The Short- and Medium-Run Effects of Computerized VAT Invoices on Tax Revenues in China (Very Preliminary)

Haichao Fan (Fudan), Yu Liu (Fudan), Nancy Qian (Northwestern) and Jaya Wen (Yale)

2nd IMF-Atlanta Fed Research Workshop on China’s Economy

May 17, 2017
Table of Contents

Overview

Background

Empirical Framework

Data

Results

Interpretation

Conclusion
Motivation

- All governments tax: central questions
  - Enforcement
  - Economic consequences
    - Short run vs Long Run
- Large body of evidence on short-run responses
- No direct evidence on longer-run elasticities, which can be very different from SR
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

- Little is known about the details of the Chinese tax system
- Data limitation
- Casual identification
This paper

- Observe VAT paid from the Manufacturing Census, 1998-2007
- Interviews tax authorities and firm managers to understand the Chinese tax system
  - 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.
  - Instrument for sector-specific deductible share in China with measures taken from U.S. data
Computerization increased VAT revenues
  ▶ Short run gains are larger than longer-run gain
▶ Consistent with simple model where firms can adjust more in the LR than the SR
  ▶ Verify additional empirical implications: computerization reduces increases TFPR, reduces sales and inputs
Related Literatures

- Short vs. Long-run responses to taxes (see review by Saez et al., 2012)
  - 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 (Duflo et al., 2012; Muralidharan et al., 2014)
- Chinese VAT – focused on exports (Chandra, 2013; Garred, 2016)
- Chinese firm productivity (e.g., Hsieh and Klenow, 2009; Hsieh and Song, 2015)
Roadmap

- Background
- Empirical strategy
- Data
- Result on VAT
- Interpretation – model, additional empirical results
- Conclusion
Table of Contents

Overview

Background

Empirical Framework

Data

Results

Interpretation

Conclusion
VAT in China

- Started in

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

- 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.
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 (China is very big)
  - Focused attention on sectors with high shares of deductibles (e.g., furniture)
- 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
Caveats

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

Overview

Background

Empirical Framework

Data

Results

Interpretation

Conclusion
Second Stage: Differences-in-Differences

- More affected vs. less affected sectors, before and after 2001
- Baseline:

\[
y_{ist} = \gamma_0 + \sum_{t=1999}^{2007} \beta_t t_t \cdot \tilde{VAT}_s + \tau_t + \phi_i + \varepsilon_{st}. \tag{2}
\]

- \(\phi_i\) firm fixed effects, \(\tau_t\) year fixed effects. SE clustered at the sector level.
Instrumental Variables

- To avoid endogeneity, we use pre-computerization data to calculate the sector-VAT share

\[
\hat{\text{VAT}}_s = \left( \frac{\text{Sales}_s - \text{Inputs}_s}{\text{Sales}_s} \right)
\]

- But pre-computerization VAT Share captures true VAT share and evasion.
  - Problem if tax officials use better/different dataset (can’t verify).
  - Instrument with U.S. data (2007 U.S. Input-Output Accounts Data from the Bureau of Economic Analysis)
  - 9 interaction instruments for 9 endogenous interaction variables in the baseline
  - First stage F-stat around 10.
  - Instrument mainly deals with measurement error
  - Later: Robustness controls for omitted variables
Table of Contents

Overview

Background

Empirical Framework

Data

Results

Interpretation

Conclusion
Data

- Annual Survey of Industrial Production, 1998-2007
- All manufacturing firms with revenues of 5+ mil RMB
- Cutoff is not applied systematically. We impose a strict cutoff to be consistent.
- Key variables: VAT, assets, employment, inventory, liability and sales.
## Enforcement pre 2001

### Dependent Variable: # of Tax Officials

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Officials</td>
<td>Ln Officials</td>
</tr>
<tr>
<td>VAT Share</td>
<td>-159,543***</td>
<td>-46.44***</td>
</tr>
<tr>
<td></td>
<td>(39,824)</td>
<td>(5.835)</td>
</tr>
<tr>
<td>Normalized Coef.</td>
<td>-0.162</td>
<td>-0.556</td>
</tr>
<tr>
<td>Ruggedness</td>
<td>2,314</td>
<td>0.151</td>
</tr>
<tr>
<td></td>
<td>(1,684)</td>
<td>(0.110)</td>
</tr>
<tr>
<td>Normalized Coef.</td>
<td>0.125</td>
<td>0.0965</td>
</tr>
<tr>
<td>Size of Province (Square km)</td>
<td>0.000685</td>
<td>2.20e-07</td>
</tr>
<tr>
<td></td>
<td>(0.00231)</td>
<td>(2.15e-07)</td>
</tr>
<tr>
<td>Normalized Coef.</td>
<td>0.0189</td>
<td>0.0717</td>
</tr>
<tr>
<td># Firms</td>
<td>2.146***</td>
<td>0.000125***</td>
</tr>
<tr>
<td></td>
<td>(0.272)</td>
<td>(1.85e-05)</td>
</tr>
<tr>
<td>Normalized Coef.</td>
<td>0.644</td>
<td>0.442</td>
</tr>
<tr>
<td>Observations</td>
<td>91</td>
<td>91</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.404</td>
<td>0.502</td>
</tr>
</tbody>
</table>

