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THE VALUE-ADDED TAX REFORM PUZZLE

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ABSTRACT

We explore the impact of a tax reform in some provinces of China which eliminated the value-added tax on some investment goods. While the goal of the experiment was to encourage upgrading of technology, our results suggest that there was no evident increase overall in fixed investment, and employment fell significantly in the treated provinces and sectors. The reform reduced the total number of employees for all types of firms. For domestic firms, it reduced employment by almost 8%. 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 experiment has since been extended to the rest of China.

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1. Introduction

Much of the literature in public finance focuses on the role of tax reforms in affecting firm behavior. Policy makers in many countries use tax incentives to encourage firm investment, and China is no different. 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 estimated that VAT revenue accounted for approximately 31 percent of China's overall revenue.[3]

Beginning in 2004, the Chinese government implemented a value-added tax reform in three northeastern provinces, which removes fixed asset investment from the value-added tax base. The reform has since been extended to the whole country, beginning in 2009. 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, as well as to encourage fixed asset investments to promote an industrial policy now focused on more technologically advanced sectors. [4]

[3] See www.dorsey.com/china_vat_reform

[4] According to the People's Daily Online, December 9, 2008, quoting Zheng Jianxin, 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."

In this paper, we use a firm-level panel dataset ranging from 1998 to 2007 to identify the effect of the selective 2004 reform, which selectively reduced value-added taxes on fixed investment. We explore a number of firm level outcomes, including investment, new product introductions, productivity, employment, and exports. The advantage of the reform is that we know exactly which provinces and sectors were sequentially targeted, and consequently we have a clean treatment group as well as controls. We begin the paper 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 similar results.

The government's choice of tax reduction in areas or 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 value-added tax reform of China in 2004: the three northeast provinces were chosen as the first pilot group because while many coastal cities had undergone rapid modernization of capital and technology after the opening-up of the Chinese economy, the northeast regions with their traditional industrial base were left behind. Encouraging firms in these provinces to invest more on 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]

[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".

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, which 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 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 value-added tax paid by firms, with value-added taxes falling 1 to 2 percentage points in the treatment areas relative to the statutory rate of 17 percent of value-added. However, the impact of the tax reduction on physical investment was limited. There is no improvement in overall investment and no differential increase in new product introductions in the treated regions after the reform. The reform had no significant impact on firm productivity, while it decreased export intensity for most types of firms. The primary impact of the reform was to encourage firms to substitute physical capital for labor: the policy significantly reduced firms' total number of employees across all ownership types. The net impact of the reform was to increase the capital intensity of

production, as physical investment remained level but employment fell, without improving technology levels as measured by TFP or new product introductions.

Our results build on but diverge in significant ways from Nie et al (2010), who also explore the impact of the value-added tax reform in China. They find smaller, but still negative effects on employment and positive, significant effects on fixed asset investment. Our results differ in large part from Nie et al (2010) for two reasons. First, they look at the short run effects of the reform, focusing on data of one year following the 2004 reform. In this paper, using more extensive time series and examining three years following the reforms allows us to examine the longer term effects. In addition, we explicitly address the potential endogeneity of the reform targets through an IV as well as nonparametric propensity score matching techniques. Using their approach, we show that the beneficial effects of the reform on investment had a short-run positive impact on investment, but were restricted to the state owned enterprises (SOEs). Over a three-year horizon, the short run positive effects on investment disappear. One way to interpret the two sets of results is that Nie et al (2010) document the short run effects of the VAT reform , while we identify the effects on firm behavior over the longer term.

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 encourage firms to shift 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. Another possible explanation is that Chinese policy makers expect a longer term labor shortage and a shift away from their

traditional comparative advantage in labor-intensive techniques, and these reforms accelerated the shift towards capital-intensity in production.

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 the propensity score matching. Section 6 concludes.

2. Background

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 a firm A purchased capital inputs from other firms at a price of 100 RMB, and if its total sales equals 400RMB, then the VAT base is 300, and firm A pays 30 RMB VAT.

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 expenditure on fixed assets from the value-added tax base.

This reform was expected to eliminate double taxation and alleviate firms' tax burden, leading to lower prices for consumers and more investment in fixed assets. 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.

3. Data, Variable Definitions and Summary Statistics

3.1 Dataset

The data we use for analyses 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. To further clean the sample, we delete observations whose information on variables such as firm identifiers, county code, sector id, year established are missing, or 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. 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, the share of new products in total sales, total factor productivity (TFP), employment, the capital-labor ratio, and export intensity. We use three measures of investment: first, we define the level of investment by the growth of fixed assets for production plus depreciation; second, we calculate the investment ratio, defined as the ratio between current-year gross fixed investment and beginning of year net fixed asset; third, we look at the composition of fixed asset by calculating the share of fixed assets for production in total assets. Our third measure is indicative of the composition of investment, and in particular the share of machinery and equipment in the total stock of capital The value of total fixed assets and fixed assets for production is deflated by the fixed assets investment index. Since the data on R&D expenditure is only available for the year 2004, we use the share of new product output in total industrial output as a proxy. 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). In our OP approach, we use the standard two-step approach to estimate input share coefficients for each 2 digit subsector. To avoid omitted variable bias in estimating input share coefficients, we also include relevant policy variables—in this case the VAT reform and tariffs—as state variables in the first stage.

