Productivity, Reallocation, and Economic Crisis: Evidence from Ecuadorian Firm-Level Data

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Introduction

- This paper studies firm dynamics, input distortions and productivity growth in a developing small open economy.
- Recent economic crises highlight the need of understanding the effect of a severe recession.
- Firm level data: micro evidence allowing inherent heterogeneity of firm behaviour.
- Why Ecuador?
  Perfect laboratory to study the effect of bad shocks and economic reforms at firm and aggregate levels.
- Are reforms good? On what margin?

Objective/Summary

1. Stylized facts regarding firm turnover and reallocation
2. Support of *Cleansing effect of recessions*.
3. Is there any *Sullying effect of recessions*?
4. How far are we from the "First-best"? Quantify input distortions.
   - Heavy (capital-intensive) industry - mostly capital distortion.
   - Light (labour-intensive) industry - both capital and labour.
5. Do resources get efficiently reallocated?
6. Relative importance of these effects on Aggregate Productivity Growth (APG).
   - APG is higher for Heavy (11.9%) versus Light industries (9.6%) on average.
   - APG reallocation term is 9.5% and 4.9% for Heavy and Light industries, respectively.
   - Reallocation of capital is more important than that of labour.

Timeline

Our study focuses on Ecuador due to some unique economic events in 1998 - 1999:

- El Ninõ weather phenomenon affected the agricultural sector.
- Oil price was historically low - less than $10 per barrel.
- Aftermath of the war with Peru.
- Fiscal deficit was 6.2% and total debt/GDP was 66.3 %.
- Financial crisis in Asia led to sudden stop of capital inflow.

Jamil Mahuad elected as president

- Dollarization in 2000.
- Ousted in coup two weeks later.

Annual Survey of Manufacturing and Mining

- Prepared by the Ecuadorian National Institute of Statistics and Censuses (INEC) 1998-2007.
- Cross section of manufacturing firms with 10 or more employees.
- Output is defined as value-added by each firm.
- Labour is number of employees hired by a firm.
- Use industrial price deflators to express all monetary variables in thousands of 2002-US dollars.
- Data was cleaned in order to maintain longitudinal consistency.
- Sectors are classified into Light and Heavy industry according to their 2-digit ISIC numbers.

Table 1: Classification of Industries based on two-digit International SIC

ISIC	Light Industries	Obs.	Firms
15	Food	0.51	0.52
16	Tobacco	0.00	0.00
17	Textiles	0.14	0.14
18	Apparel	0.15	0.15
19	Leather	0.06	0.06
36	Furniture	0.14	0.14
ISIC	Heavy Industries	Obs.	Firms
23	Refined petroleum	0.01	0.01
24	Chemicals	0.26	0.26
25	Rubber	0.30	0.30
26	Non-metallic mineral	0.22	0.22
27	Basic metals	0.04	0.04
28	Fabricated metal	0.16	0.18