Notes: This sample comprises of a panel of provinces during 1999-2001. 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.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Full Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Observations (1)</td>
</tr>
<tr>
<td>VAT (1000s RMB)</td>
<td>236487</td>
</tr>
<tr>
<td>Sales (1000s RMB)</td>
<td>236487</td>
</tr>
<tr>
<td>Asset (1000s RMB)</td>
<td>236487</td>
</tr>
<tr>
<td>Employment (workers)</td>
<td>236487</td>
</tr>
<tr>
<td>Inventory (1000s RMB)</td>
<td>236487</td>
</tr>
<tr>
<td>TFPR</td>
<td>199410</td>
</tr>
</tbody>
</table>

Notes: A unit of observation is a firm in a given year. The sample comprises a balanced panel of firms, 1998-2007.
<table>
<thead>
<tr>
<th>Table of Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
</tr>
<tr>
<td>Background</td>
</tr>
<tr>
<td>Empirical Framework</td>
</tr>
<tr>
<td>Data</td>
</tr>
<tr>
<td><strong>Results</strong></td>
</tr>
<tr>
<td>Interpretation</td>
</tr>
<tr>
<td>Conclusion</td>
</tr>
</tbody>
</table>
VAT Payment

(a) VAT

(b) VAT/Sales
VAT Gross and Deductibles

(c) Gross VAT

(d) VAT Deductibles
Table of Contents

Overview

Background

Empirical Framework

Data

Results

Interpretation

Conclusion
Simple Model

- Cobb-Douglas technology $k^\alpha l^{1-\alpha}$
- Perfect Competition
- Three periods
  - $t = 0$: $\tau_0 = 0$
  - $t = 1$: $\tau_1 > 0$, firms can only adjust $l$
  - $t = 2$: $\tau_2 = \tau_1 > 0$, firms can adjust $l, k$
- Here, $k$ reflects intermediate inputs
Key Intuition: $q_0 < q_1 < q_2$

- $q$ is pre-tax (consumers pay) price, $p$ is post-tax (producer’s get) price
Tax Revenues

- Tax revenues depend on tax rate and sales, \( \frac{\tau_t}{1+\tau_t} \times q_t y_t \)
- \( 0 = \tau_0 < \tau_1 = \tau_2 \)
- \( qy_0 > qy_1 > qy_2 \)
  - \( q_0 < q_1 < q_2, \) but \( y_0 > y_1 > y_2. \)
  - If \( \sigma > 1, \) \( y \downarrow \) faster than \( q \uparrow \Rightarrow qy_0 > qy_1 > qy_2. \)
- \( t = 1: \) increase in tax rate offset fall in sales.
- \( t = 2: \) sales keep falling, but tax rate is constant
  - \( \rightarrow \) taxes_0 < taxes_2 < taxes_1
Empirical Implications

- \( \text{taxes}_0 < \text{taxes}_2 < \text{taxes}_1 \)
- \( q_0 < q_1 < q_2 \) \( (q = \frac{qy}{k^\alpha l^{1-\alpha}} = TFPR) \)
- \( qy_0 > qy_1 > qy_2 \)
- \( l_0 > l_1 > l_2, k_0 > k_1 > k_2 \)
TFPR and Sales

- Follow De Loecker et al. (2012) to estimate TFPR

(e) TFPR  
(f) Ln Sales
(g) Ln Employment  
(h) Ln Intermediate Inputs  
(i) Intermediate Input Share
Alternative Explanation – Firms Learn to Evade

- Consistent with decline in sales
- Inconsistent with decline in deductible VAT inputs, intermediate inputs, and intermediate input share
- Hard to reconcile with increase in TFPR
- Look at firms at the top and bottom of the chain
  - always relatively easier to evade
  - no differential effect
Other Results

- Robust to sector-year specific export/import tariffs (WTO)
- No effect on ln exports, export share, ln assets
- All firms (allow entry and exit) results similar to balanced panel
  - No effect on # firms per sector (i.e., net entry/exit)
- By ownership
  - No effect on foreign firms
  - Effect on domestic state-owned and privately owned firms are similar
Table of Contents

Overview

Background

Empirical Framework

Data

Results

Interpretation

Conclusion
Preliminary Conclusion

- Computerization increased VAT revenues
  - Technology can improve state capacity, even absent third-party info
- Long-run gains are smaller than short-run gains
  - Evidence consistent with real effects – LR elasticities are larger, firms can adjust production downward
- Work-in-progress:
  - Extend data to 2013 (some data quality and sampling issues)
  - Extend model: GE, three factors, one factor is deductible
The End

Thank you!

Comments and suggests are very welcome!