Accrual Accounting and Resource Allocation: A General Equilibrium Analysis

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Overview

Motivation: What is the value of *accrual accounting systems* (accounting performance measures) to real production decisions?
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Unobservable / Construct

Real economic performance (fundamentals)
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Real economic performance (fundamentals)

Cash flows

Acc Earnings - CF = Accruals

Accounting Earnings

Timing & Estimation Errors

Timing

Estimation
Overview

**Motivation:** What is the value of accrual accounting systems (accounting performance measures) to real production decisions?

The relative magnitude of timing and estimation errors determines whether accrual accounting systems provide managers with a better measure of fundamentals than cash accounting systems.
Overview

Empirical Challenge:

- Firms production decisions are inherently endogenous
- Lack of counterfactual for different accounting systems
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Approach:

- Build a GE model (variant of David et al. 2016)
  - Single (representative HH); Multiple heterogeneous firms
  - Resources allocated to firms through product and input markets
  - Production functions using Labor and Capital as inputs but varying in productivity
  - **Key friction:** managers’ information of *current* and *future* productivity.
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  - Key friction: managers’ information of current and future productivity.

- The role of accruals:
  - consequently, accounting information can directly affect resource allocation and aggregate productivity by reducing information frictions.

\[
\text{Future Productivity} = F(\text{Cash Flows, Accounting Earnings, Everything Else})
\]

- Structural estimation with data from the US, China and India
Outline

(1) GE Model

(2) Data and Identification

(3) Quantitative Analysis

(4) Robustness Tests
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General Equilibrium Model

**GE model with accounting systems** by adapting David et al’s (2016) GE model and Nikolaev’s (2016) accrual accounting model.
General Equilibrium Model

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![Diagram of economy and market connections](image)

Figure 1: Economy
This figure illustrates the economy in my model.
General Equilibrium Model

**GE model with accounting systems** by adapting David et al’s (2016) GE model and Nikolaev’s (2016) accrual accounting model.

**Representative HH:**
Maximizes her utility from consumption \[ \sum_{t=0}^{\infty} \beta^t u(C_t), \]
subject to budget constrain: \[ C_t + K_{t+1} \leq (1 + R_t - \delta)K_t + W_t L_t + \Pi_t, \forall t \geq 0, \]

- \( K_t \) is the aggregate capital stock (owned by the representative HH)
- \( L_t \) is labor (inelastically supplied)
- \( \Pi_t \) total profit from the operation of all firms

**Technology:**
There is a continuum of intermediate-good producers (indexed by \( i \)) with fixed measure of 1.
Each intermediate-good producer has a Cobb-Douglas production technology
\[ Y_{it} = K_{it}^{\alpha_1} L_{it}^{\alpha_2}, \quad \alpha_1 + \alpha_2 = 1, \]
General Equilibrium Model

**GE model with accounting systems** by adapting David et al’s (2016) GE model and Nikolaev’s (2016) accrual accounting model.

**Market Structure and Revenue:**
Market structure: monopolistic competition with heterogeneous firms with CES aggregator for the final good.

$$Y_t = \left( \int A_{it} Y_{it}^{\theta-1} \, d\hat{i} \right)^{\theta^{-1}}, \quad \theta \in (1, \infty),$$

(log) Productivity follows an AR(1) process:

$$a_{it} = (1 - \rho)a + \rho a_{it-1} + \varepsilon_{it}, \quad \varepsilon_{it} \sim N(0, \sigma^2), \quad \sigma^2_a \equiv \frac{1}{1 - \rho^2} \sigma^2,$$

Product market competition: each firm faces a downward-sloping demand:

$$P_{it} = A_{it} \left( \frac{Y_{it}}{Y_t} \right)^{-\frac{1}{\theta}}.$$

Revenue of firm $i$:

$$P_{it} Y_{it} = Y_t^{\theta} A_{it} K_{it}^{\alpha_1} L_{it}^{\alpha_2}, \quad \alpha_j = (1 - \frac{1}{\theta}) \alpha_j, \quad \alpha \equiv \alpha_1 + \alpha_2.$$
General Equilibrium Model

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**Input Choices with Imperfect Information**

Firms makes input choices under imperfect information about future productivity. Conditional expectation of future productivity \( E_{it-1}[A_{it}] \) affects labor and capital investment decisions.

The firm’s PMP is

\[
\max_{K_{it}, L_{it}} E_{it-1}[P_{it}Y_{it} - W_{it}L_{it} - R_{it}K_{it}]
\]

\[
= \max_{K_{it}, L_{it}} Y^\frac{1}{\theta}_{it} E_{it-1}[A_{it}] K^{\alpha_1}_{it} L^{\alpha_2}_{it} - W_{it}L_{it} - R_{it}K_{it},
\]

Optimal capital investment decision:

\[
K_{it} = \frac{E_{it-1}[A_{it}]^\theta}{\int E_{it-1}[A_{it}]^\theta d\theta} \int K_{it} d\theta.
\]

(a firm consider average capital and average expected productivity to determine the level of its capital investment)

FOC of the PMP:

\[
\hat{\alpha}_1 K^{\alpha_1-1}_{it} Y^\frac{1}{\theta}_{it} E_{it-1}[A_{it}] L^{\alpha_2}_{it} = R_{it}, \quad \hat{\alpha}_2 L^{\alpha_2-1}_{it} Y^\frac{1}{\theta}_{it} E_{it-1}[A_{it}] K^{\alpha_1}_{it} = W_{it}.
\]
General Equilibrium Model

**GE model with accounting systems** by adapting David et al’s (2016) GE model and Nikolaev’s (2016) accrual accounting model.