Figure 1: Job Creation & Destruction

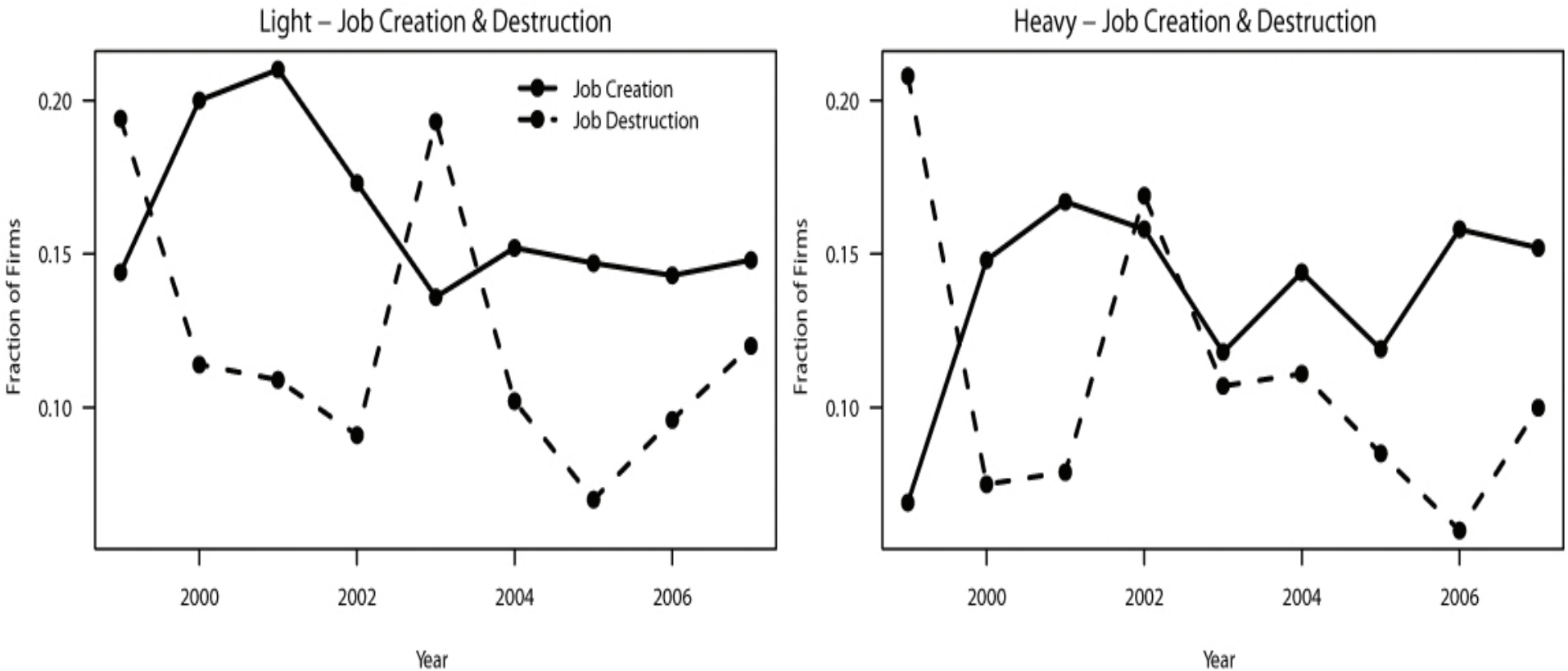


Figure 2: Entry & Exit Rates

