

Quantitative Macroeconomics

Motivation: Firm Heterogeneity

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UnB

Motivation: Firm heterogeneity

- Firms are at the core of research in macro, international trade, industrial organization, labor, etc.
- Why should we treat them as one type or one single entity?
- What do we miss and what we gain?
- What type of heterogeneity should we consider?
 - ▶ Productivity?
 - ▶ Labor?
 - ▶ Capital?
 - ▶ Debt?
 - ▶ Demand for their products?

Motivation

Why should we model about firm heterogeneity:

- (i) Because that is the way the world is. ×
- (ii) Many policies likely affect one type of firm and not the others. ✓
- (iii) The firm-level data can be informative about many macro-questions. ✓
 - ▶ How the economy reacts to an aggregate shock.
 - ▶ Why some countries are poor and others are rich.

Firm Heterogeneity: Employment (US)

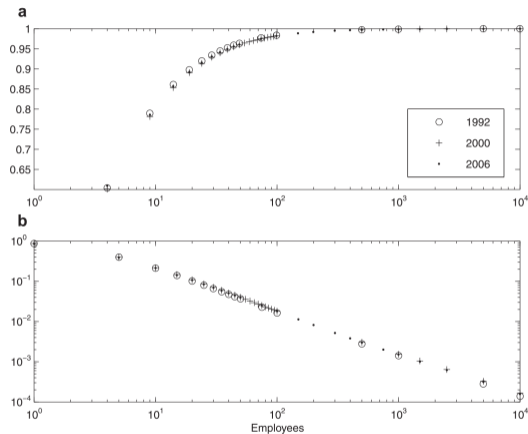


Figure 2

The firm size distributions reported by the Small Business Administration for 1992, 2000, and 2006.

Source: Luttmer (2010, Annual Rev. Econ).

Firm Heterogeneity: Employment (Portugal)

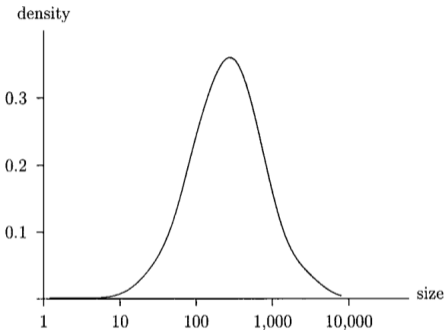


FIGURE 1. FIRM SIZE DISTRIBUTION, BASED ON EMPLOYMENT DATA FROM THE IF4 DATA SET

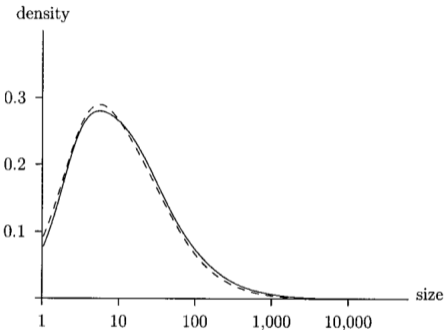
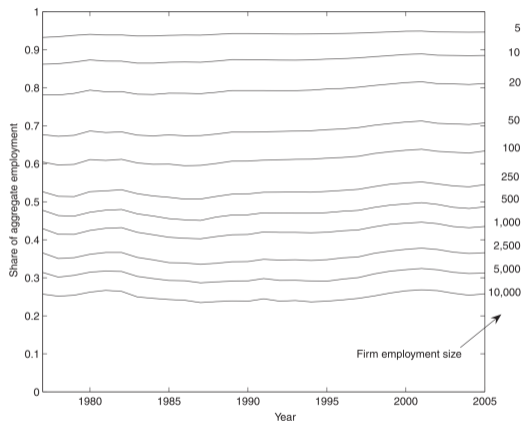


FIGURE 2. FIRM SIZE DISTRIBUTION IN 1983 (SOLID LINE) AND 1991 (DASHED LINE), BASED ON EMPLOYMENT DATA FROM THE *QUADROS DO PESSOAL* DATA SET

Source: Cabral and Mata (2003, AER).

Firm Heterogeneity: Employment (US)



Source: Luttmer (2010, Annual Rev. Econ).

