Industrial Policy in China: Some Intended or Unintended Consequences?

Jing Cai[1]
University of Michigan

Ann Harrison[2]
University of Pennsylvania and NBER

April 2016

Abstract

We explore the impact of a tax reform in China which reduced the value-added tax on investment goods. While the goal of the reform was to encourage upgrading of technology, our results suggest that there was no significant increase in fixed investment, new product introductions, or productivity. However, we do find that firms shifted the composition of investment towards machinery, and increased the capital intensity of production, which is consistent with a fall in the price of capital relative to labor. As a result, employment fell significantly in the treated provinces and sectors. For domestic firms, employment fell by almost 7.5%. Our results are robust to a variety of approaches, and suggest that the primary impact of the policy has been to induce labor-saving growth. This policy has since been extended to the rest of China.

Keywords: Value-added tax, labor, investment, productivity

JEL code: H3, O1

[1] Department of Economics, University of Michigan, 611 Tappan Street, 365A Lorch Hall, Ann Arbor, MI 48109-1220 (e-mail: caijing@umich.edu; Phone: 734-764-0241)
[2] Corresponding author. The Wharton School, University of Pennsylvania, 2016 Steinberg Hall-Dietrich Hall, Philadelphia, Pennsylvania 19104-6370 (e-mail: annh@wharton.upenn.edu)

1. Introduction

Much of the literature in public finance focuses on the role of tax reforms in affecting firm behavior (Hassett and Hubbard (2012), Griffith, Miller, and O'Connell (2014)). Policy makers use tax incentives to encourage firm investment, and China provides a fertile ground for observing some of these policy experiments. Beginning in 2004, the Chinese government implemented a value-added tax reform in three northeastern provinces, which eliminated double taxation of investments in fixed assets. In 2009, this tax reform was extended to the whole country.

The objective of the 2004 reform was to encourage firms to raise investment spending on fixed assets for production (excluding structures) and to upgrade their machinery and equipment. The goals of the 2009 reform were similar, but in addition the government expressed the need to provide additional assistance to domestic enterprises to help them weather the adverse effects of the 2008-2009 global financial crisis. The government also wished to encourage fixed asset investments to promote an industrial policy now focused on more technologically advanced sectors.[3]

In China, the value-added tax is the major source of fiscal revenue for the government, generating much more revenues than any other types of tax. In 2002, the revenue from value-added taxes was 814.4 billion RMB, accounting for around 48% of the state total tax revenue in that year. In 2009, the Chinese Ministry of Finance

[3] According to the People's Daily Online, December 9, 2008, quoting ZhengJianxin, deputy director general of the taxation department of China's Ministry of Finance, "The VAT reform would encourage investment and technological upgrading at Chinese companies, boost domestic demand, improve companies' competitive strength and play a positive role in helping companies tackle the financial crisis". The article also states that "The reform was aimed at a shift from the existing production-based to a consumption-based VAT regime, which would enable companies to get tax deductions on spending on fixed assets, Zheng said, adding that this would reduce the tax burden on companies by more than 123 billion Yuan."

estimated that VAT revenue accounted for approximately 31 percent of China's overall revenue.[4]

In this paper, we assess the effectiveness of the 2004 VAT reform in China. We use a firm-level panel dataset covering 1998 through 2007 to identify the effect of the 2004 value-added tax reduction in selected provinces on firm behavior. Our measures of firm outcomes are broad, including investment, the share of new products in sales, productivity, employment, and exports. One advantage of this reform for researchers is that we know exactly which provinces and sectors were targeted first, and consequently we have a clean treatment group as well as a control group.

We begin the paper with a simple model to illustrate the likely effects of the VAT reform. We show that theoretically lowering the after tax cost of physical capital relative to other inputs in the production function leads firms to substitute towards physical capital and away from other inputs. This implies that when other possible inputs include labor, human capital, or research and development investment in new products, then favoring physical capital inputs are likely to lead to a reduction in labor-intensity, and a possible reduction in research and development intensive goods if these goods favor inputs other than physical capital.

For the empirical strategy, we adopt a three pronged approach. We begin by simply regressing a variety of outcomes on a treatment dummy, and add a large set of controls including province dummies, industry dummies, year effects and firm fixed effects. We then augment this difference-in-difference specification with an instrumental variable estimation using treatment as the instrument for VAT payments as the endogenous policy variable. Both approaches yield very similar results.

[4] See www.dorsey.com/china_vat_reform

The government's choice to lower statutory VAT payments first in specific areas and sectors could be non-random, and may depend on sector or firm attributes such as size, productivity, capital intensity, ownership, etc. This creates a potential selection bias in policy treatment. Consider the 2004 value-added tax reform in China: the three northeast provinces were chosen as the first pilot group because while many coastal cities had undergone rapid changes and upgrades in both capital assets and technology after the opening of the Chinese economy to the world, the northeast regions with their traditional industrial base were left behind in the race for technological advancement and prosperity. Encouraging firms in these provinces to invest more in fixed productive assets to upgrade their technology, and to revitalize their old industrial base was the main reason to implement the value-added tax reform in these provinces first.[5]

Our concerns about the non-random nature of the reform lead us to adopt a third approach, in addition to the OLS and IV approaches. This third approach also yields comparable results. We use a nonparametric technique, propensity score matching combined with difference-in-difference estimation, to confirm the causal effect of value-added tax reduction. This method has two advantages. First, it emphasizes the comparability of the treated and control firms by excluding firms that are not comparable. Second, it relaxes the parametric assumptions associated with regression-based techniques such as the linear regression framework. We assess the credibility of the matching procedure using an absolute standardized bias measure and formal paired t-tests. Moreover, we combine the matching technique with difference-in-difference

[5] According to the Xinhua News Agency on December 22, 2005, "The experiment, which moves the tax from production to tax on consumer spending has encouraged northeast China to increase investment in machinery and equipment and phase out outdated equipment".

estimation to deal with concerns about possible unobservable firm characteristics that share the same time dynamics for both treatment and control firms.

All three estimation approaches suggest that the reform was effective in reducing the incidence of value-added taxes paid by firms, with value-added taxes falling 1 to 2 percentage points in the treatment areas relative to the non-treatment areas. The statutory rate for the VAT is 17 percent, so the reduction in VAT paid in treatment areas accounts for a 6 to 12 percent reduction in the statutory rate. We also explore the consequences of this significant reduction in the effective price of physical capital for investment and other outcomes. The reform encouraged firms to substitute physical capital for labor: the policy significantly reduced firm total employment across all ownership types. The net impact of the reform was to increase the capital intensity of production, defined as the labor to capital ratio. While physical investment did increase for a restricted ownership type of enterprises, primarily the reform prevented firms from reducing physical capital investments.

We also explore the impact on new product introductions, exports, and total factor productivity growth. We find a reduction in new product introductions after the reform. The reform also negatively and significantly affected firm productivity, and significantly decreased export intensity for most types of firms. The negative effects of the reform on productivity growth, new product introductions, and exporting is consistent with our theoretical model showing that the reform led firms to favor physical investments over human capital or intellectual capital investments. In addition, the reform led firms to favor capital intensive technologies which may not

have been consistent with China's comparative advantage, at least during the time period of our sample.

Our evidence suggests that the primary effects of the tax reform over the three-year period following the policy changes were to reduce value-added tax payments and cut employment, as firms shifted to more capital-intensive or labor-saving technologies. One puzzle is why, in light of these limited gains, the policy was extended to the rest of China. One possible explanation is that the tax reform was part of a package of measures for fiscal stimulus during the 2008-2009 financial crisis.

The remainder of the paper is organized as follows. In Section 2, we discuss the value-added tax system and the tax reform in China. Section 3 discusses the identification strategy. Section 4 presents estimation results for the OLS and IV results, while Section 5 presents our approach using propensity score matching. Section 6 concludes.

2. Background and Theory

A value-added tax (VAT) is a tax on the difference between total sales and purchases of inputs from other firms. The most common type of VAT is the consumption-based type VAT, where both costs such as purchases of production materials, wage payments, and the purchase of fixed assets are deducted from sales when calculating a firm's VAT liability. For example, suppose the VAT rate is 10%. If firm A purchased capital inputs from other firms at a price of 100 RMB, and if its total sales equals 400 RMB, then the VAT base is 300, and firm A pays a VAT tax of 30 RMB.

Mainland China introduced the value-added tax as part of a major general tax reform initiative in 1994. The standard rate is 17% (of value-added), and the reduced rate is 13% for sectors such as agricultural production. Export enterprises receive value-added tax refunds as an export incentive, with refund rates ranging from 9% to 17%.

The VAT is an important source of government tax revenue. For example, from 2001 to 2008, on average, VAT receipts accounted for 36% of total tax revenue. However, the VAT system in China is different from the commonly used consumption-based VAT. China's system is a production-based VAT, and purchases of fixed investment cannot be deducted from sales when calculating VAT liabilities. In this case, if we consider the example above, firm A needs to pay 40 RMB VAT. In consequence, investment goods are twice subject to the VAT, first as final products of their producers and second as intermediate inputs for their users. One concern is that such a policy could lead firms to operate with old equipment and out-of-date technology, leading to less productivity growth.

Starting in 2004, China began its VAT reform by transforming the current production-based VAT to a consumption-type VAT. The main objective of the reform was to promote a more equitable market environment, allowing domestic and foreign firms to compete more easily, and to give firms more incentives to upgrade machinery and technology. In July 2004, the Chinese government selected three northeastern provinces as a pilot area to implement the consumption-type of value-added tax. In these provinces, value-added tax payers in six selected industries, including agricultural product processing, equipment manufacturing, petrochemicals, metallurgy,

ship building and automobile manufacturing, were allowed to deduct expenditures on fixed assets from the value-added tax base.

This reform was expected to eliminate double taxation and alleviate firms' tax burden, which as a result could lower prices for consumers and encourage more investment in fixed assets[6]. At the end of that year, the government further included military products and high-tech products as pilot sectors and extended the scope of the tax deduction from incremental quantity to the full amount of fixed assets. In 2007, the reform was extended to six provinces in the central area, including 26 cities. In 2008, eastern Inner Mongolia was further included, and finally in January 2009, the consumption-based value-added tax policy was implemented in all sectors and provinces of China.

A simple model that allows us to understand the implications of the 2004 reform for firm choices can begin with a generalized production function. Following Hamermesh (1986) a firm using N factors of production X_1 through X_N would have the following generalized production function:

$$Y = f(X_1, \ldots, X_N),\ f_i > 0,\ f_{ii} < 0$$

The associated cost function is given by

$$C = g(w_1, \ldots, w_N,\ Y),\ \ g_i > 0$$

Hamermesh shows that the elasticity of factor demand for a given input X_i with respect to a change in a factor price w_j is given by the following general equation, which holds across many different functional forms:

[6] We checked the set of industrial policies implemented in treated regions around the year 2004, and there were no other big reforms in those regions on treated sectors targeted by the VAT reform. China's entry into the WTO occurred in 2001, and affected all sectors and regions (the WTO impact is absorbed by time dummies or time dummies interacted with province dummies in the Appendix tables).

$$\partial lnX_i/\partial lnw_j = \eta_{ij} = s_j\sigma_{ij}$$

Since the own factor demand elasticity η_{ii} is less than zero and since the sum of all the elasticities must sum to zero (factor demands are homogenous of degree zero in all factor prices) then this implies that at least one η_{ij} is greater than zero. In the case of the VAT reform, these results imply that we would expect a tax reform that reduces the price of capital goods would increase the demand for capital or investment goods ($\eta_{ii} < 0$) but reduce the demand for at least one other good—such as labor. This would imply that labor and capital are so-called p-substitutes. However, in the multi-factor case with more than 2 inputs it is possible that some factors $j \neq i$ the elasticity could be negative, implying labor and capital could be p-complements.