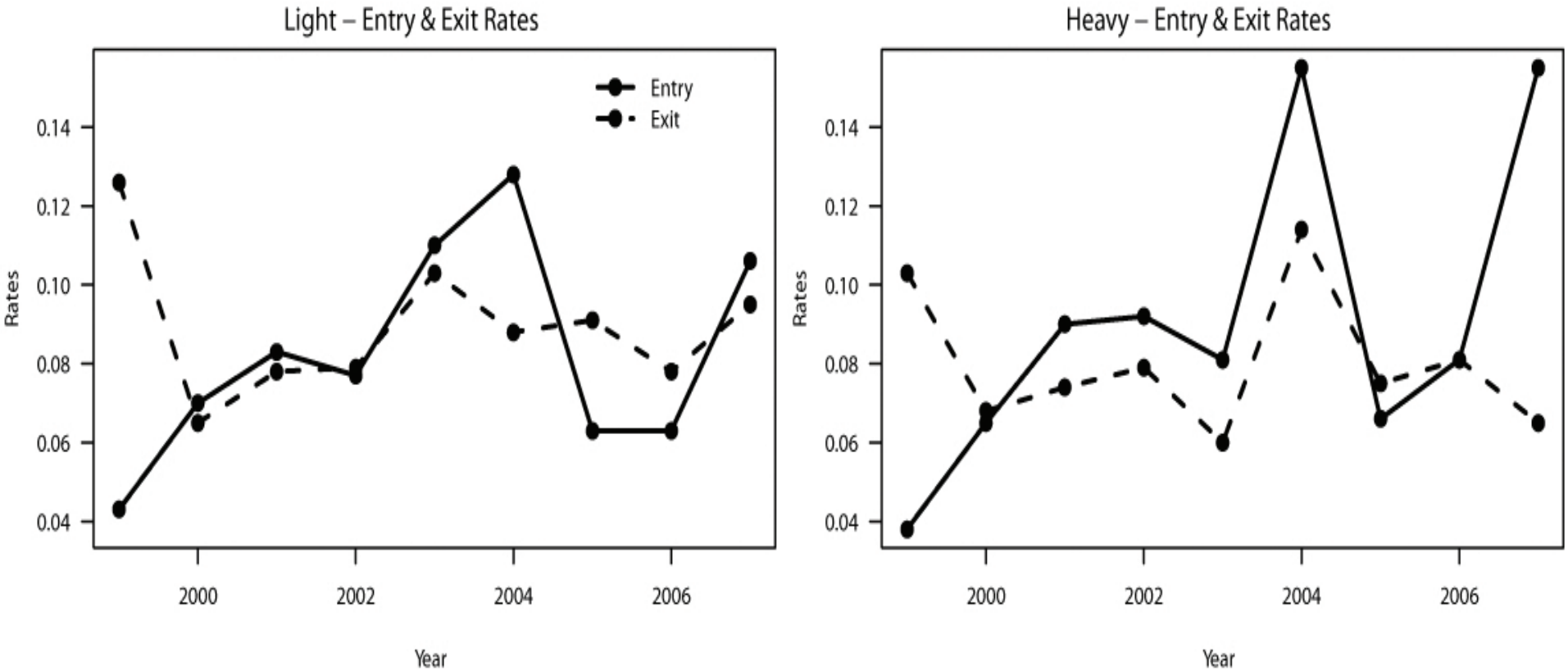
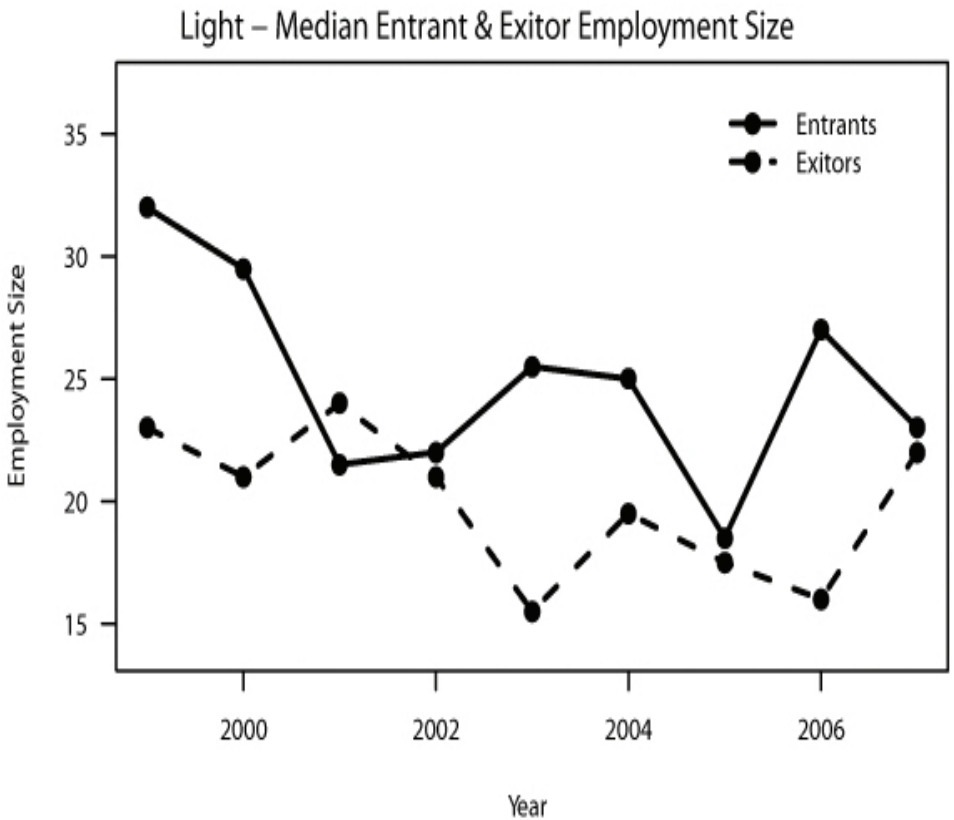