Firm Size Distribution

- Firm size distribution (measured by employment) has a thick right tail.
- In the US (and many other countries), the firm size distribution follows the **Zipf's law**.
 - ▶ **Zipf's law**: the frequency of observation has an inverse relation to the rank.
- One-half of total employment is accounted for by 18,000 firms.
- A quarter is accounted for by the 1,000 or so firms with more than 10,000 employees.
- More than 80% of firms have less than 10 employees!

Firm Size Distribution

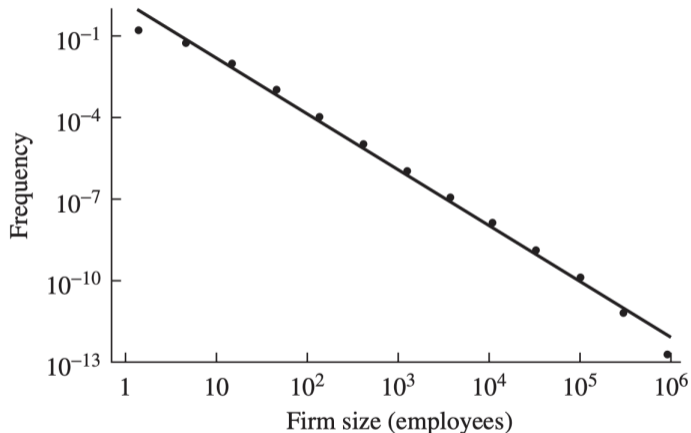
- Many economic (and natural) phenomena follow a power law of the form: $Y = kX^\alpha$.
 - ▶ Wealth, income, city-size, firm-size, word use, etc. See Gabaix (2009).
- The CDF and survival function (i.e, the tail) of the Pareto distribution:

$$F(x) = 1 - \left(\frac{x_m}{x}\right)^\alpha, \quad P[X > x] = \frac{k}{x^\alpha}, \quad \text{for } x \geq x_m$$

where $k = x_m^\alpha$.

- **Zipf's law** means that $\alpha \approx 1$. Firm size: $\alpha = 1.059$.
- There is some evidence that for large enough firms, the firm growth rate is independent of size (**Gibrat's law**)
 - ▶ This means that the growth of an individual firm is nonstationary!
 - ▶ But with small departures (i.e., frictions), we can get a stationary distribution consistent with Zipf's law and Gibrat's law.

Zipf Distribution of U.S. Firm Sizes



Source: Axtell (2001, Science).

Employment Reallocation across Firms (U.S)

Firm size is not fixed and there is a lot of heterogeneity in firm's growth rate.

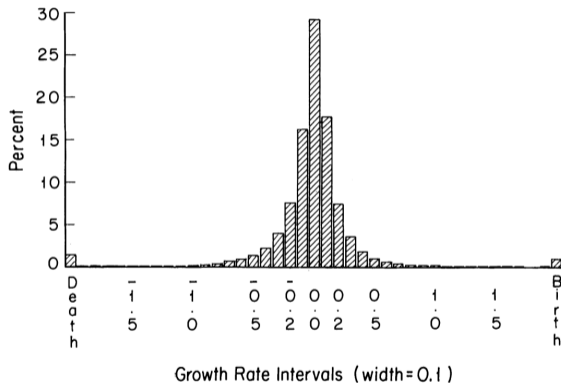


FIGURE 1b
Size-Weighted Growth Rate Distribution

Source: Davis and Haltiwanger (1992, QJE).

Job Reallocation across Firms (U.S)

- There is evidence that the reallocation is falling over time.
- **Job Reallocation** = Job Creation + Job Destruction of all firms.
 - ▶ Net Job Flows of firm i :
 $JF_{it} = \text{Hiring} - \text{Separations}$.
 - ▶ If $JF_{it} > 0 = \text{Job Creation}$.
 - ▶ If $JF_{it} < 0 = \text{Job Destruction}$.

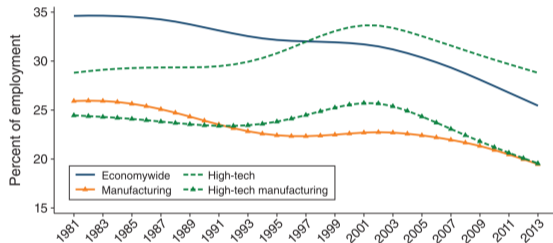


FIGURE 1. JOB REALLOCATION PATTERNS DIFFER BY SECTOR

Notes: HP trends using parameter set to 100. Industries defined on a consistent NAICS basis; high-tech is defined as in Hecker (2005). Data include all firms (new entrants, continuers, and exiters).