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

In Figures 1.1 to 1.4, we illustrate the evolution of the value added tax in treated and control groups from 1998 to 2007, for the whole sample and by ownership type. The value-added tax is defined as the value-added tax paid divided by value-added at the firm level. Consider Figure 1.1: First, over the sample period, the value added tax for firms in treated sectors in control provinces does not change much, decreasing slightly from an average of 14 to 12 percent. Second, we compare the evolution of the value added tax between firms in treated sectors in treated provinces and firms in treated sectors in control provinces. We can see that before 2004, the value added tax for treated firms was consistently higher than than for control firms in treated sectors. However, one year after the value added tax reform was implemented in 2004, there is a significant decrease in the value added tax paid by treated firms, and the tax paid by treated firms continued to fall until 2007. While treated sectors in treated regions paid an average of 16 percent VAT in 2000 (nearly the full statutory rate of 17 percent), by 2007 these same firms paid an average VAT of nine percent.

In Figures 1.2 to 1.4, we report the evolution of the value added tax from 1998 to 2007 for 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. However, we see in Figure 1.2 that SOEs paid on average more than other types of firms, with treated firms paying an average of 17 percent VAT prior to the reform and paying an average of 12 percent post-reform. This is much higher than for foreign owned enterprises, where treated sectors paid on average a 13 % VAT in 2001 and only 8 percent in 2007. 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.

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 for 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, exports, and productivity. We first begin by examining whether the regression results show consistent magnitudes for 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. 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 the visual evidence presented in 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) through (7) explore the impact of the reform on fixed investment. Investment is measured in column (5) as the log of total investment, in column (6)as the ratio of investment to fixed capital, and in column (7) as the share of machinery investment in total fixed 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. Since employment fell significantly, but physical capital did not, these differential trends explain the resulting increases in the capital-labor ratio and in output per worker.

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. While it might seem puzzling that TFP did not increase when employment fell so dramatically, it is also important to remember that output stagnated (see Figure 2) and capital substituted for falling employment. These offsetting effects explain the lack of movement in TFP. Exports as a share of sales fell significantly, which is plausible if the reform shifted firm investments away from China's comparative advantage, which at that time was still in more labor-intensive products.

An alternative approach would be to restrict the OLS DID estimation to only treated sectors. Appendix Table A.1 reports the DID results when we restrict the sample

to only treated sectors and define treatment using the province dummy. The results are very close to the results reported in Table 2, indicating that much of the variation is coming from differences within sectors across the treated and untreated regions. The treated sectors are sufficiently broad to cover almost all sectors—this is why the restricted sample in Appendix Table A1 is only reduced by 20 percent of the original full sample. The fact that most sectors were included in the treatment also explains why restricting the sample to only the treated provinces and defining treatment based on sectors yields insufficient variation both in terms of numbers of observations and in terms of heterogeneity across sectors.

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 results using this alternative 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 significantly associated with 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.

The last three columns use the same IV approach to measure reform-induced impact of VAT payment reductions 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. The only firms with a slightly different outcome are firms with foreign ownership. For foreign owned enterprises, the VAT payment reduction associated with the reform is associated with falling employment, rising investment, and increasing TFP.

The results in Tables 2 and 3 suggest a consistent story across specifications. The VAT reform led to a reduction in VAT payments of 1 to 2 percentage points. The fall in VAT payments led firms to increase the share of machinery in total investment, but not the aggregate level of 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. Consistent with the fact that labor was replaced with machinery but aggregate investment did not increase, neither TFP nor the share of new products in aggregate sales increased. The reform encouraged firms to replace people

with machinery, but had no evident impact on either aggregate investment or long run productivity growth.

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 were 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 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.[6]

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

[6] 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.