Figure 3: Entrant & Exitor Employment Median Size



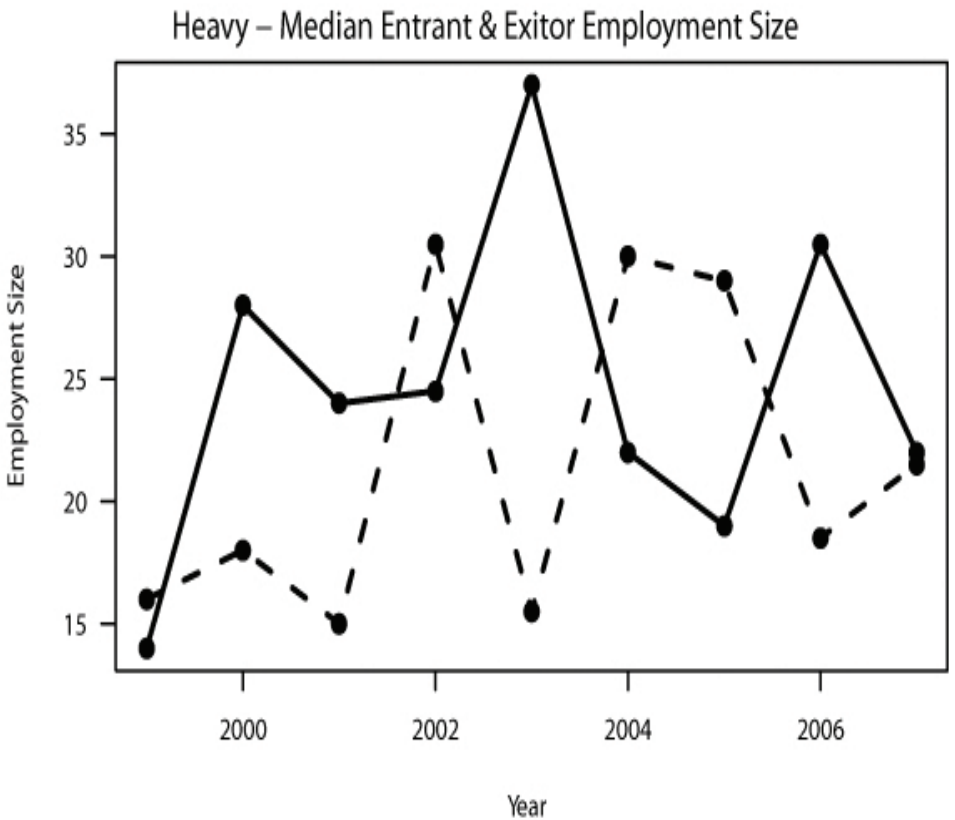


Figure 4: Entrant & Exitor Median Labour Productivity

Quantifying the Distortions

Hopenhayn & Rogerson (JPE, 1993): industry dynamic model of "Job Turnover and Policy Evaluation."

- Restuccia & Rogerson (RED, 2008): quantify **policy distortions**.
- Guner, Ventura & Xu (RED, 2008): Size-dependent policies.
- Hsieh & Klenow (QJE, 2010): industry-level China, India, and the US.

1. Focus of our study is to look at firm-level data from Ecuador.
2. Look at the evolution of these distortions.
3. Policy reforms and distortions?

Estimating Factor Shares

- Firm's Production Function: output (Y) of firm i in industry $j \in \{heavy, light\}$ at time t is:

$$Y_{it} = z_{it} K_{it}^{\alpha_j} L_{it}^{\gamma_j}, \tag{1}$$

where K is capital and L is labour. Factor shares are α_j and γ_j.

- Taking logarithms the production function can be rewritten as:

$$\ln Y_{it} = \log z_{it} + \alpha_j \log K_{it} + \gamma_j \log L_{it}. \tag{2}$$

- Estimate the firm-level production function using fixed-effects panel data estimator, see Pavcnik (REStud, 2002).

$$\log Y_{it} = c_i + \alpha_j \log K_{it} + \gamma_j \log L_{it} + \{b_{j,k} YEAR_k\}_{k=1999}^{2007} + \epsilon_{it}. \tag{3}$$

Table 2: Production Function Estimates

	Light	**Heavy**
$\widehat{\alpha}_j$ (capital)	0.1493	0.1560
	(0.0082)***	(0.0122)***
$\widehat{\gamma}_j$ (labour)	0.6160	0.4510
	(0.0159)***	(0.0241)***
Constant	1.9754	2.6402
	(0.0675)***	(0.0981)***
Firm-level σ_c	0.7545	0.8143
Random σ_ϵ	0.3580	0.3499
$\rho(c_i, X_i)$	0.8163	0.8442

Measuring Input Distortions

Firm's problem:

$$\max_{K,L} \pi_{it} = \max_{K,L} \left\{ Y_{it} - \left(1 + \tau_{it}^{K}\right) r_{it} K_{it} - \left(1 + \tau_{it}^{L}\right) w_{it} L_{it} \right\} \tag{4}$$

where τ_{it}^{K} and τ_{it}^{L} are the input taxes on capital and labour respectively. Capital expenditure is $r_t K_{it}$ and $w_t L_{it}$ is the wage bill.

