, the high amount of R&D investment cannot be deducted, which limits the technological innovation and

development of enterprises. Therefore, the research questions of this article are whether VAT has an impact on corporate investment and R&D capabilities; and what is the status quo of VAT levy on industries in which chip companies are the focus of the trade war. This article provides a strong empirical basis for the current policy of reducing VAT rates.

**FIGURE 1**
**TREND CHART OF VAT AS A PERCENTAGE OF TOTAL TAX**




## INFERENCES ON THE IMPACT OF VALUE ADDED TAX ON THE BEHAVIOR OF HIGH-TECH ENTERPRISES

The collection and management of value-added tax in our country was formed during the special reform period. The purpose is to promote professional division of labor, play a role in optimizing resource allocation and improving production efficiency. (Zhao and Wang, 2016) The original production value-added tax did not allow enterprises to deduct the tax on fixed asset investment, which caused long-term repeated taxation of fixed assets and increased enterprise production costs. After the transformation of the value-added tax in 2009, allowance for deduction of input tax on the purchase of fixed assets reduced the investment cost of enterprises, and in particular played a positive role in promoting the overall investment in high-tech industries with high levels of capital investment. (Xu and Chen, 2016) In 2013, the "business-to-business reform" policy changed the original high-tech service enterprises' business tax payable to only the value-added portion. The input tax on outsourced raw materials and equipment can be used to reduce the tax burden on high-tech enterprises. Promote corporate investment. (Yuan, et al., 2015) Foreign scholars also verified the promotion of corporate investment by reducing tax burden after tax reform. (Hall and Jorgenson, 1967; Blundell, et al., 1992) Therefore, the hypothesis is proposed that the reduction of VAT has a significant positive impact on corporate investment.

The characteristics of high-tech enterprises that are dominated by intangible assets limit their applications for loans from banks, so they have high financing constraints. Once the shortage of funds in high-tech industries with high R & D intensity, it will affect the development of enterprises. VAT reduction helps ease corporate financing constraints (Ye and Chen, 2015) Although "business-to-business reform" has reduced the actual tax rate of enterprises, R&D personnel's investment accounts for the main R&D costs invested by high-tech enterprises, but there is still no way to offset. (Li, 2017) Therefore, it is assumed that the negative value-added tax relationship is negatively related to corporate R&D and technological innovation.

## RESEARCH DESIGN

### Model Setting

This article selected 18 listed high-tech industries based on the "Eight Technology Fields" specified in the 2016 "High-Tech Fields Supported by the State". Take the high-tech enterprises of A-share listed companies from 2010 to 2016 as the research sample. Data on the main variables such as VAT taxes, input tax deductions, VAT refunds, corporate investment, corporate R & D expenditures, patents, etc. were obtained from the CSMAR and Wind databases. The data was truncated from 1% to 99%, and the missing values of the variables were deleted to obtain 1,400 high-tech enterprises, with a total of 3,700 annual observations. After controlling the "business-to-business" policy in 2013, the following multi-panel regression model was obtained.

$$CI_{it} = \beta_0 + \beta_1(\text{VAT burden, VAT refund, input tax deduction})_{it} + \beta_2\text{“ VAT Reform” policy} + \varepsilon_{it} \quad (1)$$

$$R\&Dit = \beta_0 + \beta_1(\text{VAT burden, VAT refund, input tax deduction})it + \beta_2\text{“ VAT Reform” policy} + \varepsilon_{it} \quad (2)$$

### Variable Setting

The company investing in the explained variables introduces the "cash paid for purchasing PPE, intangible assets and other long-term assets" in the cash flow statement. Prior to the "business-to-business" policy, the input tax deductible included equipment-type fixed assets, with the exception of buildings and buildings. This article deducts buildings and buildings from the investment amount in the year before the policy and takes the logarithm.

The research and development of the explained variables of this article adopts two measures: "R&D expenditure" and "Number of patents". R&D expenditure uses the "R&D investment amount" under the R&D investment table in the CSMAR listed company's R&D innovation database as a measure; the number of patents is the number of patents in the "Patent Details" table under the database.