**Information Structure**

Accounting systems affect firms’ production decisions by shaping managers information about future productivity.

Information frictions arise from the uncertainty in the change in future productivity \((A_{it} - A_{it-1})\)

but also from uncertainty about current productivity \((A_{it-1})\).

\[
E_{it-1}[A_{it}] = E_{it-1}[A_{it} - A_{it-1}] + E_{it-1}[A_{it-1}].
\]
General Equilibrium Model


Information Structure
Accounting systems affect firms’ production decisions by shaping managers information about future productivity. Information frictions arise from the uncertainty in the change in future productivity $(A_{it} - A_{it-1})$ but also from uncertainty about current productivity $(A_{it-1})$.

$$E_{it-1}[A_{it}] = E_{it-1}[A_{it} - A_{it-1}] + E_{it-1}[A_{it-1}].$$

Accrual accounting systems improve expectations of future productivity through this term.

Key difference between this paper and David et al. (2016), which assumes $E_{t-1}[A_{it-1}] = A_{it-1}$
General Equilibrium Model


Introducing Accounting Systems
The paper builds on Nikolaev’s accrual accounting model because it models an accrual system that improves an imperfect measure of firm performance by explicitly introducing true earnings into accounting systems

\[
\Pi_{it} = \frac{Y_t^{\delta} A_{it} K_{it}^{\alpha_1} L_{it}^{\alpha_2}}{\text{Revenue}} - (W_{it} L_{it} + R_t K_{it}).
\]

CFs and Acc Earnings:
\[
CF_{it} = \Pi_{it} + \epsilon_{it}^c \quad \text{(Timing error)} \quad AE_{it} = CF_{it} + AC_{it}
\]
\[
= \Pi_{it} + \left( A_{it}^{ac} - 1 \right) Y_t^{\delta} A_{it} K_{it}^{\alpha_1} L_{it}^{\alpha_2} \epsilon_{it}^c
\]
\[
= Y_t^{\delta} A_{it} A_{it}^{ac} K_{it}^{\alpha_1} L_{it}^{\alpha_2} - W_{it} L_{it} - R_t.
\]

\[AE_{it} = \Pi_{it} + \epsilon_{it}^e \quad \text{(est. error)}\]
\[
= \Pi_{it} + \left( A_{it}^{ae} - 1 \right) Y_t^{\delta} A_{it} K_{it}^{\alpha_1} L_{it}^{\alpha_2} \epsilon_{it}^e
\]
\[
= Y_t^{\delta} A_{it} A_{it}^{ae} K_{it}^{\alpha_1} L_{it}^{\alpha_2} - W_{it} L_{it} - R_t K_{it}.
\]

\[A_{it}^{ac} \text{ and } A_{it}^{ae} \text{ are accounting cash- and earnings-based productivity measures}
\]
\[a_{it}^{ac} \text{ and } a_{it}^{ae} \text{ are iid and follow normal distributions}
\]

Accruals:
\[AC_{it} = \epsilon_{it}^c - \epsilon_{it}^e. \text{ (as the size of timing errors becomes large relative to est. errors, accrual acc. systems do more to improve the measure of fundamentals)}
\]
\[E[\epsilon_{it}^c] = E[\epsilon_{it}^e] = 0, \ E[CF_{it}|A_{it}] = E[AE_{it}|A_{it}] = \Pi_{it}.
\]
**General Equilibrium Model**

**GE model with accounting systems** by adapting David et al’s (2016) GE model and Nikolaev’s (2016) accrual accounting model.

**Managers’ Information**

Three sources of info: CFs’, Accounting Earnings and all other info:  
\[ \mathbb{I}_{it-1} = \{a_{it-1}^c, \cdots, a_{i0}^c, a_{it-1}^e, \cdots, a_{i0}^e, s_{it-1}, \cdots, s_{i0}\} \]

The conditional variance of fut. Productivity \[ V_{it-1}[a_{it}] \] is what defines informational frictions for managers. Stationarity means \[ V_{it-1}[a_{it}] = \bar{V} \]. Managers form \[ E_{it-1}[a_{it}] \] from imperfect measures (Kalman filter).

