Taxes, Misallocations and Productivity

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Motivation I

Cross-country differences in income are mostly accounted by TFP

Policies that distort allocations could explain much of these differences

(Jones, 2011)
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Cross-country differences in income are mostly accounted by TFP

Policies that distort allocations could explain much of these differences

(Jones, 2011)

Scarce empirical evidence that relates distortions to observable policies

- firms in developing countries face many distortions
Motivation II

Taxes are a natural candidate as source of distortions in poor countries

- poor countries have low fiscal capacity and tax narrow tax bases

  (Besley and Persson, 2014)

- the resulting tax system can be very inefficient
This paper

I exploit a tax reform in Brazil to quantify distortions of *taxes on inputs*
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1. I build a model to show the distortions generated by these taxes
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I exploit a tax reform in Brazil to quantify distortions of *taxes on inputs*

1. I build a model to show the distortions generated by these taxes

2. I document sectoral reallocation of resources by exploiting:
   - the timing of the reform
   - its differential impact across sectors
   - Tax on inputs hit more sectors on longer production chains
Taxes on inputs

Taxes on input usually take the form of turnover taxes:

- business taxes levied on total turnover with no deduction for inputs
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Turnover taxes are distortive:

- they alter relative prices of inputs
- they tax more sectors that produce on longer production chains

In 2013, 60 countries have some form of turnover tax in place. Of these, 22 were Low Income Countries (63% of the 35 LICs) (World Bank "Doing Business", 2013)
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Turnover taxes are distortive:

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Turnover taxes are very common, especially in developing countries

- In 2013, 60 countries have some form of turnover tax in place
- of these, 22 were Low Income Countries (63% of the 35 LICs)

(World Bank “Doing Business”, 2013)
In 2002 Brazil converted a turnover tax into a VAT:

1. In the model, a tax on inputs creates distortions:
   - it increases costs more in sectors with longer production chains
   - consumers substitute away from goods that are taxed more
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1. In the model, a tax on inputs creates distortions:
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2. In the empirical section:
   - I develop a measure of length of the production chain
   - I show that sectors on longer production chains expand after the reform
Related Literature

Misallocations can explain cross country differences in productivity:

- **Within-sectors:** Restuccia & Rogerson, 2008; Hsieh & Klenow, 2009; ...  

- **Across-sectors:**
  - difference in productivity between agriculture / non-agriculture:
    Caselli, 2005; Vollrath, 2009; Gollin, *et al.* 2012; ...  

- **Empirical evidence:**
  - Mostly model-based calibrations: Bartelsman *et al.*, 2013; Asker *et al.*, 2014  
  - Evidence of distortions of specific policies: Garicano *et al.*, 2013; Best *et al.*, 2013

- **Public finance and optimal taxation**
  - Empirics:
    - Effects of tax on firms’ location: Alouy, 2009; Suarez-Serrato & Zidar, 2014  
Structure of the Talk

- Background and data

- Model

- Reduced-form results

- Conclusions
Background

Brazilian business taxation is extremely complex

PIS and COFINS are 2 social contributions

- they were levied on total turnover at 0.65% (PIS) and 3% (COFINS)
- in Dec. 2002 law no. 10637 converted PIS into a VAT at 1.65%
- in Dec. 2003 law no. 10833 converted COFINS into a VAT at 7.6%
- after the reforms revenues from the 2 tax increased slightly
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Firms that opt for the simplified fiscal regime “SIMPLES” are not affected

- Only firms with revenues below a threshold can opt for SIMPLES
Cobrança da Cofins é simplificada, mas alíquota aumenta para 7,6%; IPI sobre bens de capital será reduzido

Governo antecipa mudança tributária

Justiça condena 22 fiscais do propinoduto

Pacote tributário vai ter mais de 50 artigos

Source: Folha de São Paulo (http://www.folha.uol.com.br/).
Data

*PIA Empresa*: yearly industrial survey that covers:

- a panel of manufactures over the years 1996-2009
- representative of all plants and firms employing 5 workers or more
- it only records formal employment
  - in 2000 5m people: 58% of total manufacturing employment
Data

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- representative of all plants and firms employing 5 workers or more
- it only records formal employment
  → in 2000 5m people: 58% of total manufacturing employment

*Brazilian Input-Output matrix*: 2005

*Brazilian Population Census*: employment in 2000, 2010

*NBER Productivity database*: sectoral characteristics in U.S.
### Summary Statistics