Explanatory Variable Value Added Tax This article uses three measures: "VAT burden", "VAT refund" and "input tax deduction". For the VAT burden, we use the ratio of "VAT expenses" to "taxes payable" in the financial statement notes for the year as a measure, which is expected to be negatively related to corporate investment and research and development (-). VAT refund uses the "received tax refund" in the cash flow statement as a measurement index. Because high-tech industry VAT clearly stipulates that self-produced products can enjoy immediate tax refunds, the impact on corporate investment and R&D is expected. (+). For tax deduction, we use the "cash paid for purchasing goods and services" in the cash flow statement. Since the purchase of raw materials can be deducted from the value-added tax invoice, it is expected to have a positive correlation with the explanatory variable (+).

Since the implementation of the "VAT Reform" policy in 2013, in order to control the impact of the policy, dummy variables have been set. The years before 2013 are set to 0, and the years to come are set to 1. The expected sign is (+).

### Data and Statistics Description

This article selected 18 listed high-tech industries based on the "eight major technology fields" stipulated in the 2016 "High-tech Fields Supported by the State" to obtain a total of 2362 enterprises. Table 1 shows the industry statistics of high-tech enterprises. Among them, "computer, communications and other electronic equipment manufacturing industries" accounted for the highest proportion of 15%, with a total of 354 enterprises. This is also the "chip", that is, the industry to which integrated circuit companies belong, and we will conduct a detailed analysis of this industry in the future.

**TABLE 1**
**SUMMARY STATISTICS BY INDUSTRY**

| Industry | Observations | Percentage（%） |
|---|---|---|
| Power and heat production and supply industries | 66 | 2.79 |
| Electrical machinery and equipment manufacturing | 276 | 11.69 |
| Internet and related services | 51 | 2.16 |
| Chemical fibre manufacturing | 25 | 1.06 |
| Manufacturing of chemical raw materials and chemical products | 260 | 11.01 |
| Manufacturing of computers, communications and other electronic equipment | 354 | 14.99 |
| Automobile manufacturing | 180 | 7.62 |
| Gas production and supply | 16 | 0.68 |
| Software and information technology services | 185 | 7.83 |
| Ecological protection and environmental management industry | 29 | 1.23 |
| Petroleum processing, coking and nuclear fuel processing industries | 23 | 0.97 |
| Manufacturing of railway, shipping, aerospace and other transport equipment | 71 | 3.01 |
| General equipment manufacturing | 158 | 6.69 |
| Rubber and plastic products | 86 | 3.64 |
| Research and experimental development | 11 | 0.47 |
| Pharmaceutical manufacturing | 258 | 10.92 |
| Instrument manufacturing | 49 | 2.07 |
| Special equipment manufacturing | 264 | 11.18 |
| Total | 2,362 | 100 |

Table 2 is the descriptive statistics of main variables, which have been logarithmically treated. It can be seen that the mean value of the variables is similar to the median value, and the sample is normally distributed. It can be understood that high-tech enterprises have certain industry characteristics in investment, value-added tax expense and R&D expenditure, and the difference between mean and median values of variables is not obvious.

**TABLE 2**
**SUMMARY STATISTICS BY VARIABLE**

| Variables | Observations | Mean | $50^{th}$ | Min | Max |
|---|---|---|---|---|---|
| Investment | 3700 | 17.977 | 18.035 | 11.781 | 21.679 |
| VAT charge | 3704 | 14.825 | 14.947 | 9.842 | 19.254 |
| R&D spending | 3681 | 17.644 | 17.600 | 14.078 | 21.311 |
| VAT rebate | 3368 | 15.696 | 15.940 | 4.279 | 21.778 |
| Input tax deduction | 2709 | 19.956 | 19.832 | 13.599 | 24.655 |

## ANALYSIS OF MAIN RESULTS

Due to the large gap between different listed companies, this paper adopts the "fixed effect model" to eliminate the bias caused by individual differences. In addition, the annual dummy variables are generated to control the influence caused by macroscopic unpredictable factors. The main regression results are as follows.

**The Impact of Value-added Tax on Investment**

In table 3 model (1), there is a significant negative correlation between VAT tax burden and enterprise investment (t value 5.185; Significant 0.01 level), which means that enterprises with small value-added tax burden are more willing to invest, and the symbol is consistent with expectations. Model (2) VAT rebate has a significant promoting effect on enterprise investment (t value 5.518; the level of 0.01 is significant), indicating that the preferential policy of levying and refunding VAT promotes enterprise investment. Model (3) input tax deduction is significantly positively correlated with enterprise investment (t value 14.331; 0.01 level is significant), which means that the increase of deductible funds after the VAT reform promotes the enthusiasm of enterprises for investment.