Source: LBD

Job Reallocation across Firms (U.S)

The **dispersion** of job reallocation is also falling over time.

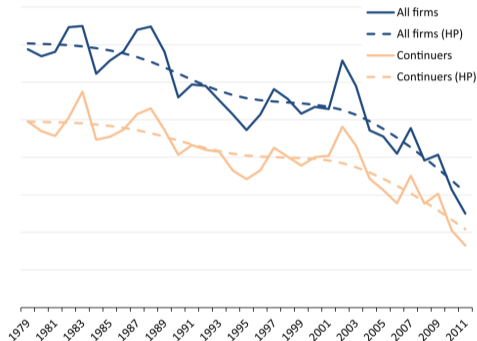


Fig. 1. 90–10 Differential in firm growth rates. *Note:* Y axis does not start at zero. The 90–10 differential is the difference between the 90th and the 10th percentile of the employment-weighted distribution of firm employment growth rates. HP filter uses parameter set to 100. Author calculations from the Longitudinal Business Database.

Source: Decker et al (2016, EER).

Job Reallocation across Firms

- Job reallocation is crucial for a healthy economy.
- The reallocation of jobs across businesses historically has reflected moving resources from less productive to more productive businesses.
- It may also reflect the fact that workers are reallocating to better matches.
- Less job reallocation implies in a less dynamic economy, low productive firms hoard too much labor.
- Another dimension of the dynamism of the economy is reflected in the **start-up entry** and the **life-cycle of firms**.

Firm Heterogeneity: Size vs Age (Portugal)

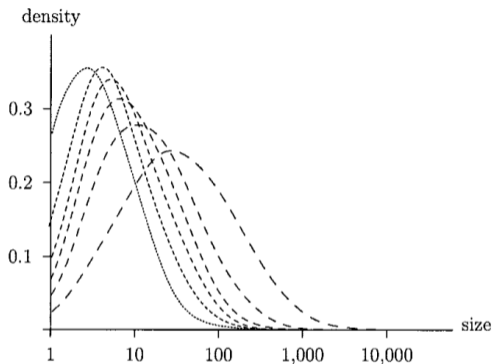
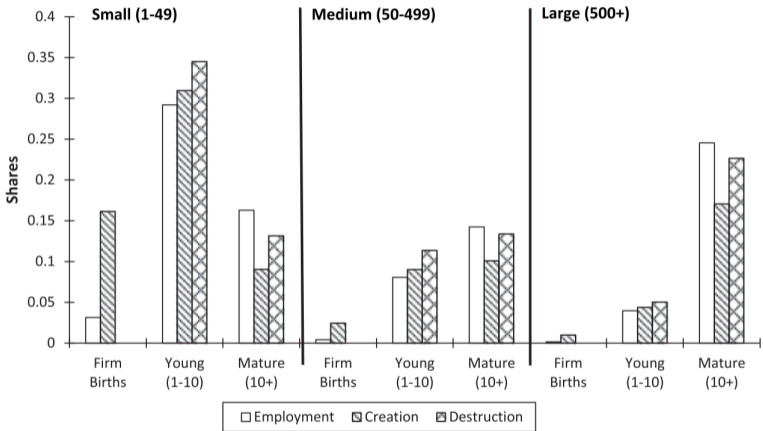


FIGURE 3. FIRM SIZE DISTRIBUTION BY AGE GROUP, BASED ON EMPLOYMENT DATA FROM THE *QUADROS DO PESSOAL* DATA SET

Note: Longer dash sizes correspond to older firms.

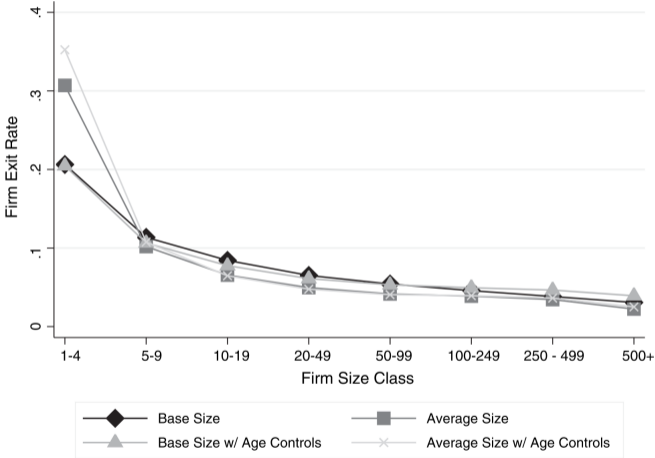
Source: Cabral and Mata (2003, AER).