**PIA Empresa**

#### Firms

<table>
<thead>
<tr>
<th></th>
<th>SIMPLES</th>
<th>Non-SIMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm-years</td>
<td>205’655</td>
<td>269’493</td>
</tr>
<tr>
<td><strong>Workers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>35</td>
<td>200</td>
</tr>
<tr>
<td>Median</td>
<td>28</td>
<td>66</td>
</tr>
<tr>
<td>St. Dev.</td>
<td>54</td>
<td>796</td>
</tr>
<tr>
<td><strong>Revenues (million 2000 R$)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.56</td>
<td>27.55</td>
</tr>
<tr>
<td>Median</td>
<td>0.30</td>
<td>3.40</td>
</tr>
<tr>
<td>St. Dev.</td>
<td>10.13</td>
<td>378.66</td>
</tr>
</tbody>
</table>

#### Multi-plant firms

<table>
<thead>
<tr>
<th></th>
<th>Firms</th>
<th>Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>46’336</td>
<td>180’584</td>
</tr>
<tr>
<td><strong>Workers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>556</td>
<td>111</td>
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<tr>
<td>Median</td>
<td>129</td>
<td>18</td>
</tr>
<tr>
<td>St. Dev.</td>
<td>1774</td>
<td>413</td>
</tr>
<tr>
<td><strong>Revenues (million 2000 R$)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>94.61</td>
<td>25.53</td>
</tr>
<tr>
<td>Median</td>
<td>8.39</td>
<td>0.78</td>
</tr>
<tr>
<td>St. Dev.</td>
<td>892.14</td>
<td>217.55</td>
</tr>
</tbody>
</table>
Structure of the Talk

- Background and data
- Model
- Reduced-form results
- Conclusions
A tax on inputs hits more sectors that produce on longer production chains.

(Similar ideas with tariffs: Corden, 1966; Yi, 2003; Fally, 2012)

Key ingredients:
- Sectors that produce on longer chains have higher costs with the tax
- Producers pass some of the higher costs to consumers
- Consumers substitute across final goods
Prices without the tax

There are $N$ sectors, each with many perfectly competitive firms producing:

$$Q_i = B_i L_i^{1-\alpha_i} \prod_{j=1}^{N} M_{ij}^{\alpha_{ij}}$$
Prices without the tax

There are $N$ sectors, each with many perfectly competitive firms producing:

$$Q_i = B_i L_i^{1-\alpha_i} \prod_{j=1}^{N} M_{i,j}^{\alpha_{ij}}$$

Price is equal to marginal cost:

$$P_i^* = \frac{1}{B_i} \left( \frac{W}{1 - \alpha_i} \right)^{1-\alpha_i} \left[ \prod_{j=1}^{N} \frac{P_j}{\alpha_{ij}} \right]^{\alpha_{ij}}$$
Prices without the tax

Taking logs and inverting the matrix system:

\[
\bar{p}^* = [I - A]^{-1} \left[ \bar{c} + (1 - \alpha)w \right]
\]
Prices without the tax

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\]

- \(\bar{p}^*\) is a \(N \times 1\) vector of \(\log(P_i^*)\);
Prices without the tax

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$$\bar{p}^* = [I - A]^{-1} [\bar{c} + (1 - \alpha)w]$$

- $\bar{p}^*$ is a $N \times 1$ vector of $\log(P_i^*)$;

- $[I - A]^{-1}$ is the total requirement matrix (Leontief inverse matrix);
Prices without the tax

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- \( \bar{p}^* \) is a \( N \times 1 \) vector of \( \log(P_i^*) \);
- \([I - A]^{-1}\) is the total requirement matrix (Leontief inverse matrix);
- \( \bar{c} \) is \( N \times 1 \) a vector with \( i \)-th element:

\[ c_i = -\log B_i - (1 - \alpha_i)\log(1 - \alpha_i) - \sum_{j=1}^{N} \alpha_{ij} \log \alpha_{ij} \]
Prices without the tax

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\[ \bar{p}^* = [I - A]^{-1} [\bar{c} + (1 - \alpha)w] \]

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  \[ c_i = -\log B_i - (1 - \alpha_i) \log(1 - \alpha_i) - \sum_{j=1}^{N} \alpha_{ij} \log \alpha_{ij} \]
- \( (1 - \alpha) \) is a \( N \times 1 \) vector with \( i \)-th element: \( 1 - \alpha_i = 1 - \sum_{j=1}^{N} \alpha_{ij} \)
Prices without the tax

Taking logs and inverting the matrix system:

$$\bar{p}^* = [I - A]^{-1} [\bar{c} + (1 - \alpha)w]$$

- $\bar{p}^*$ is a $N \times 1$ vector of $\log(P^*_i)$;
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  $$c_i = -\log B_i - (1 - \alpha_i)\log(1 - \alpha_i) - \sum_{j=1}^{N} \alpha_{ij} \log \alpha_{ij}$$
- $(1 - \alpha)$ is a $N \times 1$ vector with $i$-th element: $1 - \alpha_i = 1 - \sum_{j=1}^{N} \alpha_{ij}$
- $w = \log W$. 
Prices with the tax