These elasticities of substitution were originally developed by R.G.D. Allen, and are sometimes referred to as partial elasticities of substitution because they are developed holding output and other factor prices constant. Since in the empirical work that follows we primarily look at product mix as a share of output then the theoretical approach is aligned with the estimation. If investment goods and labor are p-substitutes, then a fall in the price of investment goods, resulting from the VAT reform, will reduce the labor to capital ratio or the labor intensity of production. Similarly, if investment goods and R and D research are substitutes, then again the VAT reform could lead to a fall in R and D research and a consequent decline in the production of new goods. The impact on trade would depend on whether the composition of exports are more intensive in labor of physical capital. If China primarily exported labor-intensive goods during the period of analysis, then we could get the result that

exports fall in the reform regions, as firms shift away from labor to physical-capital intensive goods.

We can illustrate the theoretical results with specific functional forms. In the Cobb-Douglas case with 2 inputs, firm output given by Y, physical capital inputs by K, and all other inputs by the vector Z, we can write:

$$Y = K^{\alpha}Z^{1-\alpha}$$

Allowing for imperfect competition, firms will maximize profits and set quantities of K and Z following the first order conditions:

$$P(\partial Y/\partial K) = \theta r$$

$$P(\partial Y/\partial Z) = \theta w$$

We assume that r is the price of physical capital and w is the price of the Zth input. The symbol θ indicates a markup over the competitive outcome. Under perfect competition, it would equal unity.

We can rewrite the ratio of the two first order conditions as the following:

$$(K/Z) = ((1-\alpha)/\alpha)(w/r)$$

With the introduction of the tax rebate for the VAT on physical capital K, then if the tax rebate is given by t the ratio of the first order conditions becomes

$$(K/Z) = [(1-\alpha)/\alpha][w/(r(1-t)]$$

It is easy to see from this expression that an increase in t will lower the effective (after tax) price of physical capital purchases for the enterprise relative to any other input Z. If, for example, Z is labor, then an increase in t will make labor costs w higher relative to effective capital costs r(1-t), leading to an increase in the ratio of physical capital to labor. If a component of Z is research and development investment,

which is not eligible for the tax reduction, then the reform will also be associated with increase in physical capital investments relative to R and D expenditures. To the extent that other inputs Z are more critical for total factor productivity growth or exports, it would be theoretically possible for the tax reform to be associated with productivity declines or contraction in exports. This could be the case, for example, if exports are more likely to come from labor-intensive, human capital-intensive, or R and D intensive goods.

In the Cobb-Douglas case, σ_{ij} is always equal to 1 and so the elasticity of substitution $\partial lnX_i/\partial lnw_j$ for factor Z due to a reduction in t is given by α which is always positive and the own elasticity of substitution for factor K is given by α-1 which is always less than zero. The Cobb-Douglas case is obviously less interesting, since a reduction in VAT payments on physical capital will always lead to an increase in the demand for physical capital and a reduction in the demand for other goods.

In other cases it can also be shown that the partial elasticity of substitution between the price of physical capital investment and the demand for other factors will generally (but not always) be positive. This implies that we would expect a reform that reduces the after tax price of physical capital but not the cost of other inputs would lead to a shift away from the use of these other inputs. If we relax the assumption in the theoretical derivation above that output is kept constant, it is possible that the positive impact of a tax reduction on output could outweigh the substitution effect and lead to an increase in demand for other factors. We explore the actual outcomes below.

3. Data, Variable Definitions and Summary Statistics

3.1 Dataset

The data we use in this paper comes from a large dataset developed and maintained by the National Bureau of Statistics of China (NBS). The NBS dataset contains annual firm-level unbalanced survey data of all "above scale" industrial firms with annual sales of more than 5 million RMB. On average, around 220,000 firms per year from 1998 to 2007 are included in the dataset, spanning 37 two-digit manufacturing industries and 31 provinces or province-equivalent municipal cities. Firms included in this survey account for almost 50% of China's industrial value-added, and 22% of China's urban employment in 2005.

The combined dataset contains detailed information about each firm's identity, address, industry classification, incorporation year, ownership types, new products and total value of output, total fixed assets, fixed assets for production, sales revenue, profit, total workforce, export sales, total industrial sales, employee education, income and value added tax payable. These are the key variables based on which we estimate firm level total factor productivity and impacts of the VAT reform.

The original dataset includes 2,226,104 firm-year observations. Since the paper focuses on manufacturing firms, we eliminate non-manufacturing observations. This also makes it easier to compare outcomes like exporting and total factor productivity, which are difficult to compare for non-manufacturing enterprises. To further clean the sample, we deleted observations where firm identifiers, county code, sector id, and year of establishment are missing, as well as observations with negative or zero values for key variables such as output, total workforce, capital, input, and total wages. In

addition, observations are dropped if total assets are less than liquid assets or total fixed assets, or if inputs are larger than output[7]. After implementing these data cleaning procedures, we obtain a sample of 1,543,000 observations for analysis.

3.2 Variable Definitions and Summary Statistics

In Table 1, we provide summary statistics for key variables. The main outcome variables we consider are investment, research and development intensity, total factor productivity (TFP), employment, the capital-labor ratio, and export intensity. We use three measures of investment: first, we define investment as the growth of fixed assets for production plus depreciation; second, we calculate the investment ratio, defined as the ratio of current-year gross fixed investment to beginning of the year net fixed assets; third, we look at the composition of fixed assets by calculating the share of fixed assets for production in total assets. Value of total fixed assets and fixed assets for production have been deflated by the fixed assets investment index. For new product introductions, which is one measure of innovative activity, we use the firm's reported share of new product output in total industrial output. Employment is defined as total number of employees. TFP is firm level total factor productivity estimated using two methods, OLS with firm fixed effects and the Olley-Pakes method (OP). Export intensity is calculated as the ratio of export procurement to total industrial sales. Our key controls include firm size, age, HKTM share, foreign share and state shares. Firm size is measured by total values of output, which are deflated by the sector-specific ex-factory price index of industrial products. HKTM share, foreign share, and state share are defined as the share of the firm's total equity owned by Hong Kong-

[7] Observations are dropped at the year-firm level. Estimation results are robust to including all the observations dropped.

Taiwan-Macau investors, investors from other countries, and the state, respectively. These three firm level controls are continuous variables ranging from 0 to 1.

Table 1 shows that treated and control firms are similar in employment size, while treated firms have a larger capital-labor ratio and higher levels of fixed investment. Moreover, treated firms have lower export intensity but a much higher state share than control firms.

We begin by reporting trends in the key variable of interest, the value-added tax rate. In Figures 1.1-1.4, we show the evolution of the annual growth of value added taxes in treated and control groups from 1998 to 2007, for the whole sample and by types of ownership. The value-added tax is defined as the value-added tax paid divided by value-added at the firm level[8]. Consider Figure 1.1: First, over the sample period, the value added tax rate as paid by firms in control sectors in control provinces does not change much and growth rates are essentially zero before and after the 2004 reform. Second, we compare the growth of this value added tax rate between firms in treated sectors in treated provinces and firms in treated sectors in control provinces. We can see that before 2004, for most years the annual change in the value added tax was very small (except for a jump in 1999 of treated sectors in the treated region). However, one year after the value added tax reform was implemented in 2004, there is a significant decrease of 2 percentage points in the growth of the value added tax paid by treated firms, and the tax paid by treated firms continues to fall until 2007. Looking at firms in control sectors of treated regions, there was a jump in the value added tax paid by those firms in 2005, but decreased afterwards. The evidence in Figure 1.1 is

[8] Please note that we don't have year 2004 in the figure because in the NBS data, the variable value added is missing for that year.

consistent with essentially no changes in value-added taxes for both treatment and control sectors in the control provinces, but significant reductions in the VAT rate for treatment sectors in treated provinces between 2003 and 2005. This is the change whose effects we document in the rest of this paper.

In Figures 1.2 to 1.4, we redo Figure 1.1 by different ownership types. This allows us to compare changes in the value added tax from 1998 to 2007 for firms with different ownership types. For all types of firms, there was a decline in the value-added tax in treated sectors and provinces relative to eligible sectors in control provinces after 2004. However, we see in Figures 1.2 and 1.3 that the decline in the VAT paid by SOEs (Figure 1.2) after 2004 is more significant than that of the VAT paid by private firms (Figure 1.3). For foreign firms (Figure 1.4), the only significant change in VAT payments is an increase in the VAT rate paid by foreign firms in control sectors in treated regions around the year 2005. Given these significant differences in payments across ownership types, we would expect the largest effects for SOEs and more attenuated effects for foreign owned enterprises.

In Figure 2, we plot the annual growth of sales for treated and control firms. Before the policy was introduced in 2004, the growth of firms in treated sectors in treated provinces was initially faster than in control provinces but then reversed after the reform was introduced. The same pattern holds when comparing firms in control sectors in treated provinces and those in control provinces. There is no evidence from Figure 2 that the reform was targeted at sectors that had grown slowly prior to the introduction of the reforms. However, there is evidence that the treated sectors grew more slowly after 2004.

In Figure 3, we plot the evolution of employment, investment, export intensity, new product introductions, and productivity during the sample period. Figure 3 shows that before the policy intervention in 2004, treated and control firms had similar trends in the key outcome variables of interest, suggesting that difference-in-difference estimation is an appropriate strategy.

Figure 3 also shows a significant divergence in the behavior of treated and control firms from 2004 onwards for our outcome variables. Logged employment, which was declining gradually for both sets of enterprises prior to the reform, accelerates its downward trend for treated enterprises but levels off for the control group. The divergence is quite strong for new product introductions, as the control firms prior to the reform had rates of new product introductions as a share of sales that were below the treatment group. Following treatment, product introductions decline for the treatment group and the control group overtakes them.

Figures 1 through 3 show evidence that VAT payments declined for the treatment group, and that following treatment employment declines accelerated and new product introductions declined. In the rest of the paper, we employ a series of statistical tests and add more controls to identify whether these trends are a consequence of the VAT reform.

4. Identification of the Policy Impact: Using OLS and IV Estimation

The VAT reform is well documented, and consequently the simplest approach is an OLS difference-in-difference estimation that allows us to compare outcomes for

firms in the treated regions and sectors relative to control firms. For a particular outcome of firm i in year t, region r and sector j, we have the following specification:

$$Outcome_{ijt} = a_0 + a_1 Treatment_{jrt} + a_2 Year_t + a_3 Province_r + a_4 Sector_j + f_i + \epsilon_{ij} \quad (1)$$

We explore a variety of outcomes at the firm level, including employment, capital investment, the composition of investment, capital-labor ratios, labor-output ratios, the share of new products in total sales, exports, and productivity. In all estimations, we control for year, province, sector dummies, and firm fixed effects. Standard errors are clustered to the sector level. We begin by examining whether the regression results show consistent magnitudes for a reduction in VAT payments, which is expected given the trends observed in Figure 1.

The results from estimating equation (1) are reported in Table 2. Column (1) of Table 2 reports the impact of the treatment dummy on VAT payments—the effective VAT rate. Consistent with the evidence in Figure 1, firms subject to treatment reduced VAT payments on average by 1.6 percentage points relative to control firms. The reduction is greatest for SOEs and smallest for foreign owned enterprises, also consistent with Figure 1.

The next three columns measure the impact of treatment on the log of firm employment, the capital-labor ratio, and output per worker. Treatment was associated with a large decline in log employment, indicating a fall in employment overall of 12.7 percent across all firms. The largest decline was for domestic enterprises, where employment fell by 13.1 percent, and the smallest decline was exhibited by foreign

enterprises, where treatment was associated with a 9.3 percent decline in employment. Across all firms, treatment was associated with an increase in the capital-labor ratio and an increase in output per worker.

Columns (5)-(7) explore the impact of the reform on fixed investment. Investment is measured first as the log of investment, second as the ratio of investment to fixed capital, and third as the share of machinery investment in total investment. There is no evidence that either the log of investment or the ratio of investment to the capital stock increased. However, the share of machinery investment in total investment did increase significantly for SOEs, and marginally significantly for foreign owned enterprises. These three columns indicate that while the composition of investment changed and shifted towards machinery, the actual volume of investment did not increase.

