The Dynamic Effects of Computerized VAT Invoices on Chinese Manufacturing Firms, 1998-2007
(Incomplete)

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Overview

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Motivation

- All governments tax: central questions
  - Enforcement
  - Economic consequences
    - Short run vs Long Run – can be different
- Large body of evidence on short-run responses
- No direct evidence on longer-run elasticities.
This paper

- Examines the short and longer-run effects of increasing Value Added Tax (VAT) on Chinese Manufacturing Firms
- VAT is one of the most important sources of government income for developing countries
  - Largest source of Chinese state revenue, e.g. 47% in 2002
  - Theoretically self-enforcing
    - upstream firms incentivized to understate sales
    - downstream firms incentivized to overstate input costs
- Government needs to link sales invoices along the production chain (and punish evasion)
- The Chinese government computerized invoices in 2001/2002
Main Challenges

- Relatively little is known about the details of the Chinese tax system
- Data limitations
- Casual identification
This paper

- Observe VAT paid from the Manufacturing Census, 1998-2007
- Understand the Chinese tax system
  - Detailed reading of government white papers and interview tax authorities and firm managers
  - Rampant evasion prior to computerization
  - Manual audits focused on high-deductible sectors
- Exploit computerization to identify effect of increased enforcement
  - Compare outcomes before and after 2001, between sectors with high-deductible shares and sectors with low deductible shares.
Preview of Main Results

1. Computerization significantly increased VAT
2. Short-run effects differ from long-run effects.
   ▶ Short-run (3-5 years) VAT gains are larger than longer-run (6-7 years) gain
   ▶ In the long-run, firms contract (sales, inputs, deductible inputs decline) and TFPR increases
Related Literatures

- Short vs. Long-run responses to taxes (see review by Saez et al., 2012)
  - Existing empirical evidence focus on short run
  - Has not examined VAT or China
- Third-party enforcement increases VAT (Naritomi, 2015; Pomeranz, 2015)
- State capacity and development (Besley and Persson, 2009, 2010)
  - Technology and governance (Barnwal, 2017; Duflo et al., 2012; Muralidharan et al., 2014; Sukhtankar, 2014)
- Chinese VAT – focused on exports (Chandra, 2013; Garred, 2016)
- Chinese firm productivity (e.g., Hsieh and Klenow, 2009; Hsieh and Song, 2015)
Roadmap

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VAT in China

- Started in 1994

\[
VAT \text{ paid} = 0.17 \times (Sales - Deductible Inputs) \quad (1)
\]

- Full deductions: manufactured inputs, repair inputs, retail inputs, and wholesale inputs, which typically come with VAT special invoices.
- Partial deductions (10%): agricultural products.
- No deductions: labor costs, fixed asset purchases (until 2009), capital depreciation, abnormal losses, rent, fringe benefits, interests from bank loans, and overhead/operating expenses.
Pre-2001 Enforcement

- Government issues official receipts for sales/purchases of VAT deductible inputs
- Before 2001, manually administered
  - Prone to errors and evasion
  - Costly for tax officials to manually link information from all of the invoices
  - Low enforcement everywhere
  - Focused limited attention on sectors with high shares of deductibles (e.g., furniture)
- Audit targeting
  - Official instructions focused on firms with VAT/Sales ("VAT Share") too high or too low relative to the region-sector mean
  - Region definition vague “above prefecture”
  - In practice, officials used rule-of-thumb short cut and focused on firms in sectors with high VAT share.
  - No audit data. Will substantiate indirectly in two ways.
Post-2001 Enforcement

- Computerized all invoices in 2001 – provides near perfect enforcement
  - Firms file monthly for deductions
  - Physically submit invoices and the IC card
  - Checked against national database
  - Refund when the data are verified
- Evasion is still possible, just a lot harder
- No other changes in rules or target auditing during 2001-2007 (major revamping began in 2009)
## Tax Personnel Across Provinces