Price with a tax $t$ on inputs:

$$P^T_i = \frac{1}{B_i} \left( \frac{W}{1 - \alpha_i} \right)^{1-\alpha_i} \prod_{j=1}^{N} \frac{P_j (1 + t)}{\alpha_{ij}}$$
Prices with the tax

Price with a tax $t$ on inputs:

$$P^T_i = \frac{1}{B_i} \left( \frac{W}{1 - \alpha_i} \right)^{1-\alpha_i} \prod_{j=1}^{N} \frac{P_j(1 + t)}{\alpha_{ij}}$$

Inverting the system:

$$\bar{p}^T = [I - A]^{-1} \left[ \bar{c} + (1 - \alpha)w + \alpha \log(1 + t) \right]$$
Consumption Shares

Preferences are CES across final goods

\[ U = \left[ \sum_{i=1}^{N} C_i^{\frac{\sigma - 1}{\sigma}} \right]^{\frac{\sigma}{\sigma - 1}} \]
Consumption Shares

Preferences are CES across final goods

\[ U = \left[ \sum_{i=1}^{N} C_i^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \]

Consumption shares \( \beta_i \) depend only on prices:

\[ \beta_i(P) \equiv \frac{P_i C_i}{Y} \]

\[ = \left( \frac{P_i}{\sum_{i=1}^{N} P_i^{1-\sigma}} \right)^{1-\sigma} \]

A tax on inputs distorts consumption shares through its effect on prices:

\[ \beta^*_i(P) = \left[ \frac{P_i^* P_T^i}{\sum_{i=1}^{N} P_T^i (1-\sigma) \sum_{i=1}^{N} P_i^{1-\sigma}} \right]^{1-\sigma} \]
Consumption Shares

Preferences are CES across final goods

$$U = \left[ \sum_{i=1}^{N} C_i^{\frac{\sigma}{\sigma - 1}} \right]^{\frac{\sigma}{\sigma - 1}}$$

Consumption shares $\beta_i$ depend only on prices:

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$$= \left( \frac{P_i}{\sum_{i=1}^{N} P_i^{1-\sigma}} \right)^{1-\sigma}$$

A tax on inputs distorts consumption shares through its effect on prices:

$$\frac{\beta_i^*(P)}{\beta_i^T(P)} = \left[ \left( \frac{P_i^*}{P_i^T} \right) \left( \frac{\sum_{i=1}^{N} P_i^{T(1-\sigma)}}{\sum_{i=1}^{N} P_i^{*(1-\sigma)}} \right) \right]^{1-\sigma}$$
Structure of the Talk

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Reduced Form results

Specification

Difference-in-difference regression:

\[ y_{it} = \delta_i + \delta_t + \beta \cdot Post2002_t \times \text{Production Length}_i + e_{it} \]

\[ i = 4\text{-digit sector, } t = \text{year} \]

Production Length = element \( i \) of \([I - A]^{-1}\alpha\)

- I compute it with the 2005 Brazilian I-O matrix

\( y_{it} \): sum over all \textit{plants} operating in sector \( s \) of

- workers employed;
- industrial sales;
- value added;
- number of plants
Reduced Form Results

<table>
<thead>
<tr>
<th></th>
<th>Employment</th>
<th>Industrial Sales</th>
<th>Value Added</th>
<th>Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Post2002×</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>log(Production Length)</td>
<td>0.254*</td>
<td>0.277**</td>
<td>0.307*</td>
<td>0.277**</td>
</tr>
<tr>
<td></td>
<td>(0.150)</td>
<td>(0.140)</td>
<td>(0.163)</td>
<td>(0.131)</td>
</tr>
<tr>
<td>Sector FE (245 sectors)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE (14 years)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>3,357</td>
<td>3,357</td>
<td>3,357</td>
<td>3,359</td>
</tr>
</tbody>
</table>

Robust standard errors clustered at sector level in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Sample: firms with revenues > R$50K above SIMPLES threshold.
Reduced Form results
Quantifications

Interquartile range of Production Length is 0.33.

⇒ Going from sector in 25\textsuperscript{th} percentile (electric material) to sector on 75\textsuperscript{th} percentile (Auto parts) implies:

- 8.4% expansion in number of workers
- 9.2% expansion in industrial sales
- 10.2% expansion in value added
- 9.2% expansion in number of plants
Conclusions

- I use a policy reform in Brazil to show the distortions of turnover taxes
- I build a model to show distortions generated by these taxes
- I derive from the model a prediction that I test on the data

**Future step:**
- Estimate welfare and productivity effects of the reform
Thanks!
PIS & COFINS revenues relative to Brazilian GDP

Source: Ministério da Fazenda, Carga Tributária no Brasil.