**TABLE 3**
**THE EFFECT OF VALUE-ADDED TAX ON INVESTMENT**

| | Investment | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| VAT tax | -2.518*** | | |
| | (5.185) | | |
| VAT rebate | | 0.164*** | |
| | | (5.518) | |
| Input tax deduction | | | 0.590*** |
| | | | (14.331) |
| Policy | 0.226** | 0.096 | 0.035 |
| | (2.403) | (0.530) | (0.323) |
| Constant | 18.056*** | 15.179*** | 6.209*** |
| | (20.773) | (31.787) | (7.646) |
| Firm-fixed effect | Control | Control | Control |
| Year-fixed effect | Control | Control | Control |
| Observations | 3,700 | 1,397 | 2,707 |
| Number | 1,399 | 660 | 1,055 |
| Adjusted $R^2$ | 0.477 | 0.657 | 0.338 |

Note: *, ** and *** indicate significance at 10 percent, 5 percent and 1 percent level, respectively, and that of the bracket is the value of t.

**The Impact of VAT on R&D**

In table 4, model (1) shows a significant negative correlation between VAT tax burden and R&D expenditure at the level of 0.1, and the symbols are consistent with expectations. It shows that the reduction of value-added tax burden is helpful for high-tech enterprises to ease financing constraints, reduce research and development costs, and promote enterprise investment in research and development. Model (2) and (3) showed a significant positive correlation between VAT rebate and input tax deduction on enterprise R&D, and the policy of "replacing business tax with VAT" in the model had a significant promoting effect on enterprise R&D input. In model (4), the reduction of VAT tax significantly increased the number of enterprise patents (t value 2.689, 0.01 level significantly). Model (5) and (6) VAT credits and refunds also show a significant positive correlation with the number of patents. To sum up, the reduction of value-added tax and related preferential policies for deduction and refund have promoted enterprises' R&D investment and technological innovation.

**TABLE 4**
**THE IMPACT OF VAT TAX ON R&D**

| | R&D spending | | | Patent | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| VAT tax | -0.640 | | | -9.161 | | |
| | (0.993) | | | (1.663) | | |
| VAT rebate | | 0.076** | | | 5.783*** | |
| | | (2.120) | | | (3.316) | |
| Input tax deduction | | | 0.202*** | | | 1.088* |
| | | | (4.037) | | | (1.758) |
| Policy | 0.713*** | 0.942*** | 0.703*** | 2.656 | 6.085 | 2.094 |
| | (5.838) | (3.793) | (5.351) | (1.346) | (0.684) | (0.300) |
| Constant | 17.115*** | 15.847*** | 12.944*** | 18.426 | 8.092*** | 2.025 |
| | (156.711) | (27.160) | (13.206) | (0.913) | (2.828) | (1.656) |
| Firm fixed effect | Control | Control | Control | Control | Control | Control |
| Year | Control | Control | Control | Control | Control | Control |
| Observations | 552 | 238 | 395 | 228 | 106 | 160 |
| Number | 225 | 110 | 163 | 139 | 71 | 101 |
| Adjusted $R^2$ | 0.359 | 0.371 | 0.043 | 0.247 | 0.071 | 0.614 |

Note: *, ** and *** indicate significance at 10 percent, 5 percent and 1 percent level, respectively, and that of the bracket is the value of t.

**The Influence of Value-added Tax of Chip Industry on Enterprise Behavior**

The "computer, communication and other electronic equipment manufacturing" industry of "chip" has the highest proportion in the total sample, accounting for 15%. This paper conducts empirical analysis on it as the representative industry of high-tech enterprises. There are 354 enterprises in the industry. After deleting the missing variable sample and conducting 1% horizontal truncation of the data, there are 226 enterprises and 559 companies' annual observed values. The statistical results are shown in table 5. In model (1), there is still a significant positive correlation between the VAT tax burden and enterprise investment at the level of 0.1, and model (2) and (3) the two preferential policies of VAT deduction and refund have a significant promoting effect on enterprise investment. The "replacing the business tax with a value-added tax" policy does not have a significant impact on investment promotion in this industry, which can be attributed to the defect that the salaries of R&D personnel still cannot resist the input tax. (Yuan et al., 2015)

**TABLE 5**
**THE IMPACT OF VALUE-ADDED TAX ON INVESTMENT IN "CHIP" INDUSTRY**

| | Investment | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| VAT tax | -2.106* | | |
| | (1.673) | | |
| VAT rebate | | 0.167*** | |
| | | (2.628) | |
| Input tax deduction | | | 0.675*** |
| | | | (7.230) |
| Policy | 0.133 | 0.135 | 0.116 |
| | (1.177) | (0.306) | (0.472) |
| Constant | 18.037*** | 15.080*** | 4.587** |
| | (14.939) | (14.535) | (2.509) |
| Firm fixed effect | Control | Control | Control |
| Year | Control | Control | Control |
| Observations | 559 | 240 | 398 |
| Number | 226 | 111 | 165 |
| Adjusted $R^2$ | 0.012 | 0.598 | 0.309 |

Note: *, ** and *** indicate significance at 10 percent, 5 percent and 1 percent level, respectively, and that of the bracket is the value of t.