Job Creation: Size vs Age (Brazil)



Source: Brummund and Connolly (2019).

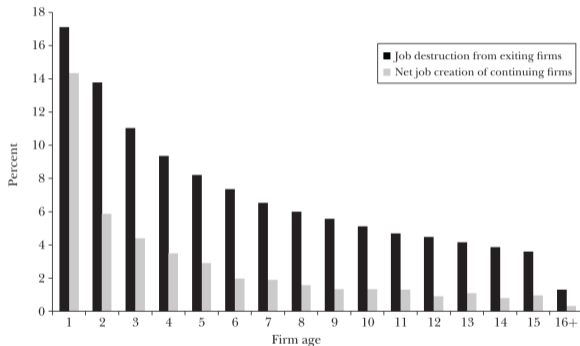
Exit Rate by Size (Brazil)



Source: Brummund and Connolly (2019).

Job Creation: Age

Figure 1
Up or Out Dynamics for Young Firms



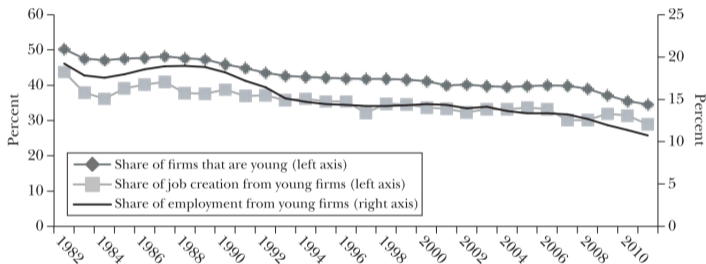
Source: Decker et al (2015, JEP).

Up or out: Young firms are responsible for most job creation and job destruction

The Importance of Young Firms is Declining (US)

Figure 4

Declining Share of Activity from Young Firms (Firms Age 5 or Less)

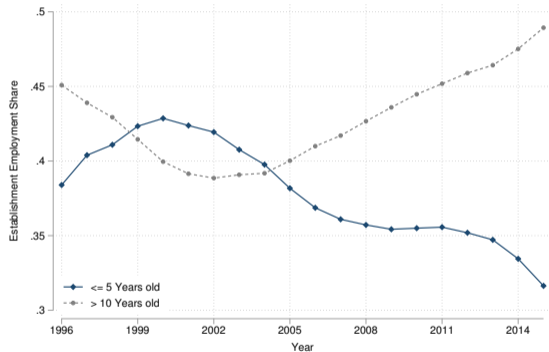
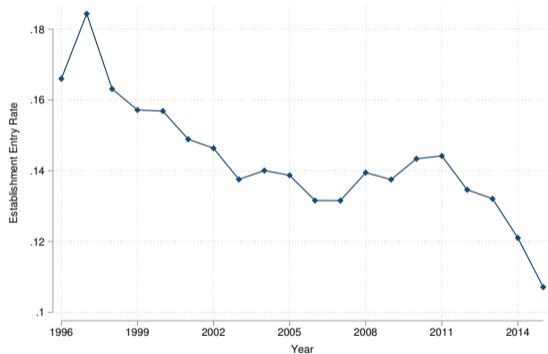


Source: Author calculations from the US Census Bureau's Business Dynamics Statistics.

Note: Employment shares in each period based on the average of employment in period $t - 1$ and t (the denominator of the Davis, Haltiwanger, and Schuh (1996) growth rate).

Source: Decker et al (2015, JEP).

The Importance of Young Firms is Declining (Brazil)



Source: Own Research.

Business Dynamism

- There is a decline in **Business and Employment Dynamism, and Entrepreneurship**.
 - ▶ Lower entry rate of start-ups.
 - ▶ Decline of job reallocation.
 - ▶ Low employment share of young firms.
- Not clear exactly why. An active area of research. Some hypothesis:
 - ▶ Decrease in labor supply (Karahan, Pugsley and Sahin, 2021; Hopenhayn et al, 2018).
 - ▶ Aging and consumer inertia (Bornstein, 2018).
 - ▶ Intangibles (De Ridder, 2019; Weiss, 2019)
 - ▶ Fixed costs (De Loecker, Eeckhout and Mongey, 2021) and increasing returns to scale (Chiavari, JMP).