FOCs:

$$\alpha_j = \left(1 + \tau_{it}^{K}\right) \frac{r_{it} K_{it}}{Y_{it}}, \tag{5}$$

and

$$\gamma_j = \left(1 + \tau_{it}^{L}\right) \frac{w_{it} L_{it}}{Y_{it}}. \tag{6}$$

Table 3: Median Distortions on Labour Input

Light				
Year	**All**	**Entrant**	**Incumbent**	**Exitor**
1998	0.196			
1999	0.586	0.646	0.584	0.056
2000	0.912	0.370	0.953	0.369
2001	0.443	0.010	0.500	1.055
2002	0.434	0.274	0.474	0.405

Heavy				
Year	**All**	**Entrant**	**Incumbent**	**Exitor**
1998	-0.040			
1999	0.203	-0.406	0.219	-0.116
2000	0.697	0.834	0.683	-0.195
2001	0.258	-0.115	0.298	0.019
2002	0.345	0.131	0.399	0.180

Table 4: Median Distortions on Capital Input

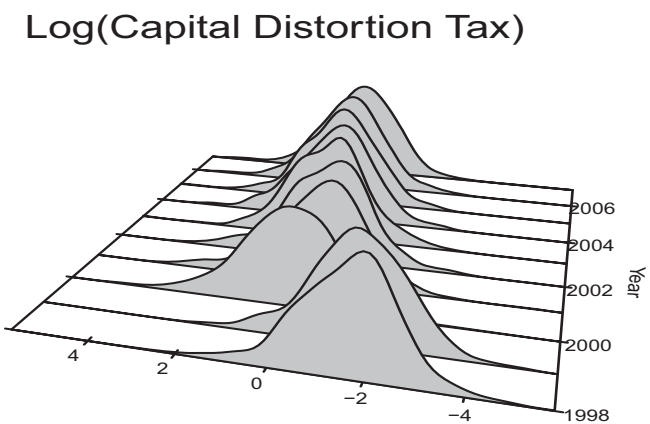
Light

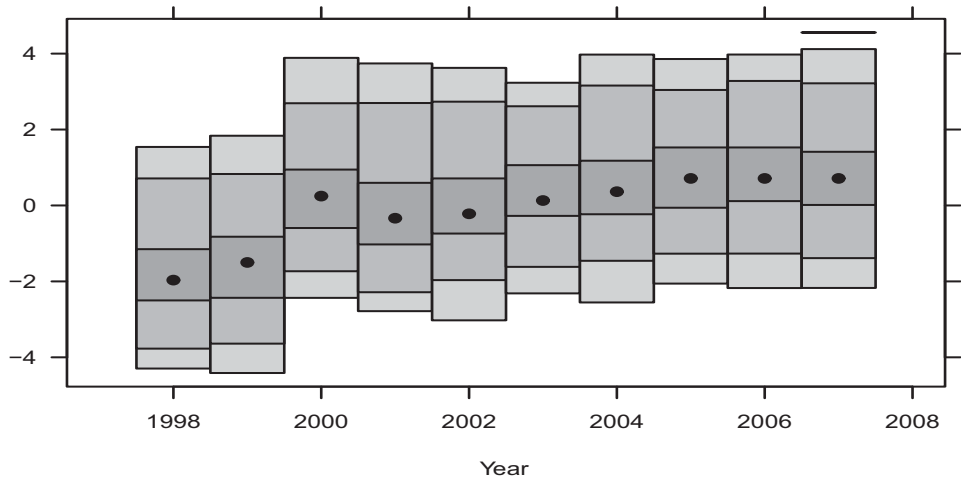
Year	All	Entrant	Incumbent	Exitor
1998	-0.824			
1999	-0.792	-0.856	-0.788	-0.865
2000	0.382	0.296	0.385	-0.777
2001	-0.080	-0.121	-0.080	0.123
2002	0.078	0.047	0.078	-0.066