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:

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

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, new product introduction, 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 error 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. First, in Table 4, we show the results of the probit regression 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 higher 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 3. 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 becomes 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. 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 panels B,C, and D of Table 6, we see that overall the tax reform did not change the 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 has 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 the overall investment did not change significantly, it is still possible that investment on certain types of activities has been significantly influenced by the reform. As a result, in Table 7, we estimate the impact of VAT reform on firms' upgrading behavior, by looking at the effect on new product introductions as a share of sales, productivity as measured by the two-stage OP approach, and export intensity. In Panel A, we look at the impact of tax reform on new product introduction, to see whether treated firms increased innovative activity after the tax incentive was provided. Consistent with our OLS and IV results, the matching estimation reveals that across all types of firms, new product introduction 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 differ in large part from Nie, Fang, and Lie (2010). Nie, Fang and Lie (2010) found positive effects of the reform on firm specific investment. Our results differ from theirs for two reasons. First, because they had access to a shorter time series, they are able only to examine the short run effects of the reform, focusing on one year of data following the 2004 reform. Using our more extensive time series and examining three

years following the reforms allows us to examine the longer term effects. In addition, we explicitly address the potential endogeneity of the reform targets through nonparametric propensity score matching techniques.

In Appendix Tables A4 through A6, we reproduce Nie, Fang, and Lie's approach to show that the beneficial effects of the reform on investment was a short run effect restricted to the state owned enterprises (SOEs). Even without the use of propensity score matching and difference-in-difference estimation, the positive impact on fixed investment disappears if we include 2006 and 2007. As a longer time series has become available, we are able to identify heterogeneous effects of the reform over time.

Table A4 replicates the Nie et al (2010) results and shows a positive effect for all firms in the short run on investment. Using just 2005 as the post-reform year shows that the VAT policy increased fixed asset growth in nominal and real terms. However, in the last three columns in Table A1 we see that the impact disappears if we include 2006 and 2007. Appendix Tables A5 and A6 distinguish between SOEs and privately-owned firms. The results show that all the positive effects on investment were concentrated in the SOEs. Contrasting the first three columns and the last three columns of Table A2, we see that even for the SOEs the positive effects of the reform on fixed assets were restricted to 2005 and are not sustained over a longer time period.

In summary, the value-added tax reform reduced firm tax burdens significantly. While the reform failed to increase investment, new product introduction, or productivity, it is associated with a significant fall in employment. Firms shifted the composition of fixed investment towards machinery and equipment, which allowed them to replace labor inputs with capital. This could be described as a process innovation, which possibly

delayed product innovation as reflected in the falling share of new products in total sales. These results are robust to other estimation strategies including OLS and IV.

6. Conclusions

This paper analyzes the impact of the value-added tax reform in China on firm investment, new product introductions, total factor productivity, employment, and export shares. We use three different approaches to ensure the robustness of our results: a treatment dummy for treated regions and sectors using OLS estimation 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 fixed investment, new product introductions, or total factor 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, and total factor 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 limited to labor-saving process innovation 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.

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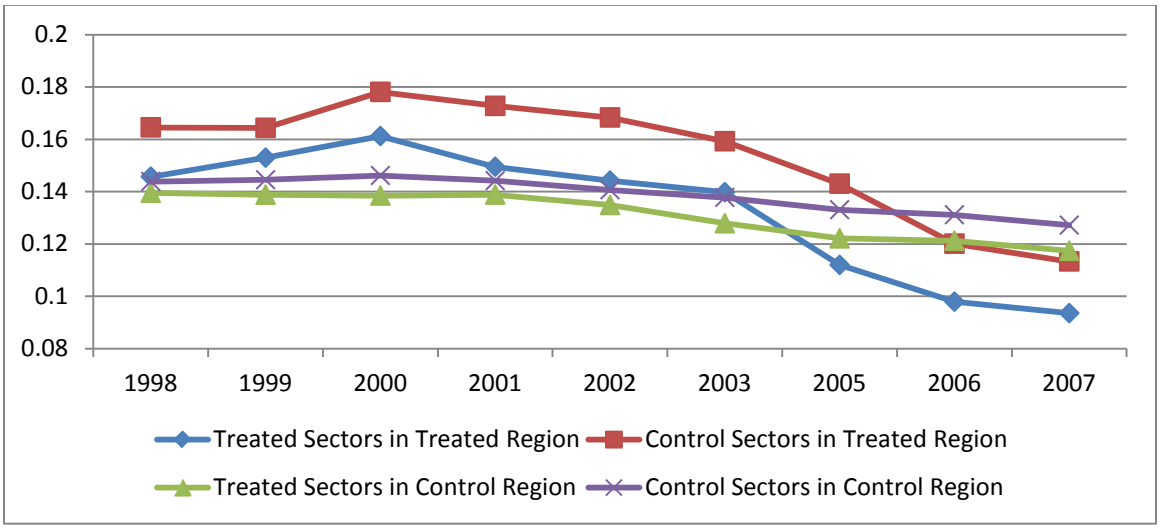
Figures and Tables

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



Note: The variable value added tax is defined as the ratio of reported value added taxes paid to value added.