All other information is another signal with information about future productive shocks \[ a_{it}^s \] is noise and follows an iid normal distribution with mean 0 and variance \[ \sigma_s^2 \]

Accrual accounting systems reduce the conditional variance of future productivity by improving an imperfect measure of current productivity.

\[
\bar{V} = \rho^2(\frac{\sigma_s^2}{\sigma^2 + \sigma_s^2})^2 \frac{\bar{V}\sigma_a^s\sigma_{ae}^2(\sigma^2 + \sigma_s^2)}{\bar{V}(\sigma_{ae}^2 + \sigma_{ac}^2)(\sigma^2 + \sigma_s^2) + \sigma_{ae}^2\sigma_{ac}^2(\sigma^2 + \sigma_s^2 + \rho^2\bar{V})} + \frac{\sigma^2\sigma_s^2}{\sigma^2 + \sigma_s^2}.
\]

IFT shows that \[ \frac{d\bar{V}}{d\sigma_{ac}} \geq 0 \].
General Equilibrium Model

**GE model with accounting systems** by adapting David et al’s (2016) GE model and Nikolaev’s (2016) accrual accounting model.

**Equilibrium Definition**
A steady-state equilibrium in this economy consists of a wage rate $W$, capital rental rate $R$, intermediate-good price and quantity $(\{P_{it}, Y_{it}\}_{i \in I})$, optimal input choices $(\{K_{it}, L_{it}\}_{i \in I})$ and aggregate levels of output, capital, labor and consumption such that

1. A representative household’s optimization implies $R = \frac{1}{\beta} - 1 + \delta$, where $\beta$ is the discount factor and $\delta$ is the depreciation rate;

2. Given $R$ and $W$, an intermediate-good producer maximizes its profits by choosing $(\{P_{it}, Y_{it}\}, K_{it}, L_{it})$;

3. All markets are cleared: $C + \delta K = Y = \int P_{it} Y_{it} d\bar{i}, \int K_{it} d\bar{i} = K$, and $\int L_{it} d\bar{i} = L$. 
General Equilibrium Model

**GE model with accounting systems** by adapting David et al’s (2016) GE model and Nikolaev’s (2016) accrual accounting model.

**Equilibrium**

**Aggregate Productivity**

Market clearing:

\[
Y = \int P_tY_tdi = K^{\alpha_1} L^{\alpha_2} Y^{\frac{1}{\theta}} \left( \frac{\int A_{it}(E_{it-1}[A_{it}])^{\frac{1}{1-\alpha}} di}{(\int E_{it-1}[A_{it}]^{\frac{1}{1-\alpha}} di)^{\frac{\alpha}{\theta}}} \right).
\]

Aggregate output expressed in a log form

\[
y = \frac{1}{\theta}y + \hat{\alpha}_1 k + \hat{\alpha}_2 l + \log \int A_{it}(E_{it-1}[A_{it}])^{\frac{1}{1-\alpha}} di - \hat{\alpha} \log (\int E_{it-1}[A_{it}]^{\frac{1}{1-\alpha}} di).
\]

\[
\begin{pmatrix}
a_{it} \\
E_{it-1}[a_{it}]
\end{pmatrix} \sim N \left( \begin{pmatrix}
\bar{a} \\
\bar{a}
\end{pmatrix}, \begin{pmatrix}
\sigma_a^2 & \sigma_a^2 - \bar{V} \\
\sigma_a^2 - \bar{V} & \sigma_a^2 - \bar{V}
\end{pmatrix} \right),
\]

\[
y = \alpha_1 k + \alpha_2 l + \frac{\theta}{\theta - 1} \bar{a} + \frac{1}{2} \left( \frac{\theta}{\theta - 1} \right) \frac{\sigma_a^2}{1 - \hat{\alpha}} - \frac{1}{2} \theta \bar{V}.
\]

Aggregate productivity
General Equilibrium Model

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**Equilibrium**

**Rental Rate of Capital and Wage Rate**

Euler Equation of the representative HH:  

\[ 1 = \beta (1 - \delta + R). \]

Wage rate  

\[ w = \frac{1}{1 - \alpha_1} \log \hat{\alpha}_2 \left( \frac{\hat{\alpha}_1}{\hat{\alpha}_2 R} \right)^{\alpha_1} L^{\hat{\alpha} - 1} + \frac{1}{1 - \alpha_1} \left( \bar{a} + \frac{1}{2} \frac{\sigma_a^2}{1 - \hat{\alpha}} + \frac{1}{2} \bar{V} + \frac{1}{\theta y} \right). \]
General Equilibrium Model


Equilibrium

Aggregate Capital and Output

Relationship between capital and labor is expressed at the aggregate level

\[ K = \frac{\hat{\alpha}_1 L}{\hat{\alpha}_2 R} W. \]

Then a log change in capital is the same as a log change in wages with respect to informational frictions

\[ \frac{dk}{dV} = \frac{dw}{dV}. \]

Then we can characterize the relation between aggregate output and informational frictions

\[ \frac{dy}{dV} = \alpha_1 \left( \frac{dk}{dV} \right) - \frac{1}{2} \theta \]
\[ = -\frac{1}{2} \theta \frac{1}{1 - \alpha_1}. \]

Informational frictions reduce aggregate output. Capital share \( \alpha_1 \) strengthens the negative relation because the economy accumulates less aggregate capital if aggregate productivity is lower.
General Equilibrium Model

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**Equilibrium - Analysis**

Quality of accrual accounting systems improves firm’s input choices and, in turn, facilitates resource allocation across firm’s through the input and product market.