Growth in Markups (US)

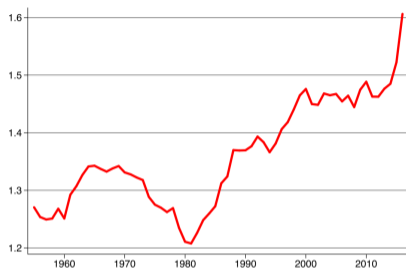


FIGURE I

Average Markups

Output elasticities θ_{st} from the estimated production function are time-varying and sector-specific (two-digit). The average is revenue weighted. The figure illustrates the evolution of the average markup from 1955 to 2016.

Source: De Loecker, Eeckhout and Unger (2020, QJE).

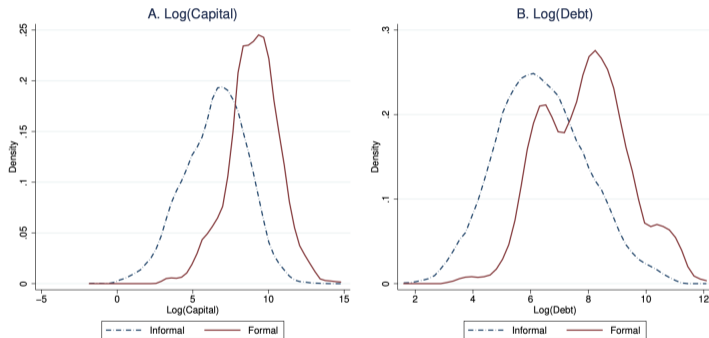
Growth in Markups: Large firms have more market power and profits are higher than in the past.

Heterogeneity in Capital

- Even conditional on size and age, firms are heterogeneous in another dimension such as capital.
- Why firms within the same industry with the same observed “TFP” have different capital intensity?
 - ▶ **Investment Adjustment Costs:** idiosyncratic shocks + adjustment costs make capital adjustment lumpy.
 - ▶ **Financial Frictions:** financial constrained firms cannot rent/buy capital to operate in optimal scale.

Dispersion in Capital and Debt in Small Firms (Brazil)

Figure 1: Distribution of Capital and Debt of Entrants



Notes: Smoothed densities of firms with less than one year old, and positive capital and debt by formal and informal. Log capital and debt are conditional on industry. Kernel function is Epanechnikov with bandwidth of 0.22. Source: ECINF 2003.

Source: Erosa, Fuster, and Martinez (2021, WP)

Aggregate Productivity and Misallocation

- Standard Growth Accounting exercises: $Y_t = Z_t K_t^\alpha L_t^\alpha$.
- How the heterogeneity helps to understand the difference across countries?
- TFP, Z shapes a lot of the differences. Two channels:
 - (i) Differences in the adoption of best technologies (i.e., countries are far from the frontier).
 - (ii) Differences in the extent to which resources are allocated efficiently.
- Models that start with an aggregate production function cannot distinguish between the two.
- Where misallocation shows up?

Plant Growth during Life Cycle

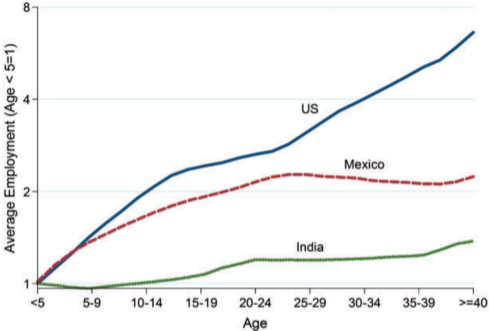


FIGURE I

Plant Employment by Age in the Cross-Section

Data from 2010–2011 ASI-NSS (India), 2003 Economic Census (Mexico), and the 2002 Manufacturing Census (United States). Employment in the youngest group (age < 5 years) is normalized to 1 in each country. The figure gives employment per operating plant versus plant age in the cross-section. In Mexico, employment includes paid and unpaid workers at fixed-location establishments. For the United States, employment covers all manufacturing establishments with at least one employee.