The last three columns explore the impact on the export ratio, the share of new products in total sales, and total factor productivity, measured using the Olley-Pakes (2003) approach. Consistent with the lack of increase in total investment, the reform did not increase the technology levels of participating establishments. TFP did not increase, nor did the share of new products in total sales. Exports as a share of sales fell significantly, which is plausible if the reform shifted firm investments away from products in which China has a comparative advantage, which at that time was still in more labor-intensive products.[9]

[9] We present robustness check results of Table 2 in appendix tables A1-A3. In Table A1, we control for the province-time trend in order to capture spurious trends between the Northeastern and other provinces. Adding this additional interaction does not change the results significantly. In appendix Table A2 and A3, we show the difference-in-difference results when restricting the sample to treated regions or treated sectors. Most effects are not significant if we only look at treated regions, because the sample size is small and we probably don't have sufficient power to identify any effect significantly. In

An alternative approach to the simple OLS difference-in-difference estimation would be to use an instrumental variable strategy with VAT payments instrumented using the VAT reform dummy. In Table 3, we report the results using this approach. We now use the treatment dummy as the first stage instrument for VAT payments which are the main independent variable of interest. This approach allows us to directly estimate the impact of VAT payments on outcomes at the firm level, but we only use shifts in VAT payments stemming from the reform for identification.

The results are consistent with the OLS estimates presented in Table 2. In the first column, we see that lower VAT payments are associated with significantly lower log employment. The point estimates, which range from 5.4 to 8.6, indicate that a VAT reduction of 2 percentage points would be associated with a reduction in employment of more than 10 percent. Columns (2) and (3) indicate that a reduction in VAT payments would be associated with an increase in both the capital-labor ratio and the output to employment ratio, consistent with the OLS results in Table 2. Columns (4) through (6) report a positive and significant association between VAT payments and the ratio of investment to capital stock, but a negative association between VAT payments and the share of machinery in total investment. The negative association with machinery indicates that as VAT payments fell, the share of machinery equipment in total investment rose. The point estimates, which range from -0.23 to -1.4, indicate that a 2 percentage point decline in VAT payments is associated with an increase in machinery's share of almost 3 percent for state-owned enterprises.

---

addition, since a majority of manufacturing sectors are treated, results on treated sectors are very similar to those reported in Table 2.

The last three columns indicate the impact of VAT payment reductions stemming from the reform on export shares, new product introductions, and TFP. Consistent with Table 2, the positive coefficient on new product introductions and TFP suggests that reductions in VAT payments were associated with a reduction in new product introductions and a reduction in TFP. These results are consistent with the negative impact we document of the reduction in VAT payments on exports: reducing VAT payments on investment in machinery appears to skew manufacturing investment away from labor-intensive activities, which during the sample period are areas of comparative advantage for China consistent with exporting, new product introductions, and productivity growth.

The results in Tables 2 and 3 suggest a consistent story across different estimation approaches. The VAT reform led to a reduction in VAT payments of 1 to 2 percentage points. Those reduced VAT payments led firms to increase the share of machinery in total investment. In turn, the shifting composition of investment was associated with a fall in employment, and an increase in both the capital-labor ratio and the output to employment ratio. Labor was replaced with machinery, and capital intensity increased as investment held steady but employment declined.

There is no evidence that the reform was associated with increase in TFP or the share of new products in aggregate sales. Treatment firms also exhibited lower export growth. One explanation consistent with these results is that the reform encouraged firms to substitute towards physical capital but away from human capital or research and development (intellectual capital) whose prices increased in relative terms. To the extent that TFP or new products are associated with research and development or

educational expenditures, productivity did not increase. To the extent that China's export growth was not associated with more capital intensive products, the reform reduced export growth. Of course, this negative impact could be a short run phenomenon, as SOEs used the reform to upgrade their machinery, leading to a temporary decline in export growth for investing enterprises. The reform encouraged firms to replace people with machinery, but had no evident impact on long run productivity growth[10].

5. Robustness: Estimation using Propensity Score Matching

Although the value-added tax reform policy was only implemented on certain sectors in certain provinces, the assignment may not have been random. The three northeast provinces were chosen as the first pilot group because while many coastal - cities had undergone rapid changes and upgrades in both capital assets and technology after the opening-up of the Chinese economy to the world, the traditional industrial base in northeast regions was left behind in the race for technological advancement and prosperity. Encouraging firms in these provinces to invest more on fixed productive assets to upgrade their technology, and to revitalize these old industrial bases was the main reason to implement the value-added tax reform in these provinces first. It is possible that these sectors or provinces were chosen because they were in decline, or because they are more capital intensive and reducing the value added tax is

[10] One concern is that the treated firm may not expect the reform to be permanent, and that control firms might have expected to eventually receive the policy. If there are such "ephemerality effects", we should expect firms with lower rates of economic depreciation to exhibit higher response to the reform. We tested the heterogeneity of the treatment effect by depreciation rates but did not find any significant effect.

more important for these types of enterprises. As a result, the key difficulty with identifying the causal effect of value added tax reform could be endogenous selection.[11]

To address this potential problem, we adopt a two-stage identification approach. First, we use nonlinear propensity score matching techniques to construct a control group of firms that match most closely firms that have been treated based on observable characteristics; second, we estimate the program impact using difference-in-difference estimation to remove all unobservable effects that have the same time dynamics in the treatment and matched control group.

5.1 Propensity Score Matching

We adopt a procedure using Gaussian kernel matching introduced by Becker and Ichino (2002). To identify the most appropriate control group, we need to specify a list of covariates as key determinants of policy assignment. Here we use sector, foreign share, state share, export share, firm size, age, capital, and productivity as matching covariates, so firms in the control group are matched to the treatment group on the basis of the pre-treatment (1998-2003) mean of these observables.

There are two steps to test whether the propensity score matching method works well. First, we need to estimate whether the covariates we chose are actually important determinants of policy treatment. For this, we estimate a probit model for the likelihood of the value added tax reform treatment:

[11]According to appendix Table A3, the common trend assumption for the difference-in-difference estimation does not hold for most outcome variables, suggesting potential placement bias.

$$Treatment_{ij} = a_0 + a_1 ForeignShare_{ij} + a_2 HKTMShare_{ij} + a_3 StateShare_{ij} + a_4 ExportShare_{ij} + a_5 logOutput_{ij} + a_6 Capital_{ij} + a_7 Age_{ij} + a_8 logTFP_{ij} + a_9 Sector_{ij} + \epsilon_{ij} \quad (2)$$

Where $Treatment_{ij}$ is a dummy variable which equals 1 if firm *i* in sector *j* was exposed to the tax reform in 2004 and 0 otherwise, and $Sector_{ij}$ includes a set of two-digit sector dummies. Second, we perform a formal pairwise t-test comparison between treated and matched control firms to see whether there are any significant differences. We impose the common support condition and confine our attention to the matched firms falling within the support of the propensity score distribution of the treated group.

5.2 Difference-in-Difference Estimation

Using difference-in-difference estimation helps remove the time-invariant unobserved heterogeneity across firms, such as sector specific effects and managerial behavior. Here we define the first difference of outcome variables, including investment, the share of new product in sales, TFP, total number of employees, capital-labor ratio, and export intensity by calculating the difference between post-treatment (2005-2007) and pre-treatment (1998-2003) means of outcome variables, which means we only keep a balanced sample of firms that existed in the sample both before and after the policy treatment. The estimator is as follows:

$$\hat{\hat{\beta}}_{DDM} = \frac{1}{n} \sum_{i \in I_1 \cap S_P} \left[(Y_{it} - Y_{it-1}) - \sum_{j \in I_0 \cap S_P} W(P_{it}, P_{jt})(Y_{jt} - Y_{jt-1}) \right]$$

Where $I_1 \cap S_p$ is the set of treated firms that falls within the common support S_p, I_0 is the set of control firms, and n is the number of treated firms in the common support set. Y is outcome variables and P measures the probability of receiving treatment based on the vector of firm characteristics X_{it-1}:

$$P_{it} = E(D_{it} = 1|X_{it-1})$$

W(.) is a Gaussian kernel weighting function that depends on the propensity score distance between the treated and control firms. $\hat{\hat{\beta}}_{DDM}$ is the estimator of the causal effect of the value added tax reform, and we obtain standard errors using a bootstrapping procedure.

5.3 Propensity Score Matching Estimation Results

In this section, we analyze the estimation result of the probit model for the policy treatment and the matching balance test. In Table 4, we show the results of the probit regression from equation (2). The dependent variable is a dummy variable which takes a value of 1 if a firm was in the value added tax reform treatment group and 0 otherwise. The objective is to check whether the covariates we chose are important determinants of policy treatment. All covariates are measured by the mean before the policy treatment.

We find that most covariates are significant determinants of policy treatment. Specifically, firms are more likely to receive policy treatment if they have lower foreign shares or HKTM shares, or higher state shares. Firms with more output or slower labor growth are more likely to be included. Younger firms or firms with lower productivity have a higher probability of being selected. The results confirm that the focus of the reform was on regions with less foreign investment, a larger state

enterprise presence, and bigger firms. These results are consistent with the anecdotal and press reports that the goal of the initial 2004 reform was to encourage upgrading in the more backward northeastern provinces.

Based on the above determinants of policy treatment, we construct a matched control group to compare with treated firms. In Table 5, we compare the pre-treatment mean of policy determinants between these treated and matched groups. The absolute standard bias measures reported in Column (3) are all below 5% in absolute value in the matched sample. Moreover, there is no significant difference in the covariates we chose between treated and matched samples. To provide a visual sense of the quality of the matching procedure, we present density plots of the propensity score for the treatment group and the control firms before and after matching in Figure 4. There is no significant difference in the density plot between the treatment group and their matched counterparts. Overall, the quality of the matching procedure is good and provides a solid foundation for the difference-in-difference estimation.

5.4 Difference-in-Difference Estimation Results

Having demonstrated the quality of the matching procedure, we then present the difference-in-difference matching estimation results. Results are listed in Tables 6 and 7. We present results for the overall sample, domestic (state-owned and non-state-owned), and foreign firms separately.

In Table 6, we report the impact of VAT reform on firm investment and employment. We begin by looking at the effect of the tax reform on value-added taxes paid by firms. The estimates show that overall, the reported value-added tax paid (rescaled by value added) by treated firms was 1.5 percentage points less than that paid

by control firms, consistent with the OLS and IV estimation results. This suggests that the value-added tax reform effectively decreased taxes paid by treated firms. The magnitude of the effect varies by firm ownership. The effect is largest for domestic state-owned firms: the reform reduced the value-added tax ratio by 3.1% for treated firms. For domestic non-state-owned firms, the reform also reduced tax paid by around 1.3%. These numbers indicate that the tax reform reduced the tax burden for SOEs three times more than for non-SOEs. Taxes paid by treated foreign firms also decreased by 1.5 percentage points. This is consistent with the fact that the reform itself focused on domestic and particularly state owned enterprises.

We then turn to the impact of the tax reduction on firm behavior. First, we estimate the impact of tax reform on firm investment. According to results in Panel B through D of Table 6, we see that overall the tax reform did not change investment behavior significantly. Turning to results on employment as shown in Panel E, the reform is associated with a fall in the total number of employees for all types of firms. For domestic firms, the VAT reform reduced employment by more than 13%, but it had a smaller effect on employment of foreign firms: they reduced employment by around 7%. Because the tax reform did not affect investment but reduced labor, we see a positive impact of the reform on the capital-labor ratio as shown in Panel F.