Each individual firm I makes more informed investment decisions if accrual accounting systems improve managers’ information about future productivity by providing a better measure of fundamentals than cash accounting systems.

Individual firms decisions ➔ aggregate effects:

- Firms access the same capital and labor market to purchase inputs, so one firm’s more efficient input choice translates into better resource allocation across firms.

- If one firm is willing to purchase more resources at the same price of resources than another firm due to its high expected productivity, **resources are allocated from the potentially low-productivity firm to the potentially high-productivity firm through prices in the input markets.**

Product market competition determines how strongly firms’ input choices respond to their understanding of future productivity. Potentially high-productivity firms are going to take more market share than potentially low-productivity ones because the HH substitutes high-productivity goods for low-productivity goods more aggressively.

HH provides aggregate capital depending on aggregate productivity, which depends on the distribution of productivity and resource allocation across firms. **Economy accumulates more capital**
Outline

(1) GE Model

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(3) Quantitative Analysis

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Data and Identification

Data

Compustat + Compustat Global (estimation of model parameters using SMM)

Exclude US firms listed in OTC markets (different information environment)

Productivity $A_{it}$ and investment $I_{it}$ are the two key variables in the paper

Estimate accruals using the B/S approach (Leuz et al. 2003)

$$AC_{it} = (\Delta CA_{it} - \Delta Cash_{it}) - (\Delta CL_{it} - \Delta STD_{it} - \Delta TP_{it}) - Dep_{it},$$

Cash flows and accounting earnings are transformed into imperfect measures of productivity

$$Y^\frac{1}{\theta} A_{it} A_{it}^{ac} K_{it}^{\alpha_1} L_{it}^{\alpha_2} - W_t L_{it} - R_t K_{it},$$

$$VA_{it}^c = VA_{it} - AC_{it},$$

(Value-added cash flows and accounting earnings)

Imperfect measures of productivity estimated by the following equations

$$a_{it}^c + Constant = va_{it}^c - \hat{\lambda}_t K_{it}, a_{it}^e + Constant = va_{it}^e - \hat{\lambda}_t K_{it}.$$  

Capital stock measured by gross PP&E. Net investment measured by the variation in capital stock

$$i_{it} = k_{it} - k_{it-1}.$$
Data and Identification

Identification

Challenge: having only noisy measures of productivity makes it difficult to identify the actual productivity process and the variance of the noise in cash flows and accounting earnings.

Vector of parameters that govern the process of firm’s productivity and the quality of different information sources

\[ \Psi = \{ \rho, \sigma_a^2, \sigma_{ac}^2, \sigma_{ae}^2, \sigma_s^2 \} \]

Moment conditions to identify \( \sigma_a^2, \sigma_{ac}^2 \) and \( \sigma_{ae}^2 \)

\[
\text{cov}(a_{it}^c, a_{it}^e) = \text{cov}(a_{it} + a_{it}^{ac}, a_{it} + a_{it}^{ae}) = \text{var}(a_{it}) = \sigma_a^2, \\
\text{var}(a_{it}^c) = \text{var}(a_{it} + a_{it}^{ac}) = \text{var}(a_{it}) + \text{var}(a_{it}^{ac}) = \sigma_a^2 + \sigma_{ac}^2, \\
\text{var}(a_{it}^e) = \text{var}(a_{it} + a_{it}^{ae}) = \text{var}(a_{it}) + \text{var}(a_{it}^{ae}) = \sigma_a^2 + \sigma_{ae}^2. 
\]

An investment-optimality condition provides identification assumptions for the quality of unobservable information \( \sigma_s^2 \)

Also choose the correlation between capital stock and a key moment condition to consider the existence of other frictions correlated with productivity.
Identification

Challenge: having only noisy measures of productivity makes it difficult to identify the actual productivity process and the variance of the noise in cash flows and accounting earnings.

Table 1: Moments

This table summarizes which specific moments help identify specific parameter values. \( a_{it}^c \) and \( a_{it}^e \) are cash-flow- and accounting-earnings-based productivity: \( a_{it}^c = a_{it} + a_{it}^{ac} \) and \( a_{it}^e = a_{it} + a_{it}^{ae} \). Productivity, \( a_{it} \), follows an AR(1) model: \( a_{it} = (1 - \rho) \overline{a} + \rho a_{it-1} + \epsilon_{it} \). \( \rho \) is the persistence of productivity. \( \sigma^2 \) is the volatility of innovation in productivity. \( i \) is investment measured as the first difference of capital stock. \( s_{it} \) is all other information about productivity: \( s_{it} = a_{it+1} + a_{it}^s \). \( \sigma_{ac}^2 \), \( \sigma_{ae}^2 \), and \( \sigma_s^2 \) are the variance of noise in cash flow, accounting earnings, and all other information, respectively.

