Growth dynamics of Colombian manufacturing plants in the context of liberalization

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Motivation

Industrial dynamics: empirical regularities

- Increasing empirical evidence on the the behavior of firms at the micro level
- Several stylized facts of the industrial dynamics and its structure, mainly for developed countries
- Empirical regularities, but also specific patterns that seem to be related with country or sector specificities

Differences between industries and across countries

- Macroeconomic factors might play a role by influencing firm growth rates

Aims of the paper

Dynamics of Colombian manufacturing plants (1995-2016)

- Micro evidence:
  - Statistical properties and empirical regularities
  - Growth rates, volatility and their distribution in a dynamic framework
- Link between micro and macro:
  - Relation between volatility of firms growth rates and macroeconomic cycles
  - Context of liberalization and "deindustrialization" taking place in Colombia since 1973

Main findings

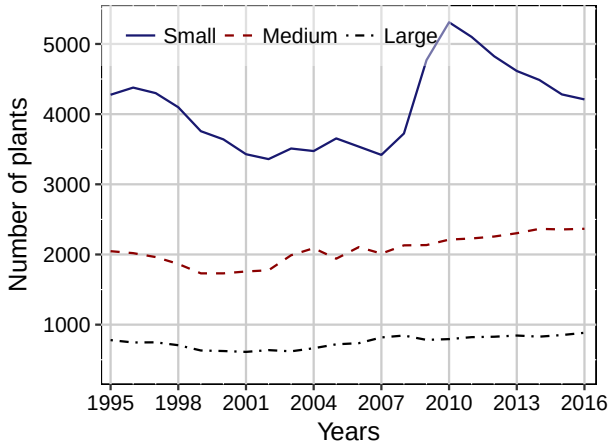
- We verify that the size distribution resembles a log-normal and that the distribution of growth rates exhibits fat-tails
- Surprisingly, we found a non-linear relation between the standard deviation of growth rates and firm size
- The aggregated behaviour of the manufacturing sector does not follow closely the business cycle of the economy
- Industrial dynamics in Colombia is quite erratic and has some remarkable differences with the evidence observed in other economies

Data and descriptive statistics

Data Description

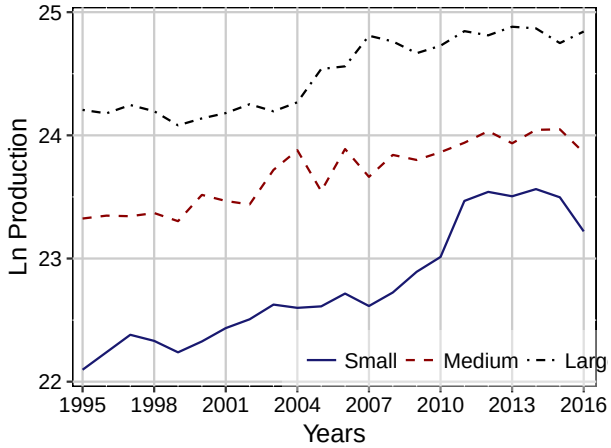
- We use data from the DANE Annual Manufacturing Survey (EAM) that covers the universe of Colombian firms with more than 10 employees
- 1995-2016

Growth and the variance-size relationship



- Most plants are small firms (less than 50 employees)

- Large plants have the highest share in total production



Stylized Facts

Plant Size Distribution

Log-Normal vs. Pareto

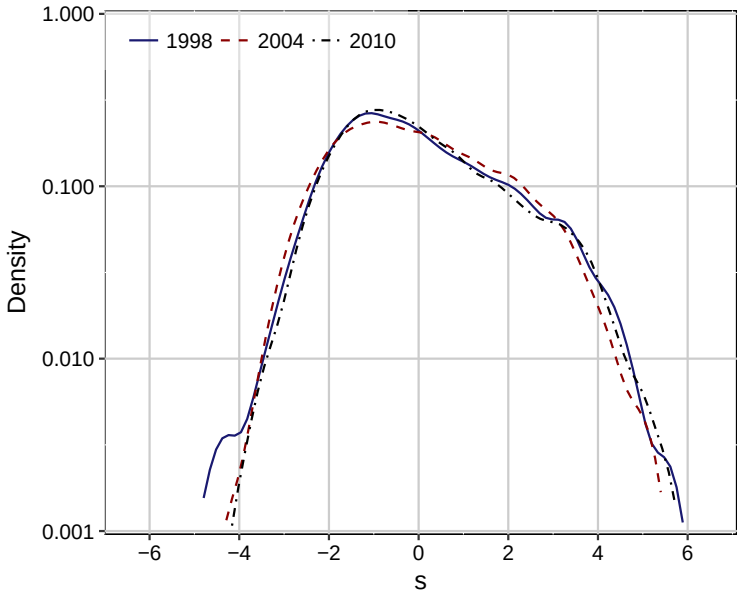
- In 1931 Gibrat showed that the size of French firms was distributed as a log-normal