Figure 1.2. Evolution of Value-added Tax, State-owned Firms

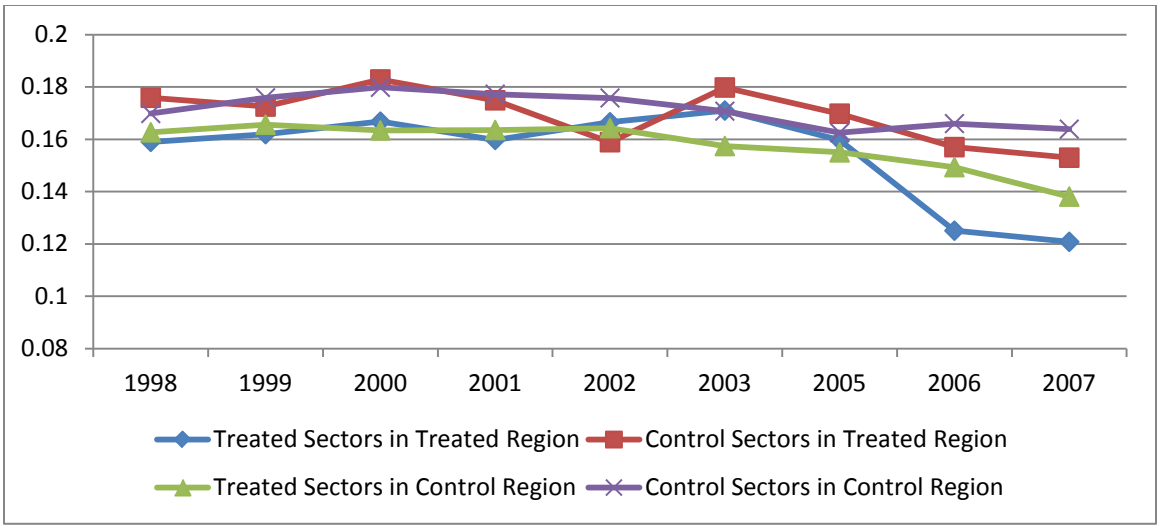


Figure 1.3. Evolution of Value-added Tax, Private Firms

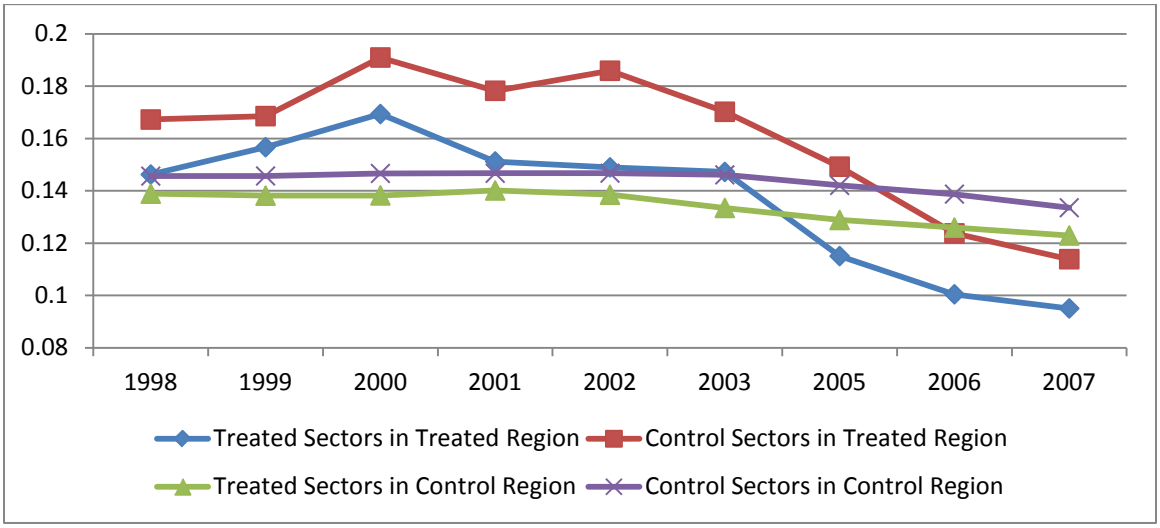


Figure 1.4. Evolution of Value-added Tax, Foreign Firms