<table>
<thead>
<tr>
<th>Moment</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>( corr(a_{it}^c, a_{it-1}^c) )</td>
<td>( \rho )</td>
</tr>
<tr>
<td>( corr(a_{it}^e, a_{it-1}^e) )</td>
<td></td>
</tr>
<tr>
<td>( cov(\Delta a_{it}^c, \Delta a_{it}^e) )</td>
<td>( \sigma_{ac}^2 )</td>
</tr>
<tr>
<td>( var(\Delta a_{it}^c) )</td>
<td>( \sigma_{ae}^2 )</td>
</tr>
<tr>
<td>( \sigma_{s}^2 )</td>
<td></td>
</tr>
</tbody>
</table>
Data and Identification

SMM

Use SMM – search for the set of parameter values that statistically satisfy the moment conditions derived from the model, assuming $\theta = 6$ and $\alpha_1 = 0.33$

Two Counterfactual Analysis

(1) Estimate the impact of accrual accounting systems on aggregate productivity by comparing them with a hypothetical economy without accrual accounting systems.

Manager’s information set only has cash flows and other info: $a_{it}^c$ and $s_{it}$

(2) Estimate the potential gains for China and India if these countries had the same quality of accrual accounting systems as the US – i.e., estimation keeping $\sigma_{ae,US}^2$

Keeping the process of productivity in China and India intact, this counterfactual analysis examines how changing the quality of accrual accounting information would affect firms' input choices and, eventually, resource allocation across firms in these countries
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## Descriptive Statistics

This table shows the descriptive statistics. Sales, capital (or gross PPP), profits, and accruals are expressed in millions of dollars. $\sigma^c$ and $\sigma^a$ are cash flow- and accounting-earnings-based productivity; $\sigma^c = \sigma_d + \sigma^{ac}$ and $\sigma^a = \sigma_d + \sigma^{ac}$. Cash flow and accounting earnings are transformed into imperfect measures of productivity: $\sigma^c + \text{Constant} = \sigma^c + \sigma^c + \text{Constant} = \sigma^c - \sigma_d + \sigma^{ac}$. The value added for accounting earnings is calculated as 50% of sales to exclude costs of intermediate inputs from sales. The value added for cash flow is measured by the following: $VA_d^c = VA_d^a - AC_d$, where $VA_d^c$ and $VA_d^a$ are the value added for cash flow and accounting earnings, respectively. $i$ is investment measured as the first difference of capital stock. I use gross property, plant, and equipment (PPP) to measure capital stock. The sample firms are public firms in the United States, China, and India in 2012. I demean variables controlling for a year fixed effect. I exclude the top and bottom 1% extreme observations for variables.