$$\frac{x_t - x_{t-1}}{x_{t-1}} = \varepsilon_t$$

- Simon and Bonini (1958) showed that the log-normal distribution comes from a special case of a 'Yule' process, which takes into account the exit and entry of firms
- Ijiri and Simon (1964, 1967, 1971) applied this distribution to explain the size of US firms
- Axtell (2001) found a power law with ex-ponent $\alpha = 1.06 \pm 0.05$

Plant Size Distribution

Relative Size



$$s_{i,t} = \ln(Y_{i,t}) - \overline{\ln(Y_{i,t})},$$

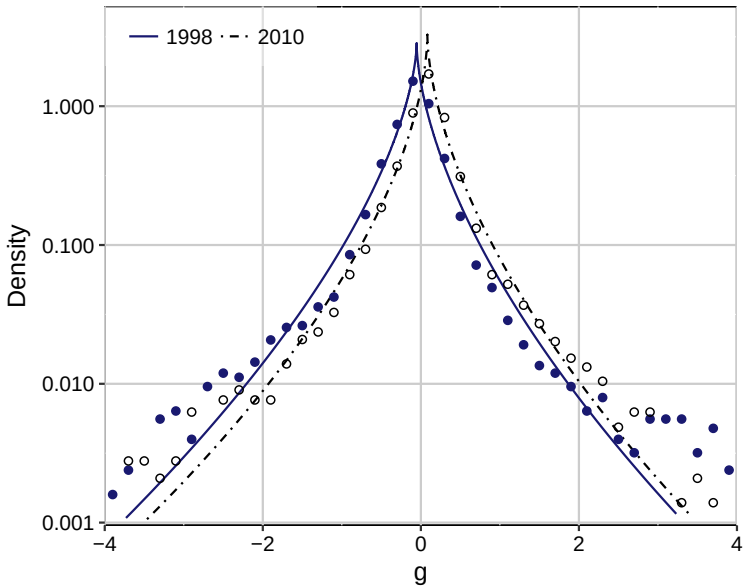
- High quantity of small plants and low quantity of large plants

Implications of Gibrat's idea

- Firms growth is independent of size
- The variance is constant for all sizes
- Growth rates must follow a normal distribution
- There is no autocorrelation in growth rates

Growth rates distribution

Growth rate

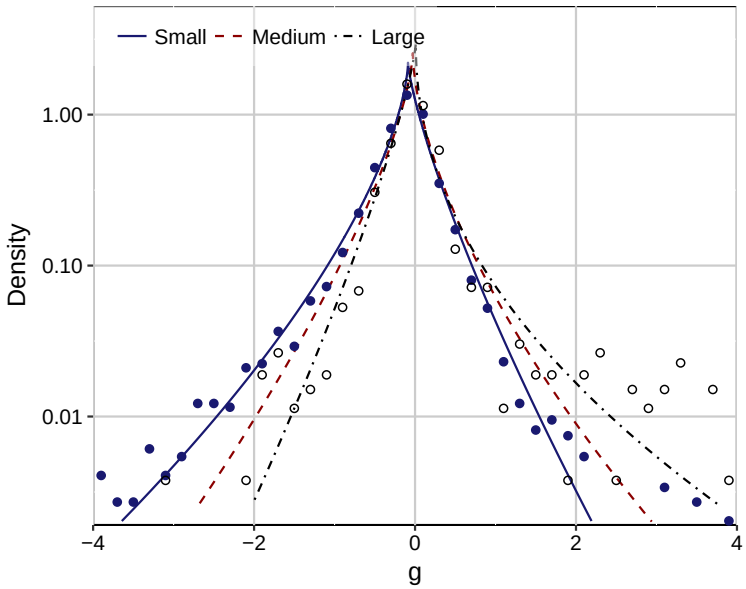


$$g_{i,t} = s_{i,t} - s_{i,t-1}$$

- Laplace distribution
- The probability of observing extreme events (both positive and negative) is higher compared to a Normal distribution