<table>
<thead>
<tr>
<th></th>
<th>Dependent Variable: Ln # of Tax Officials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Chinese VAT Share</td>
<td>-13.79***</td>
</tr>
<tr>
<td></td>
<td>(1.706)</td>
</tr>
<tr>
<td>Beta Coef.</td>
<td>-0.241</td>
</tr>
<tr>
<td>Ruggedness</td>
<td>-0.0559</td>
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<tr>
<td></td>
<td>(0.0471)</td>
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<tr>
<td>Beta Coef.</td>
<td>-0.0488</td>
</tr>
<tr>
<td>Ln Area (Square km)</td>
<td>0.129***</td>
</tr>
<tr>
<td></td>
<td>(0.0285)</td>
</tr>
<tr>
<td>Beta Coef.</td>
<td>0.184</td>
</tr>
<tr>
<td>Ln Population (10,000 people)</td>
<td>0.597***</td>
</tr>
<tr>
<td></td>
<td>(0.0622)</td>
</tr>
<tr>
<td>Beta Coef.</td>
<td>0.627</td>
</tr>
<tr>
<td>Ln # Firms</td>
<td>0.137**</td>
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<tr>
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<td>(0.0523)</td>
</tr>
<tr>
<td>Beta Coef.</td>
<td>0.224</td>
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<tr>
<td>Observations</td>
<td>91</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.947</td>
</tr>
</tbody>
</table>

Notes: This sample is comprised of a panel of provinces. All regressions control for year fixed effects. The observations are at the province-year level. Robust standard errors are presented in the parentheses. *** p<0.01, ** p<0.05, * p<0.1. Data are reported by the Tax Yearbook of China (1998-2007). Standardized beta coefficients are presented in italics.
Caveats

- Export rebates and tariffs on imports (inputs) existed in China throughout the period
  - Rebate and tariff amount changed over time
  - Accounted for in our VAT measure
- WTO entry in 2001 may have caused systematic changes
  - Will control for sector-year rebates and tariffs.
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Differences-in-Differences

- Before vs. after 2001
- More affected vs Less affected sectors
  - Sectors w/ high VAT share (i.e., low deductible share) sectors experience larger increase in enforcement
Treatment Intensity Measure

- Intensity measure = \( \tilde{VAT}_s \)

\[
\tilde{VAT}_s = \left( \frac{Sales - Inputs_s}{Sales_s} \right) .17. \tag{2}
\]

- Reform intensity increases with \( \tilde{VAT}_s \)
Baseline Equation

- Baseline:

\[ y_{ist} = \alpha + \sum_{\tau=2}^{4} \beta_{\tau} \text{Period}_{\tau} \ast \widehat{\text{VAT}}_{s} + \Gamma X_{ist} + \delta_{t} + \gamma_{i} + \varepsilon_{ist}. \quad (3) \]

- \( \gamma_{i} \) firm fixed effects (balanced panel of firms), \( \delta_{t} \) year fixed effects. \( \text{Period}_{\tau} = 1, 2, 3, 4 \) for \( t = 1998 - 2000, 2001/2, 2003/5, 2006/7. \)

- Baseline controls: year FE \( \times 1998 \) sector characteristics
  - HHI
  - sales
  - exporting share

- SE clustered at the sector level (425 sectors).
Measurement error in $\tilde{VAT}_s$

- Using average VAT share 1998-2007 is potentially endogenous
- Solution 1: use 1997 Chinese Input-Output tables
  - Reflect true VAT share and evasion.
  - Problem if ranks in VAT share across sector not positively corr with tax officials’ data.
- Solution 2: Proxy with U.S. data (main results)
  - Assume that rank in VAT share across sectors similar between the U.S. and China
- Results are similar with the two ways of measuring VAT obligations (in paper)
- Also similar with U.S. measures as instruments for Chinese measures (in paper)
Omitted Variables

- Did something else happen in 2001 to increase taxes from high VAT share sectors?
  - Not that we know of....