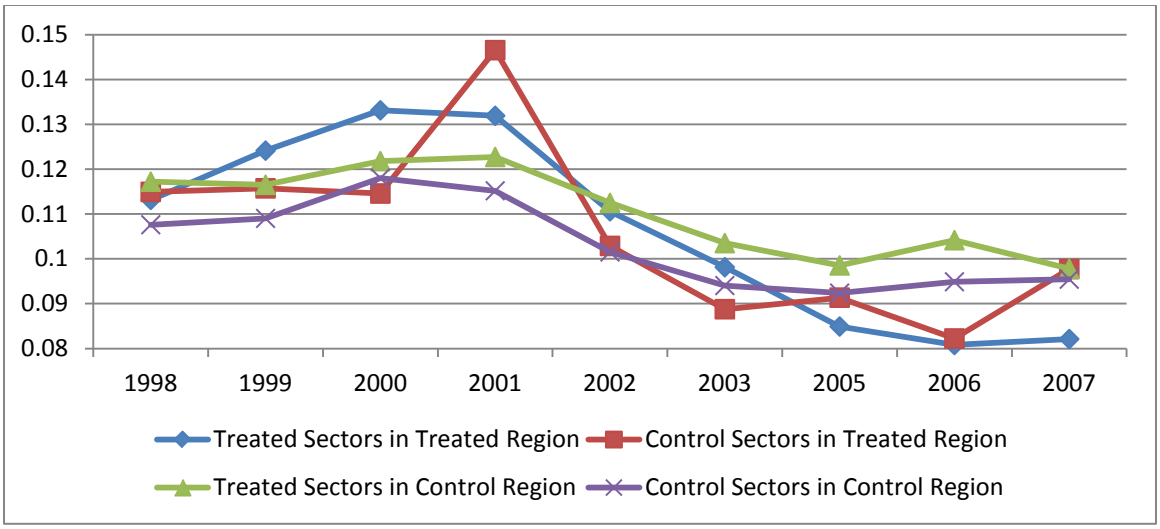


Figure 2.1. Evolution of the Annual Growth Rate of Industrial Sales, All Sample

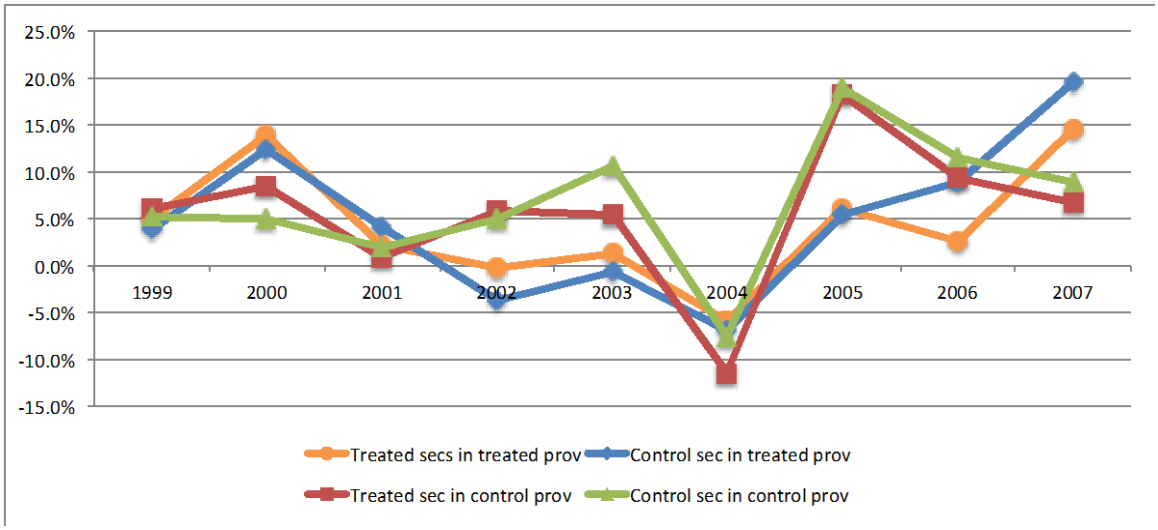


Figure 2.2. Evolution of the Annual Growth Rate of Industrial Sales, State-owned Firms