Although overall investment did not change significantly, it is still possible that the composition of investment was affected by the reform. In Table 7, we estimate the impact of the VAT reform on firm upgrading behavior, by looking at the effect on new product introduction, productivity, and export intensity. In Panel A, we look at the impact of tax reform on new product introductions, to see whether treated firms

increased innovative activity after the tax incentive was provided. However, the results show that for all types of firms, new product introductions decreased after the reform. We then consider the impact on productivity in Panel B. Similar to the results on investment, there is no positive effect of tax reform on firm productivity. Finally, we consider export activity. According to Panel C, firms' export intensity, which is measured by the share of export procurement in industrial sales, significantly fell after the tax reform policy. The effect holds for all firms except for state-owned firms.

Our results are consistent across all specifications: new product innovations, exports, and TFP declined for treated firms relative to the control group. In the last table of the paper, we explore the possibility that the VAT tax reform undermined local revenues and consequently led to reductions in subsidies, tax holidays, and low interest loans. Such declines could in part provide an alternative explanation for the observed fall in exports, TFP, and new product introductions. Exporters are a major beneficiary of tax holidays and other forms of government support (see Cai, Harrison, and Lin (2014) showing the strong correlation between export status and tax holidays for the sample period). There is also evidence supporting a significant correlation between subsidies, tax holidays, TFP growth and new product introductions in China (see Aghion et al (2015)).

One possibility is that the VAT reform put pressure on participating provinces as they lost VAT revenue, so that they may have compensated for revenue losses by cutting policies to support firm growth, such as subsidies, tax breaks, and loans. To test this, we estimated the impact of the VAT reform on firm-level receipts of subsidies, corporate income tax breaks, and lending. We coded subsidies as a zero-

one dummy variable if the enterprise indicated it had received any subsidy amount greater than zero in that year. We did the same for tax holidays, indicating using a zero-one dummy variable whether the enterprise paid below the full corporate tax rate in that year. Finally, we measured loans as paying interest on liabilities below the median in that sector and year.

As shown in Table 8, treatment defined as the VAT reform is associated with a significantly lower incidence of subsidies, tax holidays, and low interest loans. Firms in the treatment sectors and regions benefited from lower VAT payments on physical assets, but the evidence in Table 8 shows that they were also significantly less likely to receive subsidies, tax holidays, or low interest. The OLS estimates suggest that a treated establishment was 2.4 % less likely to receive tax holidays and 2.3% less likely to receive subsidized loans. The specifications include firm fixed effects, as well as location and industry effects. The fact that treated firms received less support from government support programs after treatment could also contribute to the observed fall in exports and new product sales.

6. Conclusions

This paper analyzes the impact of the value-added tax reform in China on firm investment, the share of new products in sales, TFP, employment, and export intensity. We use three different approaches to ensure the robustness of our results: OLS with treatment and an exhaustive set of fixed effects, instrumental variable estimation using treatment as an instrument for VAT payments, and a difference-in-difference

propensity score matching approach. Our results are consistent across all three approaches.

While the goal of the experiment was to encourage upgrading of technology, our results suggest that there was no significant increase in the level of fixed investment, new product introduction, or productivity. However, we do find that firms shifted the composition of investment towards machinery, and increased the capital intensity of production, which is consistent with a fall in the price of capital relative to labor. As a result, employment fell significantly in the treated provinces and sectors.

For the propensity score matching, we construct a matched group and compare the outcomes with the treated group. We find that the reform significantly reduced firms' tax burden. The tax reduction is also associated with falling employment for both domestic and foreign firms, while its effect on firm investment, new product introduction, and productivity was limited. For most firms, their exports fell in conjunction with the value-added tax reform.

The insignificant effects that we find on productive investment, new product introduction, productivity, combined with the fall in employment across the board, suggest that the VAT reform was primarily associated with increasing capital intensity and labor shedding. While the VAT reform may have prevented declines in investment, it appears that those investments were primarily associated with labor-saving techniques, rather than new product introductions or increasing process efficiency, which would have been captured by TFP.

Our most robust finding is the significant reduction in employment among treated firms. Treated firms reduced employment by more than 10 percentage points. One

policy problem that should be considered for future research is whether encouraging such labor-saving changes are optimal. Policy changes in both developed and developing countries appear to be encouraging manufacturing growth which leads to small increases in employment. For the US, for example, Ebenstein, Harrison, McMillan and Phillips (2011) show that falling prices of investment goods led to a reduction in domestic manufacturing employment.

Since the benefits from the reform in terms of increasing aggregate investment and even productive investment seem quite limited and targeted at SOEs, one question is why the reform was extended to the rest of China. One likely explanation is that extending the reform to the rest of China was part of a comprehensive stimulus package in response to the 2008-2009 financial crisis.

References

Philippe Aghion, Jing Cai, Mathias Dewatripont, Luosha Du, Ann Harrison, and Patrick Legros (2015), "Industrial Policy and Competition", *American Economic Journal: Macroeconomics*, October.

Sascha Becker and Andrea Ichino. (2002). "Estimation of Average Treatment Effects Based on Propensity Scores". *The Stata Journal*, Stata Corp LP, vol. 2(4), pages 358-377, November.

Alvaro Bustos, Eduardo M.R.A. Engel, and Alexander Galetovic. (2004). "Can Higher Taxes Increase the Long-run Demand for Capital? Theory and Evidence for Chile". *Journal of Development Economics*, 73(2004): 675-697.

Jing Cai, Ann Harrison, and Justin Lin (2015), "Patterns of Trade and Tax Interventions and Firm Performance in China", working paper.

Robert Carroll, Douglas Holtz-Eakin, Mark Rider, and Harvey S. Rosen. (2010). "Income Taxes and Entrepreneurs' Use of Labor". *Journal of Labor Economics*, 18(2): 324-351.

Rodrigo A. Cerda and Felipe Larrain. (2010). "Corporate Taxes and the Demand for Labor and Capital in Developing Countries". *Small Business Economics*, 34: 187-201.

Raj Chetty and Emmanuel Saez. (2005). "Dividend Taxes and Corporate Behavior: Evidence From the 2003 Dividend Tax Cut". *Quarterly Journal of Economics*, CXX(3): 791-833.

Avraham Ebenstein, Ann Harrison, Margaret McMillan, and Shannon Phillips, 2011. "Estimating the impact of trade and offshoring on American workers using the current population surveys," Policy Research Working Paper Series 5750, The World Bank.

Nada Eissa. (1995). "Taxation and Labor Supply of Married Women: The Tax Reform Act of 1986 as a Natural Experiment". *NBER working paper, No. 5023*.

Sourafel Girma and Holger Gorg. (2007). "Evaluating the Foreign Ownership Wage Premium Using a Difference-in-Difference Matching Approach". *Journal of International Economics,* 72(2007): 97-112.

Daniel Hamermesh. 1986., "The Demand for Labor in the Long Run", Chapter 8 in the Handbook of Labor Economics, Volume I, Edited by O. Ashenfelter and R. Layard, Elsevier Science Publishers BV.

Rachel Griffith, Helen Miller, and Martin O'Connell. (2014). "Ownership of Intellectual Property and Corporate Taxation". Journal of Public Economics, April 2014, 112:12-23.

Ann Harrison and Jason Scorse. (2010). "Multinationals and Anti-Sweatshop Activism". *American Economic Review*, 100: 247-274.
Kevin A. Hassett and R, Glenn Hubbard. (2002). "Tax Policy and Business Investment". *Handbook of Public Economics*, Chapter 20: 1293-1343.

Shuanglin Lin. (2008). "China's Value-added Tax Reform, Capital Accumulation, and Welfare Implications". *China Economic Review*, 19(2008): 197-214.

Karel Mertins and Morten Ravn. (2010). "Empirical Evidence on the Aggregate Effects of Anticipated and Unanticipated U.S. Tax Policy Shocks". *NBER working paper, No. 16289*.

Paul Rosenbaum and Donald Rubin. (1985). "Constructing a Control Group Using Multivariate Matched Sampling Methods that Incorporate the Propensity Score". *The American Statistician*, volume 39, No. 1 (Feb 1985), pp. 33-38.

Figures and Tables

Figure 1.1. Evolution of the Annual Growth of Value-added Tax, All Sample

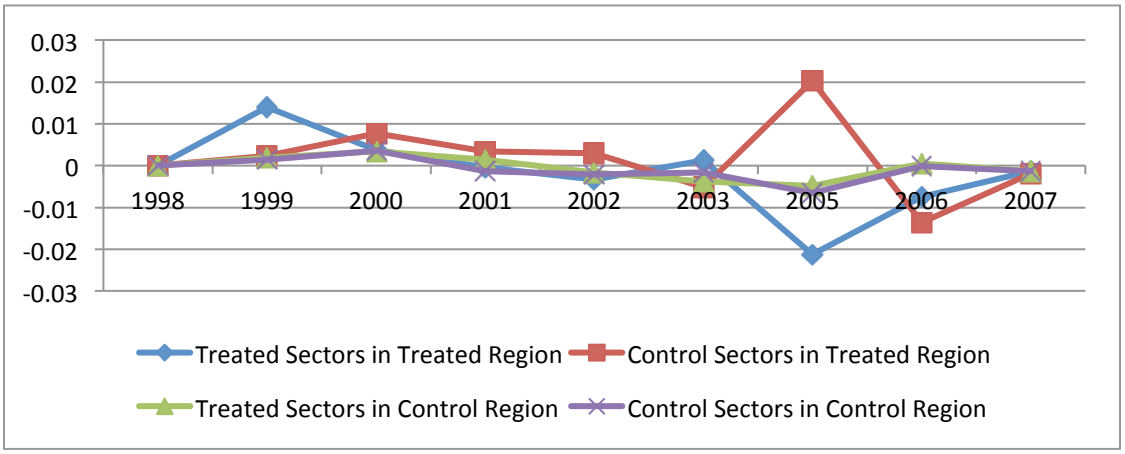


Figure 1.2. Evolution of the Annual Growth of Value-added Tax, State-Owned Firms (SOEs)