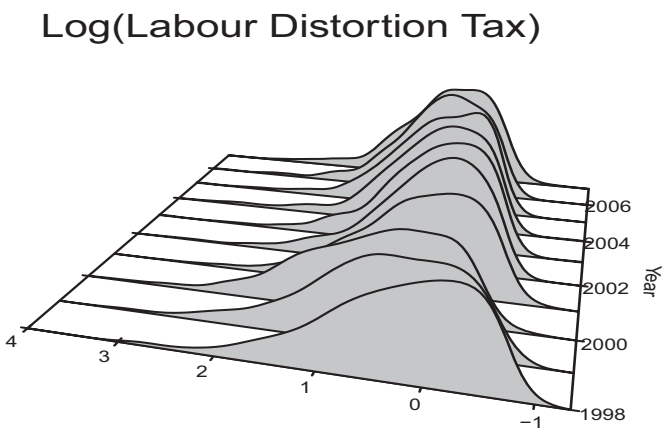
Heavy

Year	All	Entrant	Incumbent	Exitor
1998	-0.837			
1999	-0.853	-0.802	-0.854	-0.865
2000	0.044	-0.039	0.044	-0.804
2001	-0.087	-0.065	-0.097	-0.031
2002	0.114	0.206	0.114	0.027

Figure 5: Light Industry Input Distortions: $\log(1+\tau_{it})$