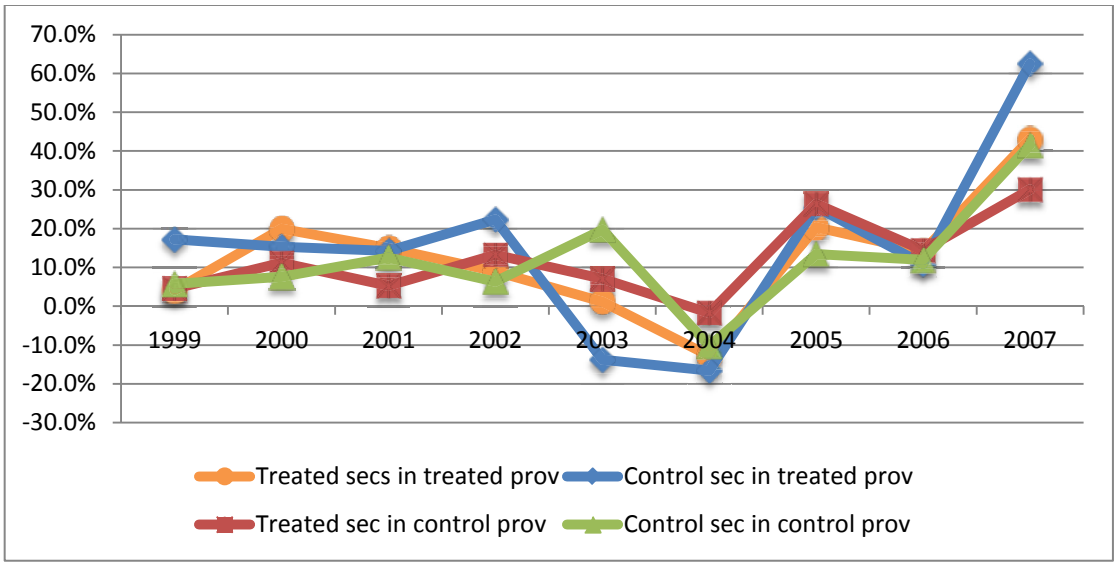


Figure 2.3. Evolution of the Annual Growth Rate of Industrial Sales, Private Firms

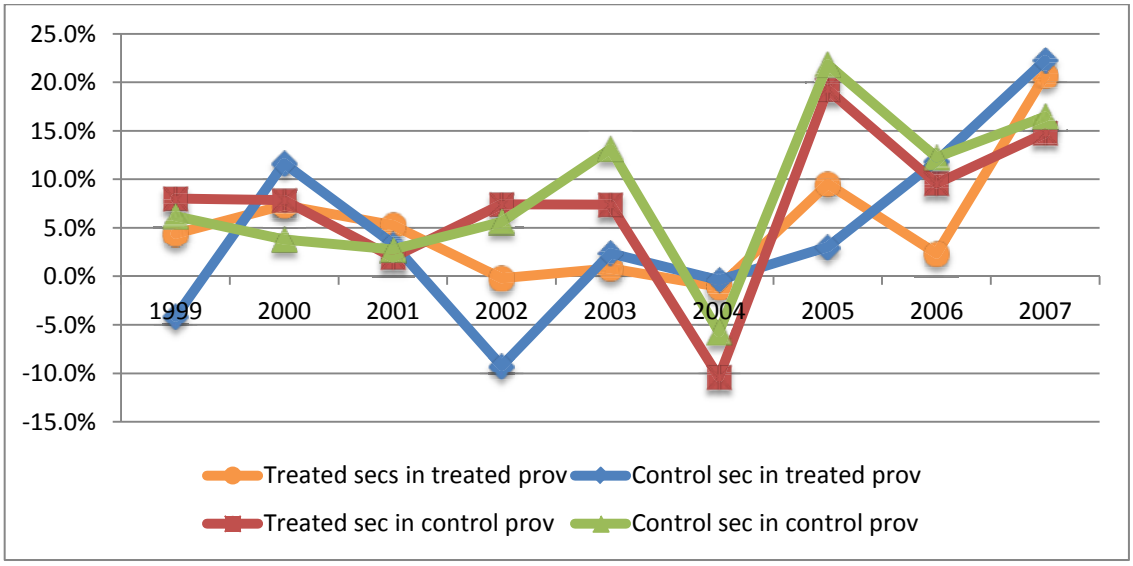


Figure 2.4. Evolution of the Annual Growth Rate of Industrial Sales, Foreign Firms

