



# From a theoretical oligopolistic model to a generative agent-based simulation

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# Outline

A book on *Rethinking Macroeconomics with Endogenous Market Structure*

Starting questions

Theoretical analysis

Main assumptions

Outputs and aggregate demand

Equilibrium in the market

## Starting questions

- Do entry, exit and changes in market structure affect the macroeconomy?
- Is there a link between the strategic interactions among oligopolistic firms and the macroeconomic equilibrium?

This questions are certainly not trivial in modern economies, where large oligopolistic firms play a relevant role and so many meetings among statesmen have the explicit scope of promoting contracts for some large and important firms of their countries.

However, surprisingly enough, the most popular theoretical models in the modern macroeconomic literature hardly see any explicit formalization for the macroeconomic effects of changes in market structure, entry, exit and strategic interactions among oligopolists.



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Mazzoli, M., Morini, M., and Terna, P. 2019. *Rethinking Macroeconomics with Endogenous Market Structure*. Cambridge University Press.

## Interactions among oligopolistic firms

We introduce a new macromodel where entry, exit and strategic interactions among oligopolistic firms are explicitly formalized and may generate macroeconomic fluctuations.

About macroeconomic impact of business formation we refer to Gabaix (2011). His “granular hypothesis” was initially studied by Jaimovich and Rebelo (2009).

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Gabaix, X. 2011. The granular origins of aggregate fluctuations. *Econometrica*, **79**(3), 733–772.

Jaimovich, N., and Rebelo, S. 2009. Can news about the future drive the business cycle? *American Economic Review*, **99**(4), 1097–1118.



## Outputs

The output of each firm is given by the production function, where  $\psi_{i,t}$  is a positive or negative shock:

$$\varphi_{i,t} = \Lambda L_{i,t}^{\alpha} + \psi_{i,t} \quad (1)$$

Summing up, with  $P_t$  the aggregate price level (as weighted average of firms' prices) and having  $\psi_{i,t}$  a zero average:

$$Y_t = P_t \Lambda \sum_{i=1}^{H_t} L_{i,t}^{\alpha} \quad (2)$$

$H_t$  is the total number of oligopolistic firms operating at time  $t$ ;

$\Lambda$  the usual constant parameter capturing technology shocks;

$L_{i,t}$  the total amount of labour employed at time  $t$  by firm  $i$ ;

$\psi_{i,t}$  an idiosyncratic stochastic shock reflecting (i) the Cournot-Nash equilibrium among the oligopolistic firms is in mixed strategies, herefore stochastic, plus unpredictable events (e.g., conflicts with the workers).

## Aggregate demand

The microfounded optimization problem of the heterogeneous consumers with the same preferences but different budget constraint (depending on whether they are workers, new entrants or incumbent entrepreneurs) yields the following aggregate demand:

$$D(\cdot)_t = \frac{\Omega(R_t)}{P_t} \{A_t + ((1 + r_t)(1 + \iota)^{-1} \sum_{i=0}^{\infty} [(1 + E(r_{t+i})(1 + \iota))]^{-i} \cdot E(n_{t+i}(W_{t+i} + h_{t+i}^e \Pi_{t+i}^e + h_{t+i}^{in} \Pi_{t+i}^{in})))\} \quad (3)$$

$\Pi_{t+i}^{in}$  and  $\Pi_{t+i}^e$  are the nominal profits of the incumbent and new entrants entrepreneurs;  
 $r_t$  is the real interest rate at time  $t$ ;  $R_t$  is the nominal interest rate on the financial asset at time  $t$  (controlled by the central bank);  $\iota$  is the «core» inflation rate, assumed to be constant under a given monetary policy regime;

$W_{t+i}$  the nominal wage at time  $t + i$ ;  $n_{t+i}$  the total number of employed individuals at time  $t + i$ ,  
 $h_{t+i}^{in}$  and  $h_{t+i}^e$  the portion of incumbent entrepreneurs and new entrant over the total labor force;  
 $P_{t+i}$  the price level emerging in the oligopolistic industrial sector (which is also the aggregate price level since we have an indifferenced good);

$\Omega$  a monotonically increasing function in the nominal interest rate.



## Equilibrium (1/2)

- ◇ Since the labor contracts establish the amount of hours to be worked by each worker, the labor is a sunk cost and, as a consequence, there is no need to distinguish between capacity and output decision.
- ◇ A few assumptions guarantee the existence of the aggregate equilibrium in the goods market.
- ◇ These assumptions correspond to those contained in Madden (1998), showing that, with a uniformly elastic demand function, the K-S-M two-stage quantity-price game reduces to the Cournot model.

Madden, P. 1998. Elastic demand, sunk costs and the Kreps-Scheinkman extension of the Cournot model. *Economic Theory*, **12**(1), 199–212.



## Equilibrium (2/2)

- ◇ With Osborne and Rubinstein (1994, p.39):
  - mixed-strategy equilibria are stochastic steady states, as
  - each occurrence of the game takes place after  $n$  players are randomly chosen from different populations.
- ◇ The interpretation is consistent with the assumptions of our model, as
  - the firms interacting in the market, due to entry and exit, are not the same in each occurrence of the game
  - and since entry and exit are affected by stochastic shocks, the firms existing in each time  $t$  are chosen stochastically.
- ◇ The amount of work hired by each firm constitutes a capacity constraint, on the basis of the labor contracts set for time  $t$ , until time  $t + 1$ .
- ◇ The quantities decided by the firms, instead of being commodities, are “contracts”, i.e., “commitments” to sell commodities to the customers. Commitments are subject to stochastic shocks.

Osborne, M., and Rubinstein, A. 1994. A Course in Game Theory. *MIT press*.