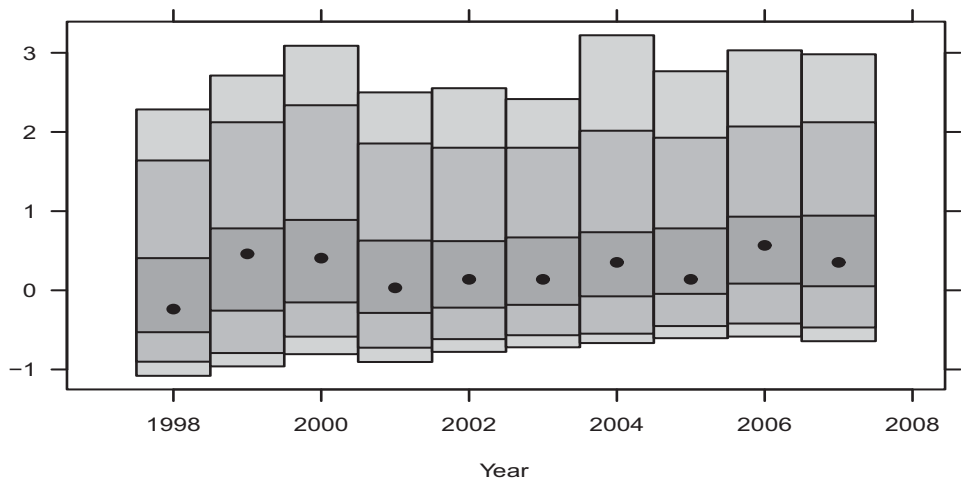
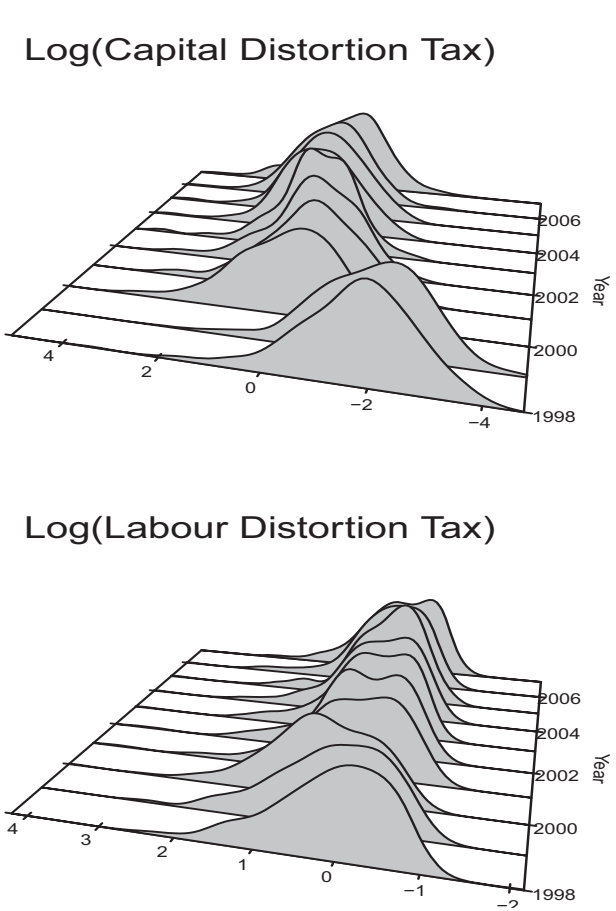
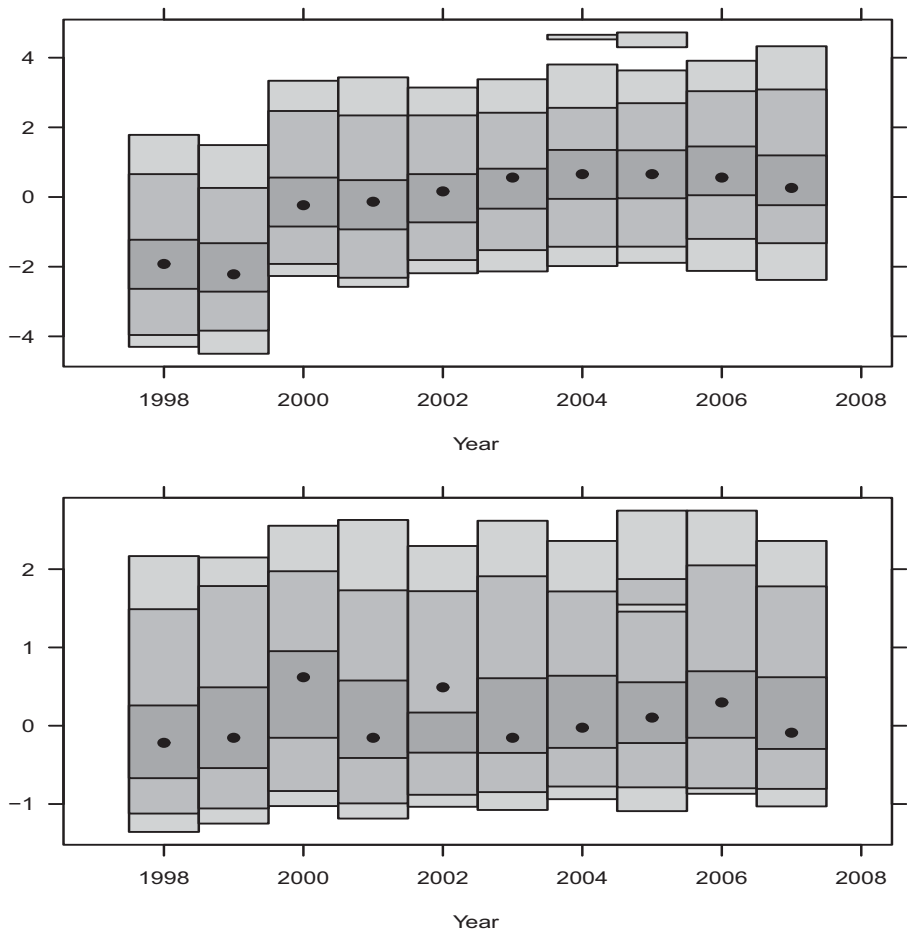


Figure 6: Heavy Industry Input Distortions: $\log(1+\tau_{it})$





Aggregate Productivity Decompositions

Petrin & Levinsohn (Rand, 2012+?): measure of reallocation based on macroeconomic principles.