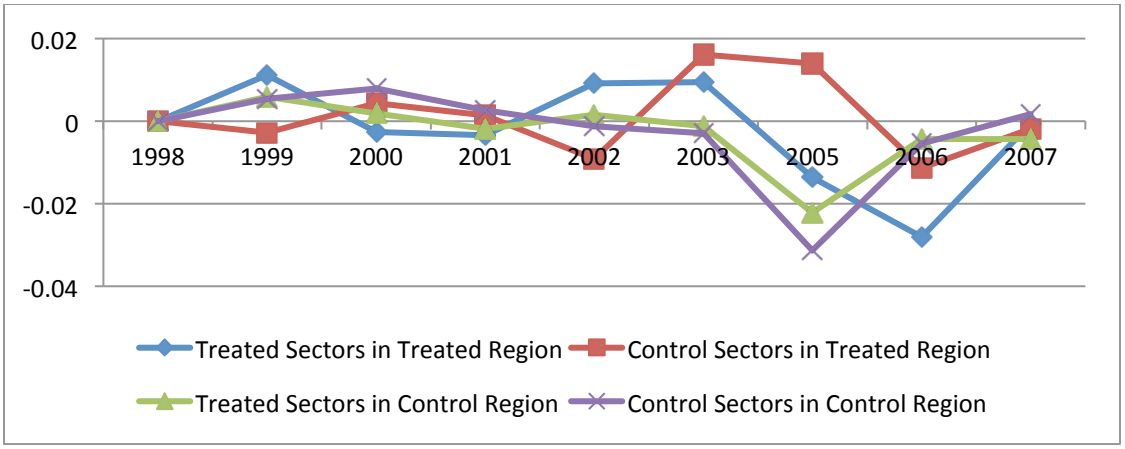


Figure 1.3. Evolution of the Annual Growth of Value-added Tax, Private Firms

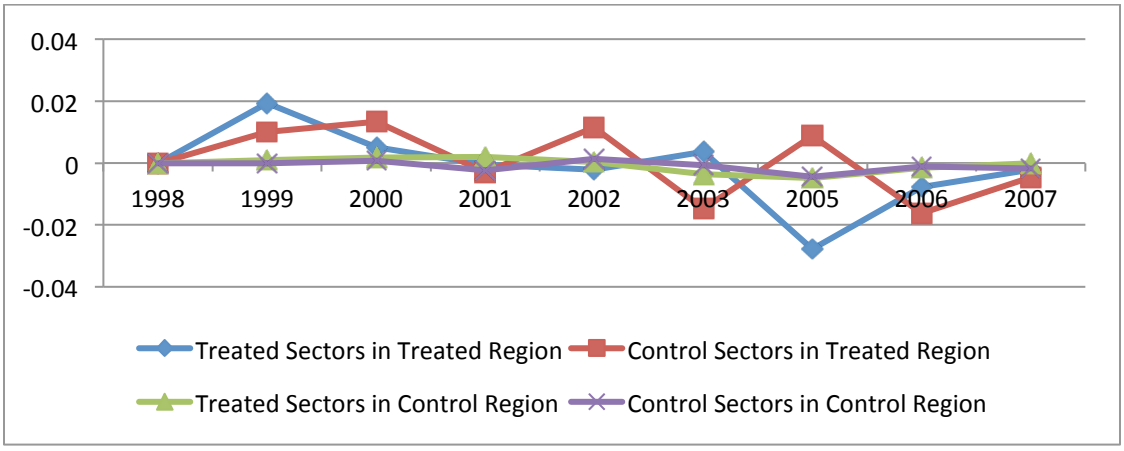
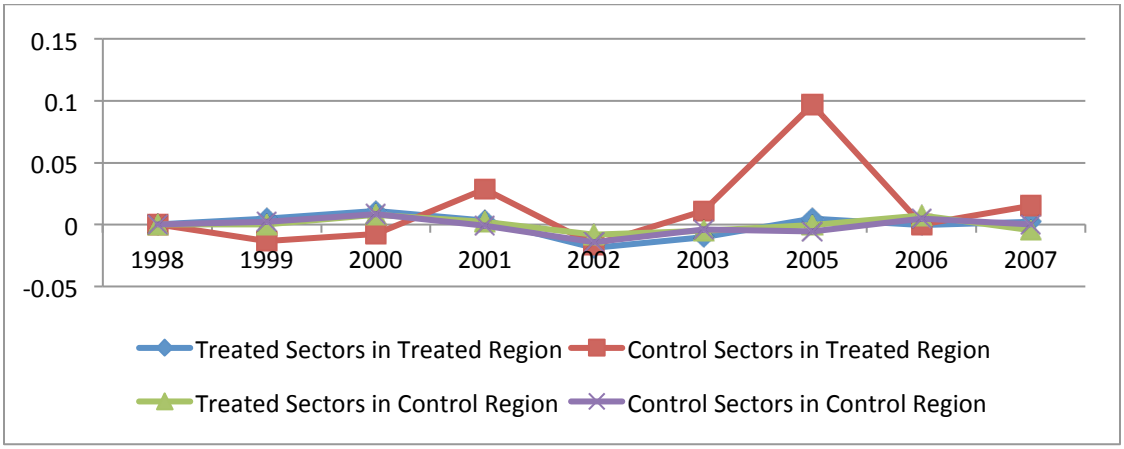


Figure 1.4. Evolution of the Annual Growth of Value-added Tax, Foreign Firms



Note: The variable value added tax is defined as the ratio of reported value added taxes paid to value added. Figures 1.1-1.4 shows the annual growth of the value added tax ratio. The data in year 2004 is not included in those figures because the variable value added is missing in that year.

Figure 2.1. Evolution of the Annual Growth Rate of Industrial Sales, All Sample

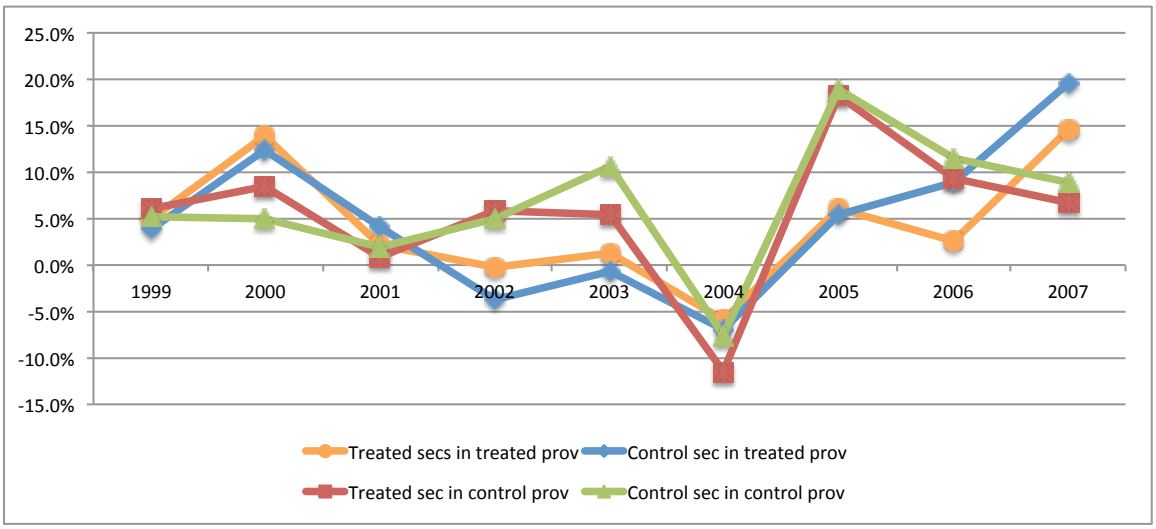


Figure 2.2. Evolution of the Annual Growth Rate of Industrial Sales, State-owned Firms

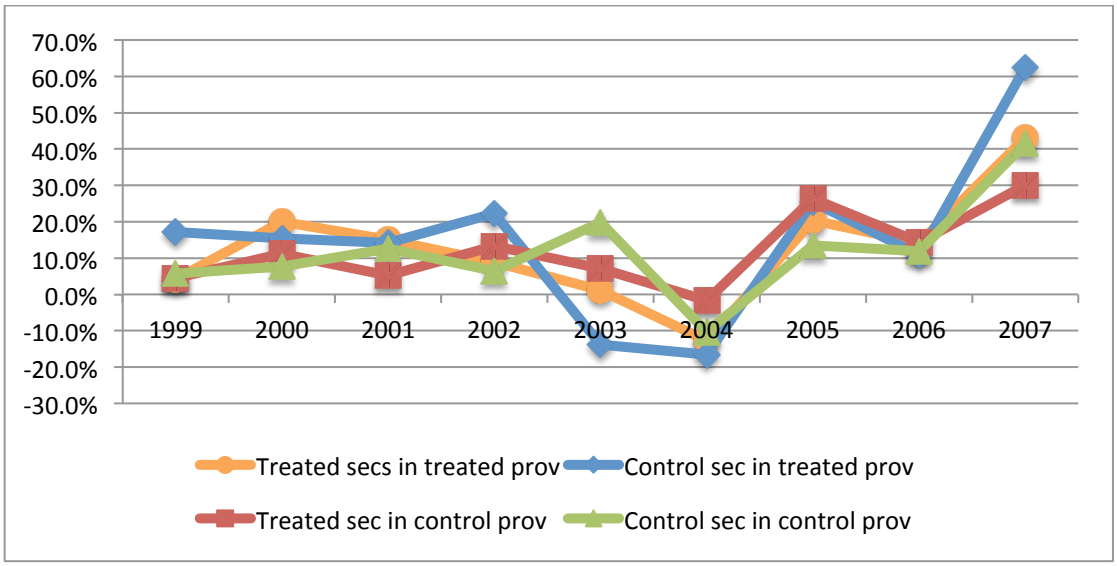


Figure 2.3. Evolution of the Annual Growth Rate of Industrial Sales, Private Firms

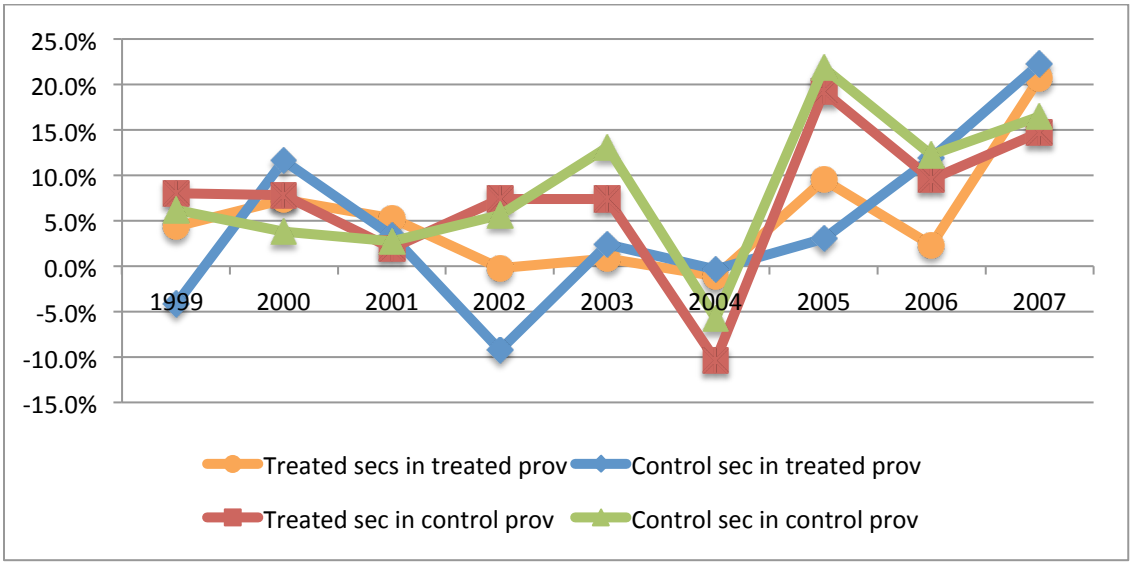


Figure 2.4. Evolution of the Annual Growth Rate of Industrial Sales, Foreign Firms