Source: Hsieh and Klenow (2014, QJE).

Size-dependent Policy: France

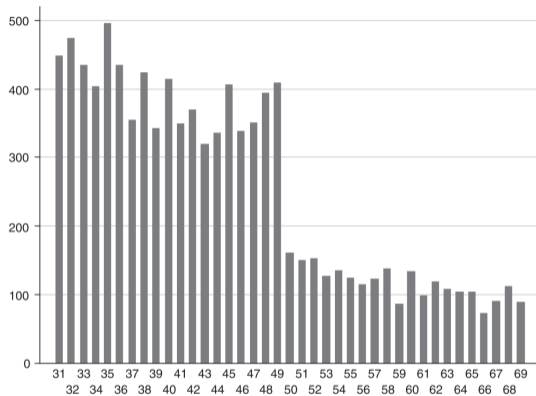


FIGURE 2. NUMBER OF FIRMS BY EMPLOYMENT SIZE IN FRANCE

Source: Garicano, Lelarge and Van Reenen (2016, AER).

Size-dependent Policy: regulations that increase labor costs when firms reach 50 workers.

This

Size-dependent Policy: Informality (BR)

Informality: Acts as a size-dependent policy since disproportionately benefits small businesses.

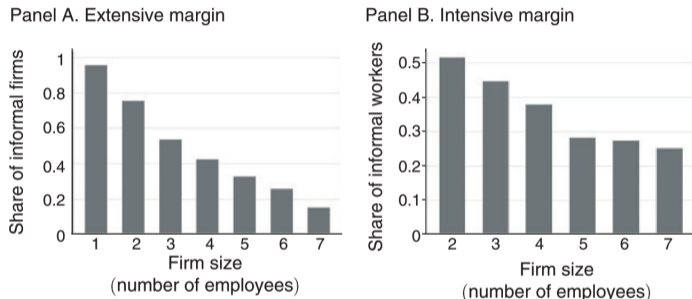


FIGURE 2. INFORMALITY MARGINS AND FIRMS' SIZE

Notes: Panel A shows the share of informal firms among firms with size $n = 1, \dots, 7$ (where size is measured as number of employees). Panel B shows the average share of informal workers within formal firms, among firms with size $n = 2, \dots, 7$.

Source: Ulyssea (2018, AER).

Size-dependent Policy: Informality (BR)

Table 2: Employment Share by Worker and Firm Informality Status and Firm Size

Worker-Firm Status	≤ 5	≥ 6 and ≤ 10	≥ 11 and ≤ 50	≥ 51	All Firms
Formal Worker in Formal Firm	42.48	69.99	82.95	91.36	78.02
Informal Worker in Formal Firm	25.76	20.35	13.79	7.54	13.80
Informal Worker in Informal Firm	31.75	9.66	3.27	1.11	8.18
Total Employment Share	17.84	13.85	19.72	48.59	100.00

Notes: Employment share by worker and firm formality status and firm size. Urban paid employees in private firms only. Size is defined by the number of paid employees. Source: PNAD-C 2012.

Source: Erosa, Fuster and Martinez (2021, WP).

Firm Structure and Managers

TABLE 1—ESTABLISHMENT SIZE AND MANAGERIAL EMPLOYMENT IN THE UNITED STATES AND INDIA

	Establishment size					Employment share of outside managers
	Average employment	1–4 employees		≥100 employees		
		Share	Employment share	Share	Employment share	
United States	42.7	32.8%	1.8%	8.8%	65.5%	12.5%
India	2.7	93.0%	54.8%	0.1%	18.6%	1.65%

Notes: The table contains summary statistics from the firm size distribution in the United States and India. The US data come from the BDS in 2012, and the data for India come from the NSS and ASI in 2010. In the last column, we report the share of outside managers, that is, all workers who are classified as managers according to the occupation classification ISCO and who are hired as wage workers. These data stem from IPUMS.

Source: Akcigit, Alp and Peters (2021, AER).

Modeling Heterogeneity

- We want a model that are able to capture most of these characteristics.
- Backbone models:
 - ▶ Lucas (1978) span of control model.
 - ▶ Hopenhayn's (1992) industry dynamic model.
 - ▶ Melltz (2003) monopolistic competition model a la Dixit & Stiglitz .
- Extend the models when necessary.