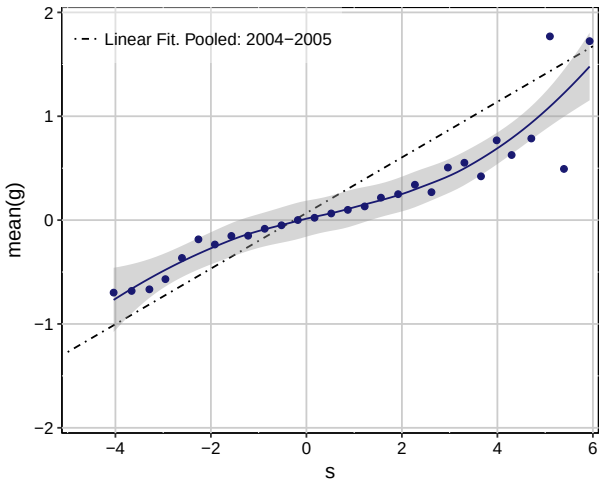
Growth rates distribution

Growth rate by plant size



- All types of plants have high volatility
- Small plants have more volatility in the left side: they are more frequently affected by negative shocks
- Large plants have more volatility on the right side: they face more often high positive shocks

Growth and the variance-size relationship. Bin statistics

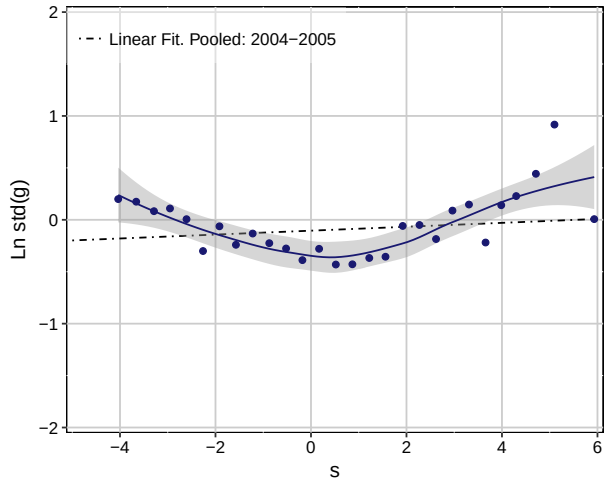


Average growth rates

- Large plants have higher growth rates
- Contradicts the empirical evidence

Standard Deviation

- Volatility is non linear
- Plants of different size are similarly affected by volatility



Modelling heteroscedasticity

- We aim to characterize the growth dynamics following

$$s_{i,t} = \gamma_1 s_{i,t-1} + \gamma_2 s_{i,t-2} + u_{i,t}.$$

- We take into account a possible heteroscedasticity of the residuals, then:

$$s_{i,t} = \alpha + \gamma_1 s_{i,t-1} + \gamma_2 s_{i,t-2} + e^{\beta s_{i,t-1}} \varepsilon_{i,t};$$

- We are interested in the parameter β:
  - $\beta = 0$ implies no heteroscedasticity: plants of different sizes face similar volatility
  - $\beta < 0$ implies larger plant face lower volatility than small plants
- We consider $\varepsilon_{i,t}$ Laplace-distributed. The Eq. can be solved by the Asymmetric Least Absolute Deviation approach

Modelling heteroscedasticity

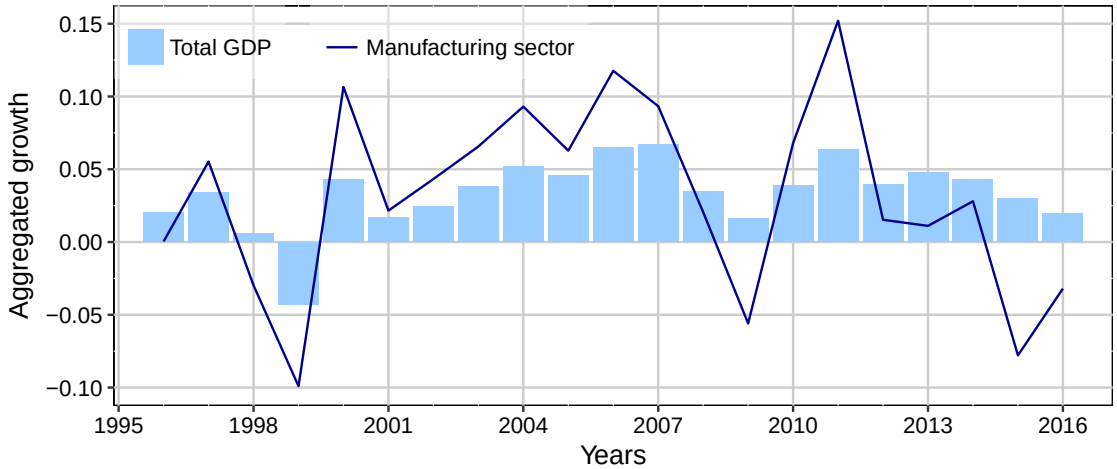
Year	β	$se(\beta)$	α	$se(\alpha)$	γ_1	$se(\gamma_1)$	γ_2	$se(\gamma_2)$
1996-2000	0.0416	0.0039	-0.0808	0.0046	0.9046	0.0078	0.0983	0.0079
2001-2005	0.2195	0.0038	0.1170	0.0056	0.9352	0.0066	0.0614	0.0063
2006-2010	0.1050	0.0037	0.0924	0.0042	0.9095	0.0065	0.0842	0.0066
2011-2015	0.0264	0.0032	-0.0379	0.0035	0.9400	0.0064	0.0601	0.0064