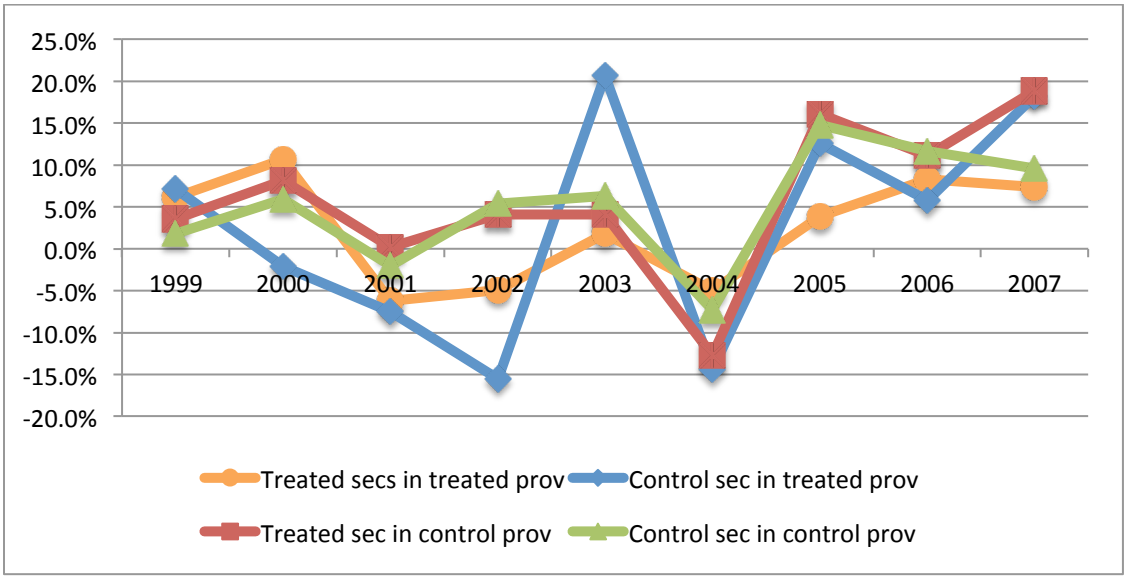


Figure 3.1. Evolution of log Employment, by Treatment

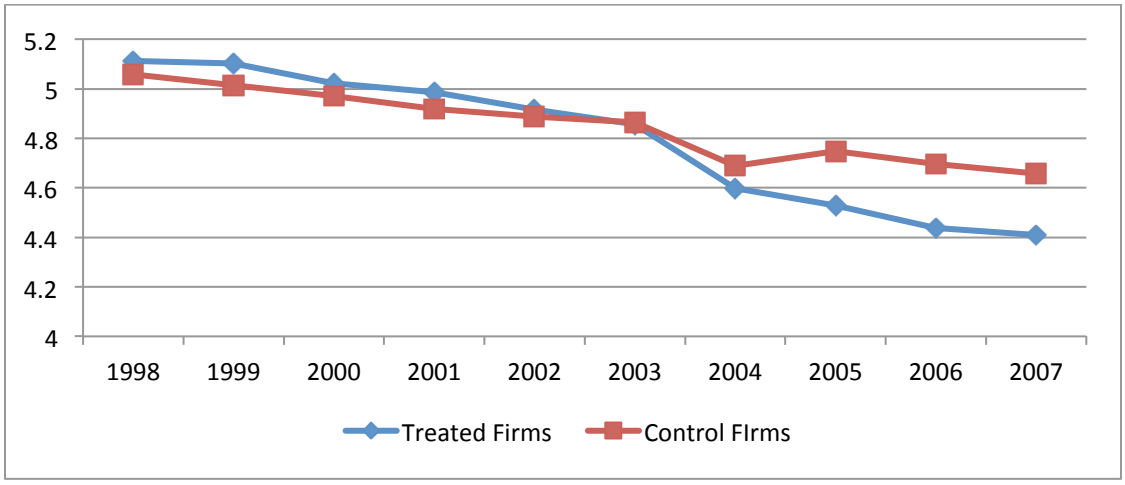
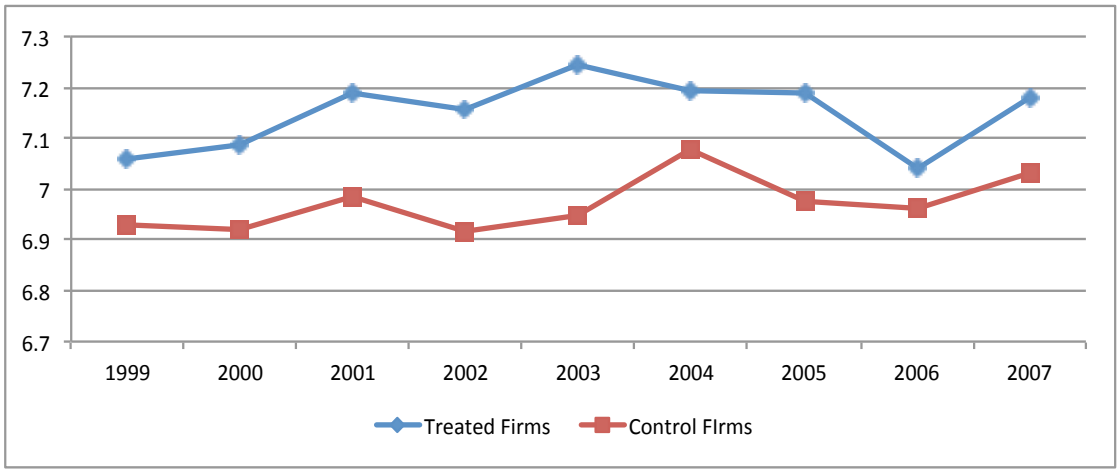


Figure 3.2. Evolution of log Investment, by Treatment



Note: Investment is calculated as the growth of fixed assets for production plus depreciation.

Figure 3.3. Evolution of Export to Sales Ratio, by Treatment

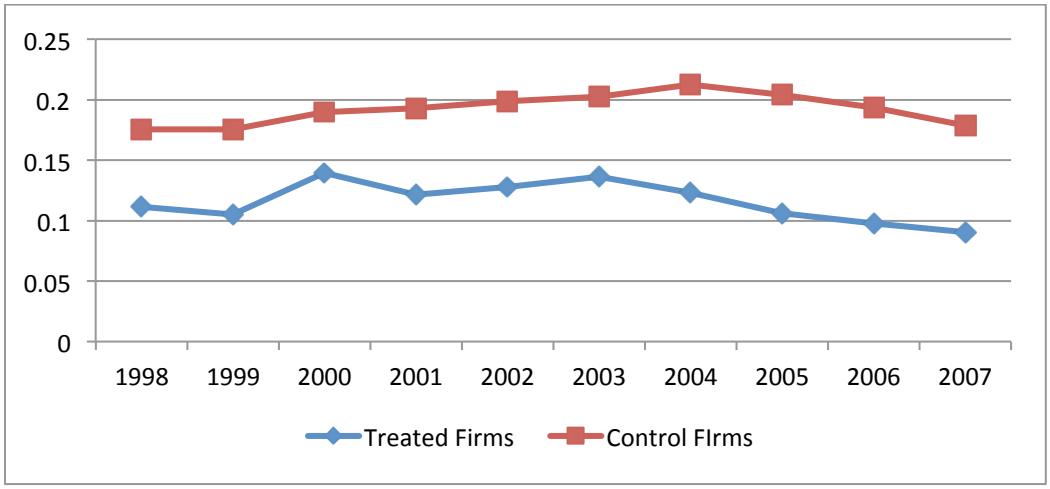
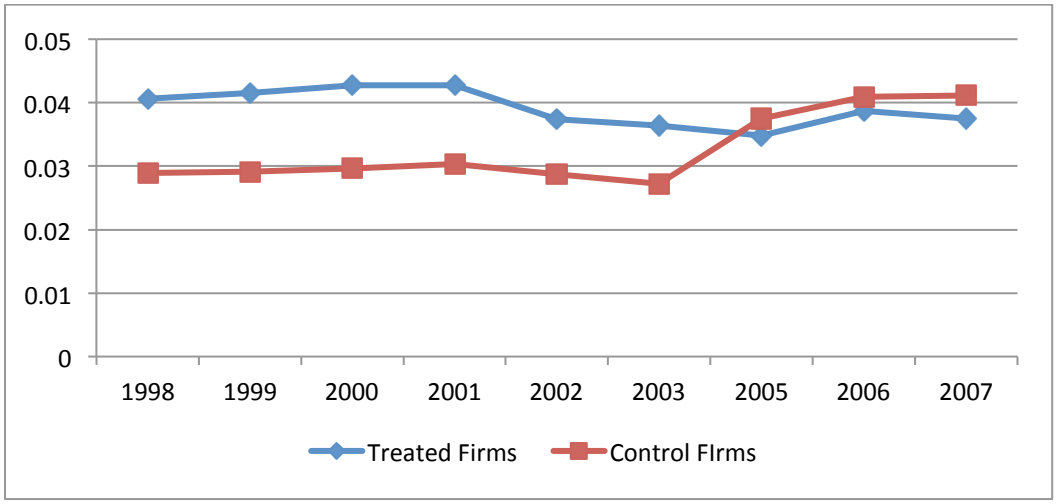


Figure 3.4. Evolution of New Product Introduction, by Treatment



Note: New product introduction is defined as the ratio of new product output to total output.

Figure 3.5. Evolution of Total Factor Productivity (Olley-Pakes), by Treatment

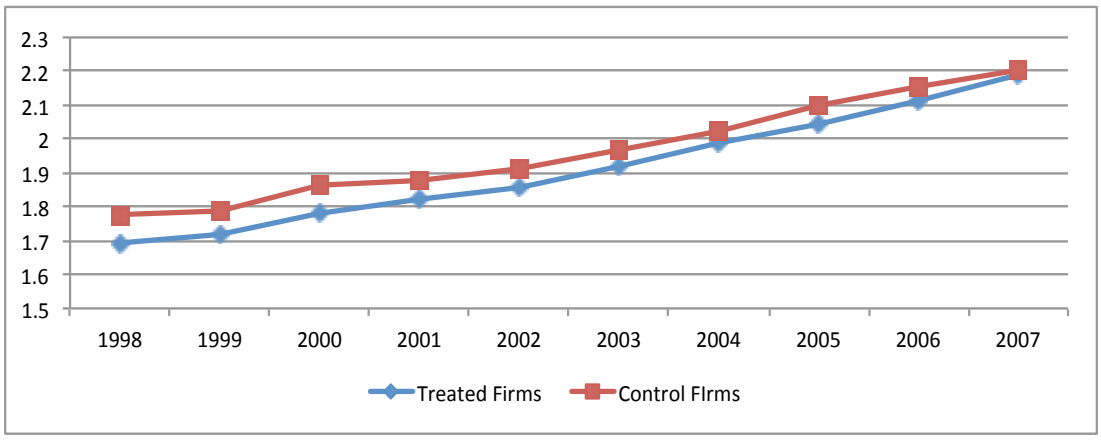


Figure 4. Propensity Score Density Plot

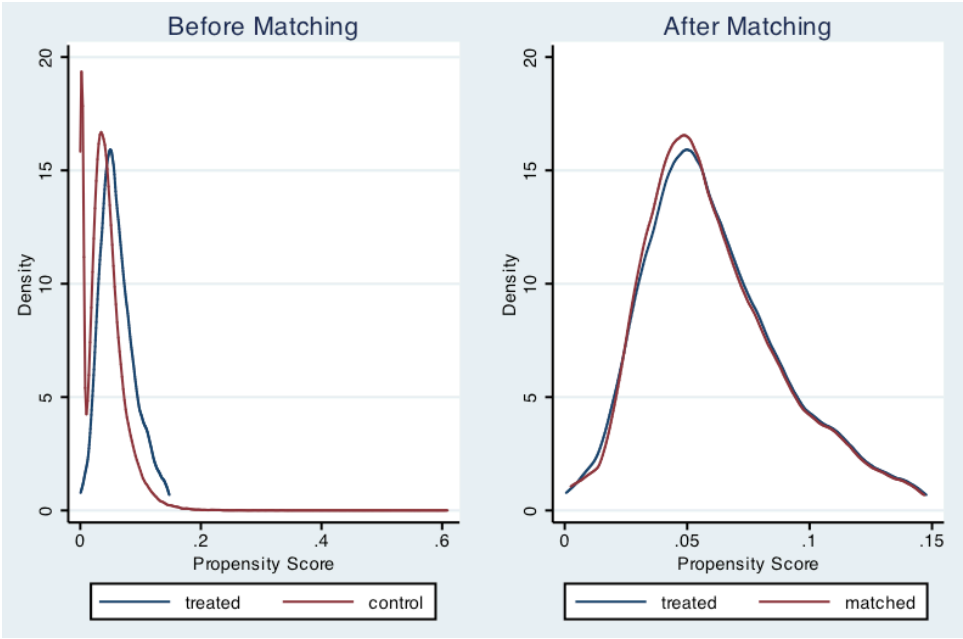


Table 1. Summary Statistics of Key Variables, 1998-2003

	Treated Sectors in Treated Region	Control Sectors in Treated Region	Treated Sectors in Control Region	Control Sectors in Control Region	All
Number of Observation	*27,782*	*8,169*	*482,855*	*155,977*	*674,783*
VAT Ratio	0.15	0.17	0.14	0.14	0.14
	(0.16)	(0.16)	(0.13)	(0.13)	(0.13)
log(Output)	9.74	9.56	9.91	9.73	9.86
	(1.3)	(1.25)	(1.21)	(1.12)	(1.2)
log(Labor)	4.99	4.99	4.92	4.97	4.94
	(1.14)	(1.14)	(1.08)	(1.03)	(1.08)
log(Fixed asset)	8.75	8.67	8.57	8.48	8.55
	(1.67)	(1.62)	(1.57)	(1.54)	(1.57)
Capital Labor Ratio	3.75	3.71	3.63	3.53	3.61
	(1.25)	(1.25)	(1.16)	(1.21)	(1.18)
log(Investment)	7.16	7.09	6.97	6.83	6.95
	(1.98)	(1.93)	(1.87)	(1.84)	(1.87)
Investment Ratio	0.30	0.28	0.27	0.25	0.27
	(1.85)	(1.83)	(1.76)	(1.81)	(1.78)
Fixed Asset for Production/Total Asset	0.42	0.43	0.41	0.43	0.41
	(0.23)	(0.23)	(0.22)	(0.23)	(0.22)
Export Intensity	0.12	0.1	0.19	0.2	0.19
	(0.3)	(0.27)	(0.35)	(0.37)	(0.36)
New Product Introductions	0.04	0.02	0.03	0.02	0.03
	(0.16)	(0.12)	(0.14)	(0.11)	(0.14)
log(TFP_OP)	1.85	1.9	1.91	2.01	1.93
	(0.41)	(0.48)	(0.41)	(0.49)	(0.43)
Foreign Share	0.11	0.08	0.16	0.13	0.15
	(0.27)	(0.24)	(0.33)	(0.31)	(0.33)
State Share	0.29	0.29	0.15	0.14	0.16
	(0.43)	(0.44)	(0.34)	(0.33)	(0.35)
Age	21.07	22.9	19.12	19.43	19.32
	(17.33)	(18.89)	(13.5)	(13.11)	(13.68)