$$\dot{APG} = \left(\sum_i dY_i - \sum_i r_t dK_i - \sum_i w_t dL_i\right) \Big/ \sum_i Y_i. \tag{7}$$

$$\begin{aligned}\Delta APG_t \approx & \underbrace{\sum_{i\in I_t} \bar{D}_{it} \Delta \log z_{it}}_{\text{TE}} \\ & + \underbrace{\sum_{i\in I_t} \bar{D}_{it} \left(\gamma_j - \bar{s}^L_{it}\right) \Delta \log L_{it}}_{\text{APG}^L_{RE}} + \underbrace{\sum_{i\in I_t} \bar{D}_{it} \left(\alpha_j - \bar{s}^K_{it}\right) \Delta \log K_{it}}_{\text{APG}^K_{RE}} \\ & + \underbrace{\sum_{i\in E_t} D_{it} \left(1 - s^K_{it} - s^L_{it}\right)}_{\text{Entry}} - \underbrace{\sum_{i\in X_{t-1}} D_{it-1} \left(1 - s^K_{it-1} - s^L_{it-1}\right)}_{\text{Exit}}.\end{aligned} \tag{8}$$

$$\bar{D}_{it} = \left(\frac{Y_{it}}{Y_t} + \frac{Y_{it-1}}{Y_{t-1}} \right) \Big/ 2 \tag{9}$$

$$\bar{s}_{it}^{K} = \left(\frac{r_{it} K_{it}}{Y_{it}} + \frac{r_{it-1} K_{it-1}}{Y_{it-1}} \right) \Big/ 2 \tag{10}$$

$$\bar{s}_{it}^{L} = \left(\frac{w_{it} L_{it}}{Y_{it}} + \frac{w_{it-1} L_{it-1}}{Y_{it-1}} \right) \Big/ 2 \tag{11}$$

where $\bar{D}_{it}$ value-added Domar weights, $\log z_{it}$ is TFP, γ_j and α_j are elasticities of output w.r.t. K & L inputs, $\bar{s}_{it}^{L}$ and $\bar{s}_{it}^{K}$ are revenue shares for each input.

Table 5: Aggregate Productivity Decompositions: Light

Year	ΔY	APG	TE	APG^L_{RE}	APG^K_{RE}	Entry	Exit
1999	-0.095	0.095	-0.024	-0.004	0.159	-0.073	-0.037
2000	0.078	0.244	0.050	0.032	0.116	0.015	-0.031
2001	0.171	0.081	0.089	0.033	-0.016	0.006	0.032
2002	0.123	0.106	0.067	0.031	0.010	0.008	0.009
2003	0.139	0.157	0.149	-0.007	0.008	0.020	0.013
2004	0.013	0.006	-0.025	0.014	0.005	0.023	0.012
2005	0.041	0.039	0.014	0.019	0.000	0.015	0.009
2006	0.118	0.104	0.078	0.018	0.001	0.016	0.009
2007	0.041	0.036	0.020	0.020	0.007	0.027	0.038
Average	0.070	0.096	0.046	0.017	0.032	0.006	0.006
Std. Dev.	0.081	0.072	0.057	0.015	0.061	0.031	0.025

Table 9: Aggregate Productivity Decompositions: Heavy

Year	ΔY	APG	TE	APG^L_{RE}	APG^K_{RE}	Entry	Exit
1999	-0.421	0.101	-0.212	-0.006	0.186	-0.019	-0.152
2000	0.202	0.578	0.220	0.011	0.329	0.018	0.000
2001	0.316	0.196	0.191	0.021	-0.020	0.016	0.012
2002	0.123	0.153	0.129	0.014	0.008	0.007	0.006
2003	-0.014	0.000	-0.004	-0.001	0.002	0.015	0.011
2004	0.022	0.021	-0.004	0.005	0.002	0.052	0.034
2005	-0.042	-0.033	-0.008	0.010	-0.003	0.005	0.037
2006	0.130	0.110	0.096	0.021	-0.013	0.013	0.005
2007	-0.034	-0.058	-0.077	0.012	-0.005	0.035	0.023
Average	0.031	0.119	0.037	0.010	0.054	0.016	-0.003
Std. Dev.	0.208	0.192	0.137	0.009	0.121	0.020	0.057

Summary/Future Work

- Investigate the turnover and reallocation of firms in Ecuador.
- Input distortions decrease in both industries.
- APG decompositions reveal that:
  - Reallocation is important
    $\Rightarrow$ large positive reallocation effect during the crisis
    $\Rightarrow$ *cleansing effect* of recession.
  - Net entry is minor.
- Source of productivity reallocation to understand cross-country income differences
  $\Rightarrow$ Collard-Wexler, Asker & de Loecker (NBER, 2011).
- Role of financial frictions on reallocation
  $\Rightarrow$ Midrigan & Xu (NBER, 2010); Buera, Kaboski, & Shin (2011)