The symbols of the model (1) and (4) in table 6 are consistent with the expected value added tax burden and R&D expenditure, but not statistically significant. The reduction of VAT tax has not promoted the R&D and technological innovation of enterprises in this industry. The reduction of value-added tax will help alleviate the capital shortage of enterprises, but in terms of R&D capability, domestic "chip" industry is at a disadvantage compared with foreign enterprises in terms of technology level, which is related to the technical capability of R&D personnel. (Chen, 2017) the two preferential policies of value-added tax deduction and refund in the chip industry have significantly promoted the R&D and technological innovation of enterprises in the chip industry. Secondly, the policy of "replacing business tax with value-added tax" has a significant promoting effect on industry R&D investment.

**TABLE 6**
**THE IMPACT OF VALUE-ADDED TAX ON R&D IN CHIP INDUSTRY**

| | R&D spending | | | Patent | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| VAT tax | -0.640 | | | -9.161 | | |
| | (0.993) | | | (1.663) | | |
| VAT rebate | | 0.076** | | | 5.783*** | |
| | | (2.120) | | | (3.316) | |
| Input tax deduction | | | 0.202*** | | | 1.088* |
| | | | (4.037) | | | (1.758) |
| Policy | 0.713*** | 0.942*** | 0.703*** | 2.656 | 6.085 | 2.094 |
| | (5.838) | (3.793) | (5.351) | (1.346) | (0.684) | (0.300) |
| Constant | 17.115*** | 15.847*** | 12.944*** | 18.426 | 8.092*** | 2.025 |
| | (156.711) | (27.160) | (13.206) | (0.913) | (2.828) | (1.656) |
| Firm-fixed effect | Control | Control | Control | Control | Control | Control |
| Year-fixed effect | Control | Control | Control | Control | Control | Control |
| Observations | 552 | 238 | 395 | 228 | 106 | 160 |
| Number | 225 | 110 | 163 | 139 | 71 | 101 |
| Adjusted $R^2$ | 0.359 | 0.371 | 0.043 | 0.247 | 0.071 | 0.614 |

Note: *, ** and *** indicate significance at 10 percent, 5 percent and 1 percent level, respectively, and that of the bracket is the value of t.

## CONCLUSIONS AND POLICY RECOMMENDATIONS

Our research proves that for the high and new technology industry with rapid development, the reduction of VAT tax significantly promotes the total investment of enterprises. The two preferential policies of VAT deduction and immediate refund have also significantly promoted the enthusiasm of high-tech enterprises to invest. In terms of R&D and technological innovation, the reduction of value-added tax burden in high-tech industry has significantly promoted the R&D expenditure and the number of patents obtained by enterprises. The two preferential policies of VAT deduction and refund have a significant promoting effect on enterprise R&D and technological innovation. In the chip industry, the reduction of VAT tax has a significant positive impact on corporate investment. However, the impact on R&D expenditure and technological innovation is not significant, possibly because domestic "chips" are still at a technological disadvantage compared with foreign ones, which is related to the overall level of R&D personnel. The policy of VAT deduction and refund still has a positive effect on the R&D and innovation of "chip" industry.

The high value-added tax burden is still a common phenomenon in the high-tech industry. As some tax professionals say, without the reform of value-added tax system, high-tech enterprises will not be able to devote themselves to research and development. From the perspective of the enterprise, the value created by the enterprise is value-added, and this part of value-added is the enterprise income. Therefore, levying value-added tax and income tax on this part of value increment is a kind of double taxation, which limits the value creation of high-tech enterprises (i.e., R&D and technological innovation). In the trade war between China and the United States, scientific and technological innovation is undoubtedly a magic weapon to win. Therefore, in addition to raising the level of research and development, the reduction of value-added tax rate has a positive impact on the development of high-tech industry.

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