Note: VAT ratio is calculated by the value added tax payable devided by valueadded. Fixed asset and value of output are deflated values. Investment is calculated as the growth of fixed assets for production plus depreciation. Investment ratio is defined as the ratio between current-year gross fixed investment and beginning of year net fixed asset stock. New product introduction equals the ratio between new product output and total output. TFP is estimated using OP method. Export intensity is defined as the export procurement divided by industrial sales. State share equals the proportion of firms' state assets in the total equity. Standard deviation in parentheses.

Table 2: The Impact of Value-Added Tax Reform on Firm Behavior (OLS)

Dependent Variables	VATratio	logLabor	Capital Labor Ratio	Output Labor Ratio	loginvestment	Investment Ratio	invest_mach	Export Intensity	New Product Introductions	TFP_OP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
All Firms	-0.0161***	-0.127***	0.0602***	0.0627***	-0.0166	-0.0531*	0.00453	-0.0126***	-0.00778**	-0.00544
	(0.00237)	(0.0165)	(0.0167)	(0.0157)	(0.0413)	(0.0294)	(0.00423)	(0.00406)	(0.00300)	(0.00989)
Observations	1,340,440	1,516,010	1,512,140	1,420,098	776,012	1,062,773	1,465,656	1,542,448	1,340,452	1,512,140
R-squared	0.002	0.010	0.053	0.146	0.006	0.002	0.003	0.002	0.003	0.447
Domestic Firms	-0.0164***	-0.131***	0.0671***	0.0656***	-0.0365	-0.0774**	0.00242	-0.00863***	-0.00917***	-0.0102
	(0.00263)	(0.0192)	(0.0156)	(0.0182)	(0.0447)	(0.0337)	(0.00453)	(0.00295)	(0.00285)	(0.0110)
Observations	1,039,688	1,175,501	1,176,165	1,099,081	583,435	807,666	1,137,477	1,195,251	1,039,696	1,171,074
R-squared	0.002	0.012	0.072	0.171	0.009	0.002	0.003	0.002	0.003	0.436
SOEs	-0.0197**	-0.0996**	0.0972**	0.0353	0.0983	0.0760	0.0174**	0.00205	-0.0118	-0.00657
	(0.00904)	(0.0380)	(0.0440)	(0.0340)	(0.0886)	(0.0866)	(0.00838)	(0.00274)	(0.00968)	(0.0190)
Observations	115,258	116,497	122,282	92,986	52,342	84,450	116,874	124,421	115,264	115,713
R-squared	0.002	0.136	0.076	0.178	0.005	0.002	0.006	0.002	0.003	0.227
Non-SOEs	-0.0161***	-0.114***	0.0540***	0.0584***	-0.0591	-0.112***	-0.000408	-0.00992***	-0.00727**	-0.0121
	(0.00254)	(0.0196)	(0.0143)	(0.0189)	(0.0424)	(0.0395)	(0.00489)	(0.00325)	(0.00294)	(0.0106)
Observations	924,430	1,059,004	1,053,883	1,006,095	531,093	723,216	1,020,603	1,070,830	924,432	1,055,361
R-squared	0.002	0.010	0.072	0.166	0.011	0.002	0.003	0.002	0.003	0.462
Foreign Firms	-0.0137***	-0.0926***	0.0267	0.0401*	0.00228	-0.0113	0.0115*	-0.0221**	-0.00716	0.00940
	(0.00375)	(0.0148)	(0.0241)	(0.0233)	(0.0575)	(0.0505)	(0.00662)	(0.0101)	(0.00608)	(0.0112)
Observations	300,752	340,509	335,975	321,017	192,577	255,107	328,179	347,197	300,756	341,066
R-squared	0.004	0.045	0.016	0.081	0.004	0.002	0.006	0.005	0.003	0.473
Province Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table presents the OLS estimation of the impact of value-added tax reform on various outcomes. Robust standard errors clustered to the sector level are in parentheses. VAT ratio is calculated by the value added tax payable devided by valueadded. Fixed asset and value of output are deflated values. Investment is calculated as the growth of fixed assets for production plus depreciation. Investment ratio is defined as the ratio between current-year gross fixed investment and beginning of year net fixed asset stock. invest_mach indicates fixed asset for production divided by total asset. New product introduction equals the ratio between new product output and total output. TFP is estimated using OP method. Export intensity is defined as the export procurement divided by industrial sales. * significant at 10% level, ** significant at 5% level, *** significant at 1% level.

Table 3: The Impact of Value-Added Tax Reform on Firm Behavior (IV)

Dependent Variables	logLabor	Capital Labor Ratio	Output Labor Ratio	loginvestment	Investment Ratio	invest_mach	Export Intensity	New Product Introductions	TFP_OP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
All Firms	8.599***	-3.643***	-5.081***	-0.206	2.003**	-0.376***	0.837***	0.483***	0.0882
	(0.742)	(0.439)	(0.952)	(1.333)	(0.778)	(0.0985)	(0.117)	(0.0780)	(0.178)
Observations	1,316,893	1,313,882	1,219,957	708,688	959,624	1,272,567	1,339,979	1,340,439	1,313,214
1st Stage F-statistics	332.359	359.236	119.737	154.74	28.122	215.812	327.936	299.351	325.614
Domestic Firms	9.029***	-4.216***	-5.427***	1.939	3.335***	-0.234	0.471***	0.560***	0.318**
	(0.678)	(0.641)	(0.891)	(1.993)	(0.928)	(0.195)	(0.0923)	(0.0887)	(0.161)
Observations	1,022,056	1,022,975	944,693	534,698	731,476	988,257	1,039,289	1,039,687	1,017,807
1st Stage F-statistics	238.921	223.56	361.585	47.2579	253.627	119.986	228.048	250.984	128.785
SOEs	5.440***	-5.102***	-4.020***	-4.003**	-3.311	-1.398***	-0.0237	0.598	0.462
	(0.972)	(1.745)	(1.071)	(1.771)	(2.740)	(0.310)	(0.130)	(0.367)	(1.226)
Observations	107,899	113,160	84,195	49,260	77,943	108,276	115,066	115,258	106,746
1st Stage F-statistics	53.009	53.548	90.705	82.57	45.78	25.965	60.727	57.718	30.71
Non-SOEs	8.228***	-3.529***	-5.056***	3.714	5.724***	-0.0579	0.540***	0.450***	0.411***
	(0.670)	(0.616)	(0.844)	(3.258)	(1.371)	(0.205)	(0.104)	(0.0948)	(0.156)
Observations	914,157	909,815	860,498	485,438	653,533	879,981	924,223	924,429	911,061
1st Stage F-statistics	160.964	150.142	201.245	19.456	92.542	118.606	17.638	155.352	89.768
Foreign Firms	7.048***	-1.156	-3.024***	-4.063*	-1.437	-1.023*	2.081***	0.523***	-0.606**
	(1.729)	(0.839)	(1.132)	(2.100)	(2.675)	(0.558)	(0.466)	(0.193)	(0.291)
Observations	294,837	290,907	275,264	173,990	228,148	284,310	300,690	300,752	295,407
1st Stage F-statistics	29.089	40.649	22.625	5.383	8.461	18.647	25.897	25.926	22.213
Province Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table presents the IV estimation of the impact of value-added tax reform on various outcomes, using the value-added tax reform dummy as the IV for VAT ratio. Robust standard errors clustered to the sector level are in parentheses. Fixed asset and value of output are deflated values. Investment is calculated as the growth of fixed assets for production plus depreciation. Investment ratio is defined as the ratio between current-year gross fixed investment and beginning of year net fixed asset stock. invest_mach indicates fixed asset for production divided by total asset. New product introduction equals the ratio between new product output and total output. TFP is estimated using OP method. Export intensity is defined as the export procurement divided by industrial sales. * significant at 10% level, ** significant at 5% level, *** significant at 1% level.

Table 4. Determinants of Value-Added Tax Reform Policy Treatment

Variables	VAT Reform Policy Treatment (1 = Yes, 0 = No)
Foreign Share	-0.0307***
	(0.0293)
State Share	0.3025***
	(0.0363)
log(Output)	0.0231**
	(0.0098)
Output growth	0.0004
	(0.0005)
Labor growth	-0.0083***
	(0.0038)
Age	-0.0025***
	(0.001)
log(TFP_OLSFE)	-0.4825***
	(0.0738)
log(TFP_OP)	0.0571
	(0.0583)
Obervations	71583
R-squared	0.0514

Note: This table tests whether variables used for matching are important determinants of the policy treatment. * significant at 10% level, ** significant at 5% level, *** significant at 1% level.

Table 5. Balancing Tests for Propensity Score Matching

	Mean		% Bias	t-test	
	Treated	Matched		t-stat	p-value
Foreign Share	0.173	0.174	0.000	-0.010	0.989
State Share	0.148	0.136	4.000	1.290	0.196
log(Output)	10.032	10.035	-0.300	-0.090	0.931
Output growth	0.737	0.485	2.000	0.760	0.448
Labor growth	0.216	0.238	-0.400	-0.260	0.792
Age	17.363	17.245	1.000	0.330	0.739
log(TFP_OLSFE)	1.897	1.901	-1.200	-0.450	0.656
log(TFP_OP)	1.933	1.932	0.100	0.050	0.961

Note: This table tests whether there's significant difference between treated and matched groups on potential determinants of policy treatment.