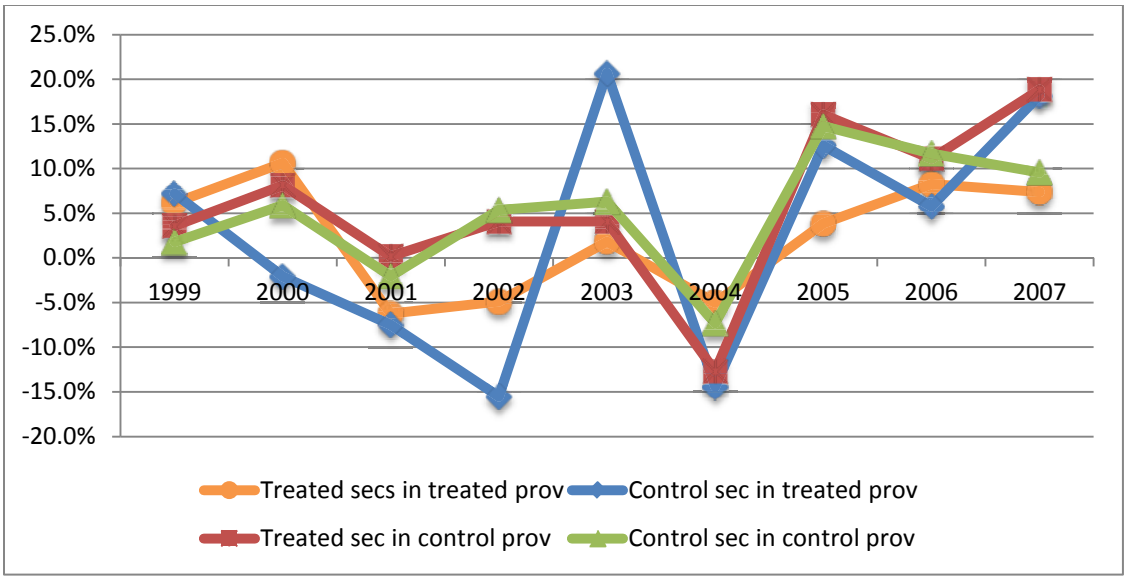


Figure 3. Propensity Score Density Plot

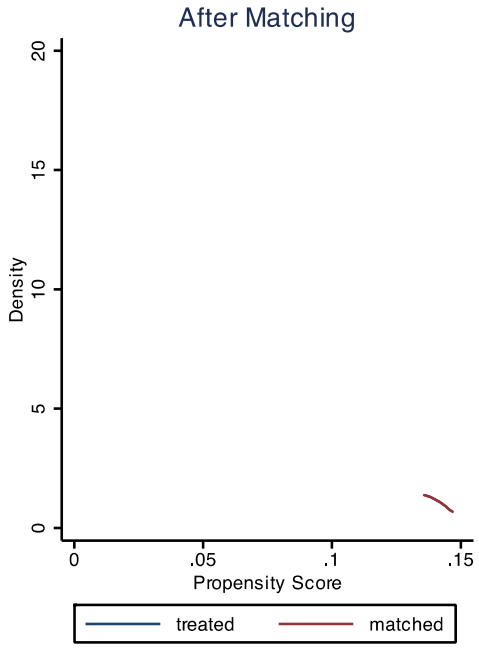


Table 1. Summary Statistics of Key Variables, 1998-2007

	# of Obs.	Mean	St. Dev	Minimum	Maximum
VAT Ratio	1,340,440	0.13	0.12	0.00	1.00
log(Output)	1,512,140	10.02	1.18	6.55	13.76
log(Labor)	1,516,010	4.80	1.06	2.30	7.92
log(Fixed asset)	1,512,114	8.47	1.56	4.32	12.89
Capital Labor Ratio	1,512,140	3.67	1.22	-0.04	6.77
log(Investment)	776,012	6.98	1.86	1.96	11.87
Investment Ratio	1,062,773	0.34	1.89	-8.18	18.72
Fixed Asset for Production/Total Asset	1,465,656	0.40	0.23	0.01	0.95
Export Intensity	1,542,448	0.19	0.36	0.00	1.00
R&D Intensity	1,340,452	0.03	0.15	0.00	1.00
log(TFP_OLSFE)	1,457,365	2.02	0.42	1.05	3.39
log(TFP_OP)	1,457,364	2.07	0.46	1.07	3.44
Foreign Share	1,543,000	0.17	0.35	0.00	1.00
State Share	1,543,000	0.09	0.27	0.00	1.00
Age	1,541,627	14.26	12.11	1.00	819.00

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. R&D intensity equals the ratio between new product output and total output. TFP is estimated using OLS fixed effect and 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.

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

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)	R&D intensity (9)	TFP_OP (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
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. 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. R&D intensity equals the ratio between new product output and total output. TFP is estimated using OLS fixed effect and 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	R&D intensity	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
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
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
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
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
Region Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Effects	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. 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. R&D intensity equals the ratio between new product output and total output. TFP is estimated using OLS fixed effect and 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. R&D Intensity			
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)

firm upgrading behavior. R&D intensity equals the ratio between new product output and total output. TFP is estimated using OLS fixed effect and 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.

Appendix Tables

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	R&D intensity	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. 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. R&D intensity equals the ratio between new product output and total output. TFP is estimated using OLS fixed effect and 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	R&D intensity	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. 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. R&D intensity equals the ratio between new product output and total output. TFP is estimated using OLS fixed effect and 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. Replicate Nie et al (2010) Results: All Enterprises