<table>
<thead>
<tr>
<th>US</th>
<th>N</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>2,388</td>
<td>1,262.41</td>
<td>17,466.83</td>
<td>172.00</td>
<td>711.10</td>
<td>2,636.13</td>
</tr>
<tr>
<td>Capital</td>
<td>2,388</td>
<td>3,276.53</td>
<td>14,847.31</td>
<td>59.26</td>
<td>315.84</td>
<td>1,563.09</td>
</tr>
<tr>
<td>Profit</td>
<td>2,388</td>
<td>303.18</td>
<td>1,789.38</td>
<td>0.06</td>
<td>27.61</td>
<td>149.16</td>
</tr>
<tr>
<td>Accruals</td>
<td>2,388</td>
<td>(197.32)</td>
<td>877.04</td>
<td>(107.69)</td>
<td>(20.67)</td>
<td>(1.53)</td>
</tr>
<tr>
<td>$\Delta \sigma^c$</td>
<td>2,388</td>
<td>0.41%</td>
<td>23.49%</td>
<td>-9.19%</td>
<td>0.55%</td>
<td>10.49%</td>
</tr>
<tr>
<td>$\Delta \sigma^a$</td>
<td>2,388</td>
<td>0.41%</td>
<td>17.68%</td>
<td>-6.80%</td>
<td>0.75%</td>
<td>8.28%</td>
</tr>
<tr>
<td>$\Delta i$</td>
<td>2,388</td>
<td>0.45%</td>
<td>17.90%</td>
<td>-4.90%</td>
<td>0.97%</td>
<td>6.08%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>China</th>
<th>N</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>1,993</td>
<td>1,619.57</td>
<td>13,302.77</td>
<td>109.51</td>
<td>251.90</td>
<td>679.81</td>
</tr>
<tr>
<td>Capital</td>
<td>1,993</td>
<td>1,348.32</td>
<td>11,972.51</td>
<td>67.14</td>
<td>162.63</td>
<td>470.12</td>
</tr>
<tr>
<td>Profit</td>
<td>1,993</td>
<td>74.97</td>
<td>609.97</td>
<td>4.12</td>
<td>13.80</td>
<td>39.70</td>
</tr>
<tr>
<td>Accruals</td>
<td>1,993</td>
<td>(62.65)</td>
<td>718.35</td>
<td>(31.24)</td>
<td>(4.88)</td>
<td>9.06</td>
</tr>
<tr>
<td>$\Delta \sigma^c$</td>
<td>1,993</td>
<td>-0.64%</td>
<td>44.93%</td>
<td>-22.60%</td>
<td>-2.95%</td>
<td>19.24%</td>
</tr>
<tr>
<td>$\Delta \sigma^a$</td>
<td>1,993</td>
<td>-0.60%</td>
<td>25.24%</td>
<td>-14.51%</td>
<td>0.98%</td>
<td>12.72%</td>
</tr>
<tr>
<td>$\Delta i$</td>
<td>1,993</td>
<td>1.13%</td>
<td>25.88%</td>
<td>-7.59%</td>
<td>3.67%</td>
<td>10.71%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>India</th>
<th>N</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>1,742</td>
<td>478.78</td>
<td>3,093.27</td>
<td>15.21</td>
<td>53.10</td>
<td>185.14</td>
</tr>
<tr>
<td>Capital</td>
<td>1,742</td>
<td>369.92</td>
<td>2,159.97</td>
<td>8.38</td>
<td>30.18</td>
<td>101.22</td>
</tr>
<tr>
<td>Profit</td>
<td>1,742</td>
<td>20.63</td>
<td>212.57</td>
<td>0.08</td>
<td>1.27</td>
<td>8.12</td>
</tr>
<tr>
<td>Accruals</td>
<td>1,742</td>
<td>(7.42)</td>
<td>183.80</td>
<td>(5.77)</td>
<td>(10.64)</td>
<td>1.91</td>
</tr>
<tr>
<td>$\Delta \sigma^c$</td>
<td>1,742</td>
<td>-0.72%</td>
<td>43.61%</td>
<td>-22.90%</td>
<td>-3.51%</td>
<td>17.48%</td>
</tr>
<tr>
<td>$\Delta \sigma^a$</td>
<td>1,742</td>
<td>1.82%</td>
<td>28.99%</td>
<td>-10.04%</td>
<td>3.02%</td>
<td>15.31%</td>
</tr>
<tr>
<td>$\Delta i$</td>
<td>1,742</td>
<td>-0.57%</td>
<td>29.73%</td>
<td>-6.50%</td>
<td>0.12%</td>
<td>5.96%</td>
</tr>
</tbody>
</table>
# Quantitative Analysis

## Moment Conditions

<table>
<thead>
<tr>
<th>Moment</th>
<th>US Empirical</th>
<th>Simulated</th>
<th>China Empirical</th>
<th>Simulated</th>
<th>India Empirical</th>
<th>Simulated</th>
</tr>
</thead>
<tbody>
<tr>
<td>$corr(a_{it}^c, a_{it-1}^c)$</td>
<td>0.9660 (0.0295)</td>
<td>0.9616 (0.0314)</td>
<td>0.8598 (0.0324)</td>
<td>0.8557 (0.0337)</td>
<td>0.8681 (0.0340)</td>
<td>0.8574 (0.0372)</td>
</tr>
<tr>
<td>$corr(a_{it}^e, a_{it-1}^e)$</td>
<td>0.9833 (0.0018)</td>
<td>0.9778 (0.0032)</td>
<td>0.9558 (0.0046)</td>
<td>0.9514 (0.0036)</td>
<td>0.9491 (0.0052)</td>
<td>0.9327 (0.0052)</td>
</tr>
<tr>
<td>$cov(\Delta a_{it}^c, \Delta a_{it}^e)$</td>
<td>0.0238 (0.0032)</td>
<td>0.0238 (0.0031)</td>
<td>0.0311 (0.0104)</td>
<td>0.0320 (0.0018)</td>
<td>0.0584 (0.0106)</td>
<td>0.0586 (0.0057)</td>
</tr>
<tr>
<td>$var(\Delta a_{it}^c)$</td>
<td>0.0551 (0.0018)</td>
<td>0.0552 (0.0032)</td>
<td>0.2017 (0.0046)</td>
<td>0.2045 (0.0036)</td>
<td>0.1901 (0.0052)</td>
<td>0.1909 (0.0052)</td>
</tr>
<tr>
<td>$var(\Delta a_{it}^e)$</td>
<td>0.0313 (0.0018)</td>
<td>0.0312 (0.0032)</td>
<td>0.0637 (0.0104)</td>
<td>0.0618 (0.0018)</td>
<td>0.0840 (0.0106)</td>
<td>0.0829 (0.0057)</td>
</tr>
<tr>
<td>$corr(\Delta i_{it+1}, \Delta a_{it}^c)$</td>
<td>0.2120 (0.0348)</td>
<td>0.2136 (0.0301)</td>
<td>0.0838 (0.0301)</td>
<td>0.1448 (0.0376)</td>
<td>0.2248 (0.0376)</td>
<td>0.2317 (0.0482)</td>
</tr>
<tr>
<td>$corr(\Delta i_{it+1}, \Delta a_{it}^e)$</td>
<td>0.2889 (0.0385)</td>
<td>0.2880 (0.0380)</td>
<td>0.3115 (0.0380)</td>
<td>0.2716 (0.0380)</td>
<td>0.3637 (0.0482)</td>
<td>0.3595 (0.0482)</td>
</tr>
<tr>
<td>J statistic</td>
<td>0.0433 (0.9786)</td>
<td>8.2609 (0.0161)</td>
<td>0.4248 (0.8086)</td>
<td>0.4248 (0.8086)</td>
<td>0.4248 (0.8086)</td>
<td>0.4248 (0.8086)</td>
</tr>
</tbody>
</table>
Quantitative Analysis