- Pre-trend analysis
- Placebo exercises: exporters, corporate tax.
- Additional controls: sector-specific trade tariffs, firm size x year FE, export x year FE, etc.
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- All manufacturing firms with revenues of 5+ mil RMB
- Cutoff is not applied systematically. We impose a strict cutoff to be consistent.
- Balanced panel (no entry or exit)
- Winsorize 1% to avoid outlier (doesn’t matter that much)
- Key variables: VAT, assets, employment, inventory, liability and sales.
- RHS VAT Share: 2007 U.S. Input-Output Accounts Data from the Bureau of Economic Analysis
- 1997 Chinese Input-Output Tables
Comparison of: Chinese IO VAT Share, Chinese Firm VAT Share, and U.S. VAT Share

(a) 1997 Chinese IO VAT Share vs. 1998-2007 Chinese Firm VAT Share

(b) 1997 Chinese IO VAT Share vs. U.S. IO VAT Share
VAT Over Time

Year
VAT (1,000 RMB)
0 200 400 600 800 1000

Low Chinese IO VAT Share  High Chinese IO VAT Share
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## Effect on VAT

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>(1) VAT (000s RMB)</th>
<th>(2) VAT/Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dep Var Mean</strong></td>
<td><strong>2066</strong></td>
<td>0.0495</td>
</tr>
<tr>
<td>U.S. VAT share x 2001-2002</td>
<td>204.5</td>
<td>0.00387</td>
</tr>
<tr>
<td></td>
<td>(237.6)</td>
<td>(0.00265)</td>
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<tr>
<td><strong>Beta Coef.</strong></td>
<td>0.0153</td>
<td>0.0269</td>
</tr>
<tr>
<td>U.S. VAT share x 2003-2005</td>
<td>839.0**</td>
<td>0.0126***</td>
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<td></td>
<td>(393.0)</td>
<td>(0.00346)</td>
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<tr>
<td><strong>Beta Coef.</strong></td>
<td>0.0701</td>
<td>0.0978</td>
</tr>
<tr>
<td>U.S. VAT share x 2006-2007</td>
<td>319.2</td>
<td>0.00960**</td>
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<tr>
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<td>(443.1)</td>
<td>(0.00442)</td>
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<td><strong>Beta Coef.</strong></td>
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<td>Observations</td>
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<td>60,900</td>
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<tr>
<td>R-squared</td>
<td>0.782</td>
<td>0.657</td>
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<tr>
<td>H0: $\beta_1=\beta_2$ (p-value)</td>
<td>0.00500</td>
<td>0.0100</td>
</tr>
<tr>
<td>H0: $\beta_2=\beta_3$ (p-value)</td>
<td>0.114</td>
<td>0.404</td>
</tr>
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</table>
Timing of the Effect

Figure: Chinese VAT Share Data

Figure: U.S. VAT Share Data
<table>
<thead>
<tr>
<th></th>
<th>(1) TFPR (HK)</th>
<th>(2) TFPR (DLW)</th>
<th>(3) Sales (000s RMB)</th>
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<tbody>
<tr>
<td><strong>Dep Var Mean</strong></td>
<td>1.100</td>
<td>0.379</td>
<td>46238</td>
</tr>
<tr>
<td><strong>U.S. VAT share x 2001-2002</strong></td>
<td>0.00880**</td>
<td>-0.0400</td>
<td>-5,794*</td>
</tr>
<tr>
<td></td>
<td>(0.00385)</td>
<td>(0.107)</td>
<td>(3,468)</td>
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<td><strong>Beta Coef.</strong></td>
<td>0.0228</td>
<td>-0.00554</td>
<td>-0.0210</td>
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<tr>
<td><strong>U.S. VAT share x 2003-2005</strong></td>
<td>0.0123**</td>
<td>0.123</td>
<td>-14,808**</td>
</tr>
<tr>
<td></td>
<td>(0.00600)</td>
<td>(0.167)</td>
<td>(6,769)</td>
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<tr>
<td><strong>Beta Coef.</strong></td>
<td>0.0354</td>
<td>0.0191</td>
<td>-0.0599</td>
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<tr>
<td><strong>U.S. VAT share x 2006-2007</strong></td>
<td>0.0150*</td>
<td>0.640***</td>
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<td>(0.00804)</td>
<td>(0.240)</td>
<td>(14,328)</td>
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<td><strong>Beta Coef.</strong></td>
<td>0.0377</td>
<td>0.0857</td>
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<td><strong>Observations</strong></td>
<td>60,900</td>
<td>60,900</td>
<td>60,900</td>
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<tr>
<td><strong>R-squared</strong></td>
<td>0.941</td>
<td>0.963</td>
<td>0.772</td>
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<tr>
<td><strong>H0: β1=β2 (p-value)</strong></td>
<td>0.218</td>
<td>0.0430</td>
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<tr>
<td><strong>H0: β2=β3 (p-value)</strong></td>
<td>0.308</td>
<td>0.000</td>
<td>0.126</td>
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</table>
## Inputs