	1999-2003 and 2005			1998-2007		
VARIABLES	Fixed assets growth (nominal)	Fixed assets growth (reall)	LogL	Fixed assets growth (nominal)	Fixed assets growth (reall)	LogL
	(1)	(2)	(3)	(4)	(5)	(6)
VAT policy	8,738*	8,857*	-0.0925***	2,331	2,935	-0.111***
	(4,863)	(4,780)	(0.00843)	(2,471)	(2,782)	(0.00855)
Firm size (logSales)	397.9	490.6	0.00892***	3,843***	2,934**	0.00745***
	(3,561)	(3,187)	(0.00153)	(1,480)	(1,447)	(0.00162)
Profit	0.870*	0.692		0.284	0.115	
	(0.509)	(0.451)		(0.174)	(0.167)	
Foreign Share	-8,722***	-7,914***	0.146***	-6,455***	-5,241***	0.182***
	(2,423)	(2,280)	(0.00751)	(1,622)	(1,545)	(0.00794)
HKTM Share	-1,778*	-1,599*	0.0672***	-2,438***	-1,987**	0.0956***
	(976.4)	(934.4)	(0.00701)	(905.2)	(849.4)	(0.00732)
State Share	10,257***	9,330***	-0.352***	9,385***	7,307***	-0.428***
	(3,173)	(3,005)	(0.00698)	(2,422)	(2,198)	(0.00717)
Export Share	2,051	1,702	0.0209***	-324.2	-431.9	0.00127
	(1,670)	(1,472)	(0.00587)	(644.7)	(607.1)	(0.00607)
Profit-sales ratio			0.000218			-0.00102
			(0.00125)			(0.00161)
Observations	91,578	90,975	121,597	96,222	95,459	128,777
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.087	0.062	0.036	0.018	0.007	0.047

Table A4. Replicate Nie et al (2010) Results: State Owned Firms

	1999-2003 and 2005			1998-2007		
VARIABLES	Fixed assets growth (nominal)	Fixed assets growth (reall)	LogL	Fixed assets growth (nominal)	Fixed assets growth (reall)	LogL
	(1)	(2)	(3)	(4)	(5)	(6)
VAT policy	8,738*	8,857*	-0.0925***	2,331	2,935	-0.111***
	(4,863)	(4,780)	(0.00843)	(2,471)	(2,782)	(0.00855)
Firm size (logSales)	397.9	490.6	0.00892***	3,843***	2,934**	0.00745***
	(3,561)	(3,187)	(0.00153)	(1,480)	(1,447)	(0.00162)
Profit	0.870*	0.692		0.284	0.115	
	(0.509)	(0.451)		(0.174)	(0.167)	
Foreign Share	-8,722***	-7,914***	0.146***	-6,455***	-5,241***	0.182***
	(2,423)	(2,280)	(0.00751)	(1,622)	(1,545)	(0.00794)
HKTM Share	-1,778*	-1,599*	0.0672***	-2,438***	-1,987**	0.0956***
	(976.4)	(934.4)	(0.00701)	(905.2)	(849.4)	(0.00732)
State Share	10,257***	9,330***	-0.352***	9,385***	7,307***	-0.428***
	(3,173)	(3,005)	(0.00698)	(2,422)	(2,198)	(0.00717)
Export Share	2,051	1,702	0.0209***	-324.2	-431.9	0.00127
	(1,670)	(1,472)	(0.00587)	(644.7)	(607.1)	(0.00607)
Profit-sales ratio			0.000218			-0.00102
			(0.00125)			(0.00161)
Observations	91,578	90,975	121,597	96,222	95,459	128,777
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.087	0.062	0.036	0.018	0.007	0.047

Table A5. Replicate Nie et al (2010) Results: Non-State Owned Firms

	1999-2003 and 2005			1998-2007		
VARIABLES	Fixed assets growth (nominal)	Fixed assets growth (reall)	LogL	Fixed assets growth (nominal)	Fixed assets growth (reall)	LogL
	(1)	(2)	(3)	(4)	(5)	(6)
VAT policy	8,738*	8,857*	-0.0925***	2,331	2,935	-0.111***
	(4,863)	(4,780)	(0.00843)	(2,471)	(2,782)	(0.00855)
Firm size (logSales)	397.9	490.6	0.00892***	3,843***	2,934**	0.00745***
	(3,561)	(3,187)	(0.00153)	(1,480)	(1,447)	(0.00162)
Profit	0.870*	0.692		0.284	0.115	
	(0.509)	(0.451)		(0.174)	(0.167)	
Foreign Share	-8,722***	-7,914***	0.146***	-6,455***	-5,241***	0.182***
	(2,423)	(2,280)	(0.00751)	(1,622)	(1,545)	(0.00794)
HKTM Share	-1,778*	-1,599*	0.0672***	-2,438***	-1,987**	0.0956***
	(976.4)	(934.4)	(0.00701)	(905.2)	(849.4)	(0.00732)
State Share	10,257***	9,330***	-0.352***	9,385***	7,307***	-0.428***
	(3,173)	(3,005)	(0.00698)	(2,422)	(2,198)	(0.00717)
Export Share	2,051	1,702	0.0209***	-324.2	-431.9	0.00127
	(1,670)	(1,472)	(0.00587)	(644.7)	(607.1)	(0.00607)
Profit-sales ratio			0.000218			-0.00102
			(0.00125)			(0.00161)
Observations	91,578	90,975	121,597	96,222	95,459	128,777
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.087	0.062	0.036	0.018	0.007	0.047