- For all the periods, β is always positive, which implies that there is no inverse relation between the size of firms and their volatility.
- This result contradicts previous findings to which $\beta \approx -0.15$ (Lee et.al. 1998)

Business cycle & the shape of the distribution of growth rates

Evolution of aggregated production growth rates

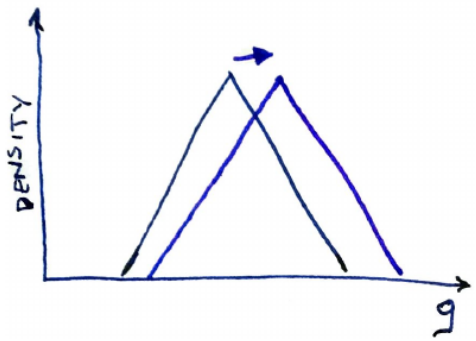
- Higson et al. (2002, 2004) analyze the effect of the business cycle for US and UK firms growth, finding that macroeconomic fluctuations affect the mean growth rate of firms
- The aggregated production of Colombian plants follows the BC in the first part of the period but not in the second part of the period



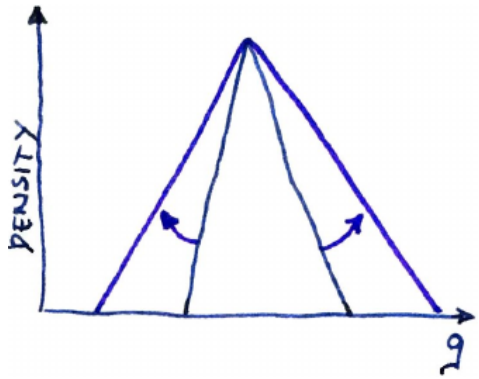
- Moreover, when we analyze the co-movement at the distribution level this evidence is difficult to accept

Business cycle and distribution of growth rates

Average (Mode) - pro-cyclical

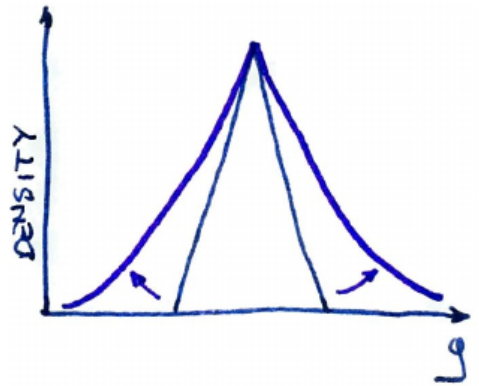


Std. Dev. - pro-cyclical



Skewness - counter-cyclical

Kurtosis - pro-cyclical



Business cycle and the distribution of growth rates

- We compute the moments of the distribution for the cross-sections and their correlation with the growth rates of the Colombian economy

Variable	All plants		Small plants		Medium plants		Large plants	
	corr.	p-value	corr.	p-value	corr.	p-value	corr.	p-value
Mean	0.38*	0.09	0.32	0.16	0.32	0.16	0.11	0.62
Std.Dev	0.34	0.13	-0.11	0.65	0.26	0.26	0.39*	0.08
Skewness	-0.08	0.71	-0.15	0.51	-0.05	0.82	-0.28	0.22
Kurtosis	0.21	0.35	0.49*	0.02	0.29	0.21	0.34	0.14

Conclusions

- Colombian plants are severely affected by volatility but:
  - Small plants show more difficulties to have a sustainable growth in the long run given that they are frequently affected by negative shocks and that they do not seem to recover during the positive cycles
  - Large plants are also affected by high negative growth rates during recessions but show higher positive growth rates during the booms compared to small plants
- This contrasts with the evidence for both developed and developing countries, where small plants tend to grow faster than large plants
- The relations between the business cycles and the different moments of the growth rates distribution are not always confirmed
- This can be related with the decrease in the share of the manufacturing sector in the aggregated product of the economy in the context of liberalization

Thank You!