<table>
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<tr>
<th>Dep Var Mean</th>
<th>Employees (#)</th>
<th>Wage Bill (000s RMB)</th>
<th>Intermediate Inputs (000s RMB)</th>
<th>All Deductible</th>
<th>Beta Coef.</th>
<th>Beta Coef.</th>
<th>Beta Coef.</th>
<th>Beta Coef.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>Dep Var Mean</td>
<td>290.7</td>
<td>3018</td>
<td>32110</td>
<td>0.838</td>
<td>0.785</td>
<td></td>
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<tr>
<td>U.S. VAT share x 2001-2002</td>
<td>12.48</td>
<td>320.7</td>
<td>-5,113*</td>
<td>0.00250</td>
<td>0.00238</td>
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<tr>
<td></td>
<td>(23.40)</td>
<td>(259.3)</td>
<td>(2,648)</td>
<td>(0.00939)</td>
<td>(0.0382)</td>
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</tr>
<tr>
<td>Beta Coef.</td>
<td>0.00713</td>
<td>0.0164</td>
<td>-0.0270</td>
<td>0.00524</td>
<td>0.00104</td>
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<tr>
<td>U.S. VAT share x 2003-2005</td>
<td>-17.35</td>
<td>517.2</td>
<td>-11,177**</td>
<td>-0.0220</td>
<td>-0.158***</td>
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<tr>
<td></td>
<td>(42.76)</td>
<td>(478.8)</td>
<td>(4,762)</td>
<td>(0.0197)</td>
<td>(0.0473)</td>
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<tr>
<td>Beta Coef.</td>
<td>-0.0111</td>
<td>0.0295</td>
<td>-0.0660</td>
<td>-0.0514</td>
<td>-0.0771</td>
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<tr>
<td>U.S. VAT share x 2006-2007</td>
<td>-34.82</td>
<td>279.8</td>
<td>-15,034*</td>
<td>-0.0534*</td>
<td>-0.268***</td>
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</tr>
<tr>
<td></td>
<td>(68.05)</td>
<td>(739.4)</td>
<td>(8,543)</td>
<td>(0.0311)</td>
<td>(0.0811)</td>
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<tr>
<td>Beta Coef.</td>
<td>-0.0193</td>
<td>0.0139</td>
<td>-0.0770</td>
<td>-0.108</td>
<td>-0.114</td>
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<tr>
<td>Observations</td>
<td>60,900</td>
<td>60,900</td>
<td>60,900</td>
<td>60,900</td>
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<tr>
<td>R-squared</td>
<td>0.820</td>
<td>0.811</td>
<td>0.789</td>
<td>0.686</td>
<td>0.408</td>
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<tr>
<td>H0: $\beta_1=\beta_2$ (p-value)</td>
<td>0.300</td>
<td>0.540</td>
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<td>0.0600</td>
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<tr>
<td>H0: $\beta_2=\beta_3$ (p-value)</td>
<td>0.559</td>
<td>0.527</td>
<td>0.504</td>
<td>0.0290</td>
<td>0.0450</td>
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</tr>
</tbody>
</table>
Robustness

- Additional controls
  - Sector specific import/export duties and levels
  - Pre-reform export growth
  - Pre-reform sales and sales growth
  - Pre-reform HHI

- “Placebos”
  - No effect on big exporters or importers
Additional Results

- No effect on corporate income tax
- Currently investigating entry and exit with firm registry data (all registered firms in the economy)
- Larger effects for sector with more inputs, and sectors closest to final consumers
- Results similar for state-owned and privately owned firms
Conclusion

- Computerization strengthened state capacity and increased tax revenues
- Short- and long-run effects differ
  - Long-run gains are likely to be smaller than short-run gains
  - Firms contract over time
  
  ⇒ Tradeoff for policy makers
Thank you!

Comments and suggestions are very welcome!