Parameter Values

Table 4: Parameter Values
This table contains the estimated parameter values. The estimation uses data from three countries. The parameters are estimated using SMM. $a_{it}^c$ and $a_{it}^e$ are cash-flow- and accounting-earnings-based productivity: $a_{it}^c = a_{it} + a_{it}^{ac}$ and $a_{it}^e = a_{it} + a_{it}^{ae}$. Productivity, $a_{it}$, follows an AR(1) model: $a_{it} = (1 - \rho)e + \rho a_{it-1} + \epsilon_{it}$. $\rho$ is the persistence of productivity. $\sigma^2$ is the volatility of innovation in productivity. $\sigma_{a}^2$ is the volatility of productivity. $s_{it}$ is all other information about productivity: $s_{it} = a_{it+1} + a_{it}^s$. $\sigma_{ac}^2$, $\sigma_{ae}^2$, and $\sigma_{s}^2$ are the variance of noise in cash flow, accounting earnings, and all other information, respectively. $\bar{V}$ is a summary measure of informational frictions (or the conditional variance of future productivity): $\bar{V} = \rho^2 \frac{(\sigma^2)^2}{\sigma^2 + \sigma_s^2} \frac{\sigma_{ac}^2 \sigma_{ae}^2 (\sigma^2 + \sigma_s^2)}{(\sigma_{ac}^2 + \sigma_{ae}^2) (\sigma^2 + \sigma_s^2) + \sigma_{ac}^2 \sigma_{ae}^2 (\sigma^2 + \sigma_s^2 + \rho^2 \sigma_s^2)} + \frac{\sigma_s^4}{\sigma_s^2 + \sigma_s^2}$. The sample firms are public firms in the United States, China, and India in 2012. I demean variables controlling for a year fixed effect. I exclude the top and bottom 1% extreme observations for variables. The standard errors are reported in parentheses.

<table>
<thead>
<tr>
<th>Country</th>
<th>$\rho$</th>
<th>$\sigma$</th>
<th>$\sigma_{ac}$</th>
<th>$\sigma_{ae}$</th>
<th>$\sigma_s$</th>
<th>$\bar{V}$</th>
<th>$\sqrt{V}$</th>
<th>$\bar{V}/\sigma_s^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>0.9837</td>
<td>0.1522</td>
<td>0.1249</td>
<td>0.0617</td>
<td>0.2206</td>
<td>0.0168</td>
<td>0.1296</td>
<td>2.35%</td>
</tr>
<tr>
<td></td>
<td>(0.0075)</td>
<td>(0.0015)</td>
<td>(0.0007)</td>
<td>(0.0018)</td>
<td>(0.0080)</td>
<td>(0.0016)</td>
<td>(0.0061)</td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>0.9749</td>
<td>0.1764</td>
<td>0.2925</td>
<td>0.1236</td>
<td>0.2439</td>
<td>0.0236</td>
<td>0.1536</td>
<td>3.76%</td>
</tr>
<tr>
<td></td>
<td>(0.0052)</td>
<td>(0.0052)</td>
<td>(0.0017)</td>
<td>(0.0034)</td>
<td>(0.0103)</td>
<td>(0.0028)</td>
<td>(0.0092)</td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>0.9530</td>
<td>0.2367</td>
<td>0.2559</td>
<td>0.1116</td>
<td>0.3826</td>
<td>0.0444</td>
<td>0.2107</td>
<td>7.27%</td>
</tr>
<tr>
<td></td>
<td>(0.0105)</td>
<td>(0.0044)</td>
<td>(0.0019)</td>
<td>(0.0048)</td>
<td>(0.0320)</td>
<td>(0.0050)</td>
<td>(0.0120)</td>
<td></td>
</tr>
</tbody>
</table>
Quantitative Analysis