PIS (COFINS) revenues went up by 14% (13%) p.a. over 2003-2009

During the same period, GDP grew by 13%; manufacturing by 12%
Equilibrium

Production of good $i$ is either consumed or used as input:

$$Q_i = C_i + \sum_{j=1}^{N} M_{ji}$$

Using F.O.C. of sector $j \left( \alpha_{ji} \frac{P_j Q_i}{M_{ji}} = P_i \right)$ and rearranging:

$$\overline{PQ} = [I - A]^{-1} \overline{\beta(P)}Y$$
Distribution of revenues by tax regime in 2005

Source: Pesquisa Industrial Anual (IBGE).

kernel = epanechnikov, bandwidth = 0.1376
### Length of production chain

5 sectors with shortest chain

<table>
<thead>
<tr>
<th>Sector</th>
<th>Production Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical and Measurement tools Manufacturing</td>
<td>0.63</td>
</tr>
<tr>
<td>Pharmaceutical Manufacturing</td>
<td>0.71</td>
</tr>
<tr>
<td>Office Machinery Manufacturing</td>
<td>0.76</td>
</tr>
<tr>
<td>Publishing and Printing of Newspapers</td>
<td>0.82</td>
</tr>
<tr>
<td>Oil and Natural Gas</td>
<td>0.87</td>
</tr>
</tbody>
</table>

5 sectors with longest chain

<table>
<thead>
<tr>
<th>Sector</th>
<th>Production Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk Manufacturing</td>
<td>1.46</td>
</tr>
<tr>
<td>Soy Oil Refining</td>
<td>1.46</td>
</tr>
<tr>
<td>Wheat Flour Manufacturing</td>
<td>1.46</td>
</tr>
<tr>
<td>Soluble Coffee Manufacturing</td>
<td>1.46</td>
</tr>
<tr>
<td>Cars and Trucks Manufacturing</td>
<td>1.49</td>
</tr>
</tbody>
</table>
Robustness of Reduced Form Result
Controlling for skill and capital intensity

<table>
<thead>
<tr>
<th></th>
<th>Employment</th>
<th>Industrial Sales</th>
<th>Value Added</th>
<th>Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post2002 ×</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>log(Production Length)</td>
<td>0.291**</td>
<td>0.267*</td>
<td>0.338*</td>
<td>0.266**</td>
</tr>
<tr>
<td></td>
<td>(0.129)</td>
<td>(0.155)</td>
<td>(0.175)</td>
<td>(0.123)</td>
</tr>
<tr>
<td>Capital Intensity</td>
<td>-0.065</td>
<td>0.059</td>
<td>0.005</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(0.064)</td>
<td>(0.090)</td>
<td>(0.101)</td>
<td>(0.045)</td>
</tr>
<tr>
<td>Skill Intensity</td>
<td>0.083</td>
<td>-0.109</td>
<td>-0.108</td>
<td>0.058</td>
</tr>
<tr>
<td></td>
<td>(0.266)</td>
<td>(0.305)</td>
<td>(0.368)</td>
<td>(0.211)</td>
</tr>
<tr>
<td>Sector FE (245 sectors)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE (14 years)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>3,209</td>
<td>3,210</td>
<td>3,210</td>
<td>3,210</td>
</tr>
</tbody>
</table>

Robust standard errors clustered at sector level in parentheses

*** p<0.01, ** p<0.05, * p<0.1
Robustness of Reduced Form Result

No effect for firms that opt for SIMPLES

<table>
<thead>
<tr>
<th>Employment</th>
<th>Industrial Sales</th>
<th>Value Added</th>
<th>Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Post2002 \times \log(Prod. \text{ Length})$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\times 1(\text{SIMPLES} = 0)$</td>
<td>0.254* (0.150)</td>
<td>0.277** (0.140)</td>
<td>0.307* (0.163)</td>
</tr>
<tr>
<td>$\times 1(\text{SIMPLES} = 1)$</td>
<td>0.020 (0.188)</td>
<td>0.070 (0.185)</td>
<td>0.074 (0.197)</td>
</tr>
</tbody>
</table>

Sector FE $\times 1(\text{SIMPLES})$: Yes, Yes, Yes, Yes
Year FE $\times 1(\text{SIMPLES})$: Yes, Yes, Yes, Yes

Observations: 6,568, 6,570, 6,568, 6,572

Robust standard errors clustered at sector level in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

SIMPLES: firms with revenues $< R$50K below SIMPLES threshold.
Robustness of Reduced Form Result

Non parametric estimation of the effect

Number of Workers

Year


Number of Workers

Other Variables
Robustness of Reduced Form Result

Non parametric estimation of the effect
Informality in Brazil: 2000-2010

Between 2000 and 2010 share of formal workers increased by 9.7%. (+8.3% in manufacturing).

\[ y = 0.07 - 0.07x \]

(0.01) (0.04)

Change in % formal employees

Log(Production Length)