Table 6. The Impact of Value-Added Tax Reform on Firm Investment and Employment (PSM)

	All Firms	Domestic Firms			Foreign Firms
		All	SOE	Non-SOE	
		Panel A. VAT Ratio			
PSM & DD	-0.0149***	-0.0148***	-0.0313***	-0.0134***	-0.015***
Post-mean - Pre-mean	(0.0027)	(0.0033)	(0.0108)	(0.0035)	(0.0044)
		Panel B. lnInvestment			
PSM & DD	0.0274	0.0068	0.3598***	-0.0408	0.0723
Post-mean - Pre-mean	(0.0355)	(0.0446)	(0.1308)	(0.0473)	(0.0575)
		Panel C. Investment Ratio			
PSM & DD	-0.0796*	-0.1623***	0.1171	-0.203***	0.1139*
Post-mean - Pre-mean	(0.0425)	(0.054)	(0.135)	(0.0586)	(0.0643)
		Panel D. Investment Machinary			
PSM & DD	0.0049	0.0033	0.0217	0.0003	0.0074
Post-mean - Pre-mean	(0.0041)	(0.0049)	(0.0156)	(0.0052)	(0.0073)
		Panel E. lnLabor			
PSM & DD	-0.1227***	-0.1347***	-0.1116***	-0.1363***	-0.0741***
Post-mean - Pre-mean	(0.0132)	(0.0155)	(0.0449)	(0.0162)	(0.024)
		Panel F. Capital-Labor Ratio			
PSM & DD	0.0465***	0.0842***	0.1323***	0.0729***	-0.0381
Post-mean - Pre-mean	(0.0178)	(0.0213)	(0.0608)	(0.0228)	(0.0308)
		Panel G. Output-Labor Ratio			
PSM & DD	0.0444***	0.0662***	0.0635	0.0667***	-0.0078
Post-mean - Pre-mean	(0.0153)	(0.0182)	(0.0572)	(0.0193)	(0.0274)

Note: This table presents the propensity score matching result of the impact of value-added tax reform on various outcomes. Fixed asset and value of output are deflated values. Investment is calculated as the growth of fixed assets for production plus depreciation. Investment ratio is defined as the ratio between current-year gross fixed investment and beginning of year net fixed asset stock. invest_mach indicates fixed asset for production divided by total asset. * significant at 10% level, ** significant at 5% level, *** significant at 1% level.

Table 7. The Impact of Value-Added Tax Reform on Firm Upgrading Behavior (PSM)

	All Firms	Domestic Firms			Foreign Firms
		All	SOE	Non-SOE	
Panel A. New Product Introductions					
PSM & DD	-0.0075***	-0.0084***	-0.0197	-0.0063*	-0.0056
Post-mean - Pre-mean	(0.0031)	(0.0036)	(0.0121)	(0.0037)	(0.0063)
Panel B. TFP (OP)					
PSM & DD	-0.0244***	-0.0319***	-0.0103	-0.0334***	-0.0037
Post-mean - Pre-mean	(0.0062)	(0.0073)	(0.0221)	(0.0078)	(0.0113)
Panel C. Export Intensity					
PSM & DD	-0.0223***	-0.0119***	0.0008	-0.0137***	-0.0467***
Post-mean - Pre-mean	(0.0037)	(0.0033)	(0.0045)	(0.0037)	(0.0096)

Note: This table presents the propensity score matching result of the impact of value-added tax reform on firm upgrading behavior. New product introduction equals the ratio between new product output and total output. TFP is estimated using OP method. Export intensity is defined as the export procurement divided by industrial sales. * significant at 10% level, ** significant at 5% level, *** significant at 1% level.

Table 8. The Impact of Value-Added Tax Reform on Subsidies, Tax Breaks, and Lending

VARIABLES	Subsidy (1=Yes, 0=No)	Tax Break (1=Yes, 0=No)	Interest rate (1=below median, 0=above median)
	(1)	(2)	(3)
VAT Tax Reform	-0.0283***	-0.0241***	-0.0231***
(1=Yes, 0=No)	(0.00433)	(0.00737)	(0.00857)
Observations	1,540,973	1,543,000	1,531,034
R-squared	0.003	0.003	0.005

Note: This table presents the OLS estimation of the impact of value-added tax reform on government subsidy, tax, and lending policies. Robust standard errors clustered to the sector level are in parentheses. Firm fixed effects, province, year, industry dummies, and province-year dummies are controlled in all regressions. * significant at 10% level, ** significant at 5% level, *** significant at 1% level.

Appendix Tables

Table A1: The Impact of Value-Added Tax Reform on Firm Behavior (OLS): Robustness Check

Dependent Variables	VATratio (1)	logLabor (2)	Capital Labor Ratio (3)	Output Labor Ratio (4)	loginvestment (5)	Investment Ratio (6)	invest_mach (7)	Export Intensity (8)	New Product Introductions (9)	TFP_OP (10)
All Firms	-0.0149***	-0.131***	0.0499***	0.0619***	-0.0371	-0.0604**	0.00322	-0.0139***	-0.00705**	-0.000711
	(0.00233)	(0.0116)	(0.0128)	(0.0133)	(0.0386)	(0.0292)	(0.00336)	(0.00384)	(0.00311)	(0.00727)
Observations	1,340,440	1,516,010	1,512,140	1,420,098	776,012	1,062,773	1,465,656	1,542,448	1,340,452	1,512,140
Province Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province*Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.003	0.018	0.056	0.152	0.008	0.002	0.005	0.005	0.004	0.424

Note: This table checks the robustness of results in Table 2 by controlling for province-time trend in addition. Robust standard errors clustered to the sector level are in parentheses. VAT ratio is calculated by the value added tax payable devided by valueadded. Fixed asset and value of output are deflated values. Investment is calculated as the growth of fixed assets for production plus depreciation. Investment ratio is defined as the ratio between current-year gross fixed investment and beginning of year net fixed asset stock. invest_mach indicates fixed asset for production divided by total asset. New product introduction equals the ratio between new product output and total output. TFP is estimated using OP method. Export intensity is defined as the export procurement divided by industrial sales. * significant at 10% level, ** significant at 5% level, *** significant at 1% level.

Table A2: The Impact of Value-Added Tax Reform on Firm Behavior (OLS, treated sectors only)

Dependent Variables	VATratio	logLabor	Capital Labor Ratio	Output Labor Ratio	loginvestment	Investment Ratio	invest_mach	Export Intensity	New Product Introductions	TFP_OP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
All Firms	-0.0156***	-0.136***	0.0585***	0.0732***	-0.0135	-0.0476	0.00415	-0.0120***	-0.00805**	-0.00324
	(0.00247)	(0.0128)	(0.0166)	(0.0123)	(0.0425)	(0.0289)	(0.00410)	(0.00446)	(0.00309)	(0.00769)
Observations	1,027,840	1,163,575	1,162,587	1,091,461	598,020	817,229	1,130,835	1,185,394	1,027,849	1,163,163
R-squared	0.002	0.012	0.055	0.141	0.006	0.002	0.004	0.002	0.003	0.393
Domestic Firms	-0.0155***	-0.141***	0.0631***	0.0795***	-0.0369	-0.0697**	0.00168	-0.00866**	-0.0103***	-0.00507
	(0.00269)	(0.0159)	(0.0150)	(0.0157)	(0.0451)	(0.0330)	(0.00437)	(0.00339)	(0.00290)	(0.00793)
Observations	785,654	889,267	891,431	832,747	442,722	611,570	866,189	905,294	785,660	887,164
R-squared	0.002	0.013	0.074	0.164	0.009	0.002	0.003	0.001	0.003	0.375
SOEs	-0.0188**	-0.102**	0.109**	0.0521	0.0888	0.0667	0.0167*	0.00146	-0.00981	0.00536
	(0.00916)	(0.0390)	(0.0477)	(0.0318)	(0.0907)	(0.0848)	(0.00902)	(0.00301)	(0.0102)	(0.0147)
Observations	87,960	88,276	93,211	70,405	39,549	64,051	89,325	94,748	87,965	87,572
R-squared	0.003	0.140	0.076	0.175	0.005	0.002	0.007	0.002	0.003	0.190
Non-SOEs	-0.0152***	-0.123***	0.0480***	0.0708***	-0.0562	-0.103**	-0.00124	-0.00987**	-0.00857***	-0.00789
	(0.00265)	(0.0159)	(0.0144)	(0.0169)	(0.0435)	(0.0393)	(0.00478)	(0.00369)	(0.00291)	(0.00809)
Observations	697,694	800,991	798,220	762,342	403,173	547,519	776,864	810,546	697,695	799,592
R-squared	0.002	0.012	0.074	0.159	0.010	0.002	0.003	0.002	0.004	0.397
Foreign Firms	-0.0138***	-0.0945***	0.0218	0.0335	0.00973	-0.00260	0.0123*	-0.0196*	-0.00527	0.00432
	(0.00377)	(0.0147)	(0.0240)	(0.0235)	(0.0601)	(0.0526)	(0.00690)	(0.0105)	(0.00615)	(0.0125)
Observations	242,186	274,308	271,156	258,714	155,298	205,659	264,646	280,100	242,189	275,999
R-squared	0.004	0.044	0.017	0.083	0.004	0.003	0.007	0.005	0.003	0.434
Region Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table presents the OLS estimation of the impact of value-added tax reform on various outcomes, restricted to treated sectors only. Robust standard errors clustered to the sector level are in parentheses. VAT ratio is calculated by the value added tax payable devided by valueadded. Fixed asset and value of output are deflated values. Investment is calculated as the growth of fixed assets for production plus depreciation. Investment ratio is defined as the ratio between current-year gross fixed investment and beginning of year net fixed asset stock. invest_mach indicates fixed asset for production divided by total asset. New product introduction equals the ratio between new product output and total output. TFP is estimated using OP method. Export intensity is defined as the export procurement divided by industrial sales. * significant at 10% level, ** significant at 5% level, *** significant at 1% level.

Table A3. Test of the Common Trend Assumption

VARIABLES	logLabor	Capital Labor Ratio	Output Labor Ratio	loginvestment	Investment Ratio	invest_mach	Export Intensity	New Product Introductions	TFP_OP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Year	0.00340	0.0709***	0.0769***	0.00389	-0.0166***	0.00585***	0.000418	-0.000605***	0.0309***
	(0.00411)	(0.00285)	(0.00514)	(0.00435)	(0.00309)	(0.000344)	(0.000519)	(0.000175)	(0.00218)
VAT Reform Treatment	0.156***	-0.181***	-0.0877**	-0.272***	-0.149	-0.00840	0.0136**	0.00639	-0.328***
(1=Yes, 0=No)	(0.0342)	(0.0300)	(0.0339)	(0.0998)	(0.110)	(0.00709)	(0.00664)	(0.00495)	(0.120)
Year*VAT Reform Treatment	-0.0508***	0.0436***	0.0187***	0.00267	-0.0208	0.000835	0.000297	-0.00215***	0.00184
	(0.00578)	(0.00521)	(0.00590)	(0.0150)	(0.0157)	(0.000936)	(0.000942)	(0.000776)	(0.00194)
State Share	0.0874***	0.0273***	-0.0751***	-0.00262	-0.0498	0.00666***	-0.000765	-0.00141	-0.0103***
	(0.00828)	(0.00799)	(0.00718)	(0.0269)	(0.0328)	(0.00211)	(0.00127)	(0.00134)	(0.00372)
Foreign Share	0.0673***	0.0130	-0.00909	0.0304	0.0130	0.00114	0.0313***	0.00245	0.0108***
	(0.00880)	(0.0142)	(0.0102)	(0.0290)	(0.0409)	(0.00403)	(0.00377)	(0.00164)	(0.00376)
Constant	4.904***	3.418***	4.720***	6.939***	0.333***	0.396***	0.181***	0.0308***	1.855***
	(0.0116)	(0.00787)	(0.0171)	(0.0134)	(0.0138)	(0.00120)	(0.00177)	(0.000592)	(0.00808)
Observations	660,286	661,466	564,609	315,522	420,448	643,511	674,358	674,782	636,493
R-squared	0.003	0.037	0.056	0.000	0.000	0.005	0.000	0.000	0.060
Number of idnew	242,738	242,848	225,435	148,138	165,760	240,264	245,897	246,057	232,494

Note: This table presents the common trend assumption for the Difference-in-Difference estimation. Robust standard errors clustered to the sector level are in parentheses. Fixed asset and value of output are deflated values. Investment is calculated as the growth of fixed assets for production plus depreciation. Investment ratio is defined as the ratio between current-year gross fixed investment and beginning of year net fixed asset stock. invest_mach indicates fixed asset for production divided by total asset. New product introduction equals the ratio between new product output and total output. TFP is estimated using OP method. Export intensity is defined as the export procurement divided by industrial sales. * significant at 10% level, ** significant at 5% level, *** significant at 1% level.