Impact of Accrual Accounting Information on Aggregate Productivity and Output

Table 5: The Impact of Accrual Accounting Information on Aggregate Productivity and Output
This table shows the impact of accrual accounting information on aggregate productivity and output. $\overline{V}$ is a summary measure of informational frictions (or the conditional variance of future productivity). To estimate the impact of accrual accounting systems on aggregate productivity and output, I first calculate a hypothetical conditional variance of future productivity, $\tilde{V}$, based on a counterfactual value of the quality of accounting earnings and the estimated values of the other parameters using the following equation:

$$\tilde{V} = \rho^2 \left( \frac{\sigma_a^2}{\sigma^2 + \sigma_z^2} \right)^2 \frac{\bar{V} \sigma_a^2 \sigma_c^2 (\sigma^2 + \sigma_z^2)}{\sigma_a^2 \sigma_c^2 \sigma_c^2 (\sigma^2 + \sigma_z^2 + \rho^2 \bar{V})} + \frac{\sigma^2 \sigma_z^2}{\sigma^2 + \sigma_z^2}.$$ Second, I use the difference between $\overline{V}$ and $\tilde{V}$ to exploit the following equations:

$$\frac{da}{d\overline{V}} = -\frac{1}{2} \theta$$ and $$\frac{dy}{d\overline{V}} = -\frac{1}{2} \theta \frac{1}{1 - \alpha_1}.$$ $a$ is the aggregate productivity. $y$ is the aggregate output. The sample firms are public firms in the United States, China, and India in 2012. I demean variables controlling for a year fixed effect. I exclude the top and bottom 1% extreme observations for variables.

<table>
<thead>
<tr>
<th>Country</th>
<th>$\Delta \overline{V}$</th>
<th>$\Delta a$</th>
<th>$\Delta y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>-0.0023</td>
<td>0.69%</td>
<td>1.03%</td>
</tr>
<tr>
<td>China</td>
<td>-0.0038</td>
<td>1.15%</td>
<td>1.72%</td>
</tr>
<tr>
<td>India</td>
<td>-0.0084</td>
<td>2.52%</td>
<td>3.76%</td>
</tr>
</tbody>
</table>
Quantitative Analysis

Impact of “US Quality” Accrual Accounting Information on Aggregate Productivity and Output in India and China

Table 6: The Impact of “US-quality” Accrual Accounting Information on Aggregate Productivity and Output
This table shows the impact of “US-quality” accrual accounting information on aggregate productivity and output. $\tilde{V}$ is a summary measure of informational frictions (or the conditional variance of future productivity). To estimate the impact of accrual accounting systems on aggregate productivity and output, I first calculate a hypothetical conditional variance of future productivity, $\tilde{V}$, based on a counterfactual value of the quality of accounting earnings and the estimated values of the other parameters using the following equation:

$$\tilde{V} = \rho^2 \left( \frac{\sigma^2}{\sigma^2 + \sigma_1^2} \right)^2 \frac{\hat{V} \sigma_{ac}^2 \sigma_{ac}^2 (\sigma^2 + \sigma_1^2)}{V \sigma_{ac}^2 \sigma_{ac}^2 (\sigma^2 + \sigma_1^2) + \sigma_{ac}^2 \sigma_{ac}^2 \sigma_{ac}^2 \sigma_{ac}^2 (\sigma^2 + \sigma_1^2 + \rho^2 \tilde{V})} + \frac{\sigma^2 \sigma_1^2}{\sigma^2 + \sigma_1^2}.$$

Second, I use the difference between $\tilde{V}$ and $\tilde{V}$ to exploit the following equations: $\frac{da}{dV} = -\frac{1}{2} \theta$ and $\frac{dy}{dV} = -\frac{1}{2} \theta \frac{1}{1-a_1}$. $a$ is the aggregate productivity. $y$ is the aggregate output. The sample firms are public firms in the United States, China, and India in 2012. I demean variables controlling for a year fixed effect. I exclude the top and bottom 1% extreme observations for variables.

<table>
<thead>
<tr>
<th>Country</th>
<th>$\Delta V$</th>
<th>$\Delta a$</th>
<th>$\Delta y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>-0.0019</td>
<td>0.57%</td>
<td>0.85%</td>
</tr>
<tr>
<td>India</td>
<td>-0.0023</td>
<td>0.70%</td>
<td>1.04%</td>
</tr>
</tbody>
</table>
Outline

(1) GE Model

(2) Data and Identification

(3) Quantitative Analysis

(4) Robustness Tests
Robustness Tests

Different specifications of Accounting Properties

\[ a_{it}^c = a_{it} + \xi^c \epsilon_{it} + a_{it}^{ac}, \]
\[ a_{it}^e = a_{it} + \xi^e \epsilon_{it} + a_{it}^{ae}, \]

Other frictions

\[ \max_{K_{it}, L_{it}} E_{it-1} \left[ Y_t^{\frac{1}{\theta}} \left( 1 - \tau_{Y_{it}} \right) A_{it} K_{it}^{\alpha_1} L_{it}^{\alpha_2} - W_t L_{it} - (1 + \tau_{K_{it}}) R_t K_{it} \right], \]

(Affect the optimal capital rule)

Different values of the elasticity of substitution \( \theta \)

Industry Analysis

Accrual accounting systems reduce informational frictions, \( V \), more in an industry with a longer operating cycle:

collections and payments more likely to be misaligned with the timing of business transactions
Thank you