Structural Change of Production and Consumption
A Micro–Macro Growth Model

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Project research question(s)

- How do we account for long term differences in income growth, and increasing divergence in cross–country wealth?
- To what extent changes in the structure of supply and demand affect economic growth & distribution?
- Which are the microeconomic explanatory mechanisms?
- Which are the microeconomic constituents on which we may play policies, and on which we can not?
How do we account for long term differences in income growth, and increasing divergence in cross-country wealth?

To what extent changes in the structure of supply and demand affect economic growth & distribution?

Which are the microeconomic explanatory mechanisms?

Which are the microeconomic constituents on which we may play policies, and on which we can not?
How do we account for long term differences in income growth, and increasing divergence in cross–country wealth?

To what extent changes in the structure of supply and demand affect economic growth & distribution?

Which are the microeconomic explanatory mechanisms?

Which are the microeconomic constituents on which we may play policies, and on which we can not?
Outline of the presentation

1. Introduction
   - Literature(s)
   - Methodology
2. The Model
3. Extensions and discussion
Aim(s) of the paper

1. Investigate the micro–mechanisms behind the effect of structural changes of supply and demand on economic growth & distribution

   S–1 Composition of production
   S–2 Organisation of production
   D–1 Income distribution
   D–2 Consumption patterns

2. An agent–based micro foundation of aggregate growth: evolution of production (technology, organisation) \(\iff\) change of income structure \(\iff\) evolution of consumption (e.g. needs)
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Where do we start from?

1 The ‘old’ school: growth as affected by changes in the structure of the economy [Pasinetti, 1981, Sirquin, 1988, Cornwall and Cornwall, 1994]

2 The recent contributions:
   - Growth as evolution [Nelson and Winter, 1982, Silverberg and Verspagen, 1995, Metcalfe et al., 2006]
   - Structural change as product variety [Saviotti and Pyka, 2004, Saviotti and Pyka, 2006]
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3 Patterns of consumption in terms of evolution of needs
   • User characteristics of goods

4 The Kuznets legacy: growth and distribution
   • Sectoral specialisation and wage level
     [Prebish, 1950, Kaldor, 1966]
   • Firms’ organisation and wage distribution
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  [Prebisch, 1950, Kaldor, 1966]
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The use of simulation models

- The evolution of an economic system depends on the behaviour of agents (inter)acting at different levels
  - Micro: production/organisation, innovation, consumption
  - Meso: sector composition, IO relations, industrial dynamics
  - Macro: growth, employment, income distribution

- Simulation models
  - Define logically consistent *ceteris paribus* conditions, that define interacting behaviour
  - Explain (unexpected) emergent properties
  - Test scenarios

- Robust statistical evidence for model assumptions rather than outcomes
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Model structure: the economy

- **Firms**: product technology, process technology, organisation
- **Capital suppliers**: R&D, vintage, process technology, organisation
- **Consumers**: preferences, consumers classes
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Firms’ production

- Each firm $f \in [1; F]$ produces one good defined in terms of a vector of $n \in [1; N]$ needs covered, with $m_n \in [1; M_n]$ characteristics (↔ endogenous definition of sectors)

- Production plans adjust to: expected sales ($Y_t^e$), desired stocks ($\bar{S}$) and uncovered demand (backlogs) ($Bl_{t-1}$)

$$Q_t^d = \max \left\{ \bar{S} - S_t + Y_t^e + Bl_{t-1}; 0 \right\}$$

- Backlogs raise from labour and capital constraints

$$Q_t = \min \left\{ Q_t^d; A_{t-1}L_{t-1}; \bar{B}K_{t-1} \right\}$$

where $A_{t-1}$ is the labour productivity embedded in capital vintages
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Demand for first tier workers inertially adjusts to production plans, productivity and employment reservoir ($u^l$).

$$L_t^1 = \epsilon_L L_{t-1}^1 + (1 - \epsilon_L) \left[ \left( 1 + u^l \right) \frac{1}{A_{t-1}} \min\{Q_t^d; \bar{B}K_{t-1}\} \right]$$

Firms need a worker to manage every batch of $\nu$ workers/employees/managers subordinates.

$$L_t^2 = L_t^1 \nu^{-1}$$

$$\vdots$$

$$L_t^\Lambda = L_t^1 \nu^{1-\Lambda}$$

where $\Lambda$ is the number of layers to manage the firm.

The total number of workers is the sum.
Firms’ workforce

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Capital and investment

- Cumulated profits are allocated to capital, product innovation and dividends (residual)
- Investment decision of new capital units is unconstrained

\[ k_t^e = (1 + u^k) \frac{Y_t^e}{\bar{B}} - K_{t-1} \]

- Increases the capital stock \( K_t \)
- Increases the efficiency of production

\[ A_t = \sum_{\tau=0}^{t} \frac{k_{\tau}(1 - \delta)^{t-\tau}}{K_t} a_{\tau} \]

- \( \delta \): depreciation; \( a_{\tau} \): vintage productivity
- modifies technology and structure of work force
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Firms order capital units to a supplier with a compatible technology, selected according to:

- productivity embodied,
- price and
- standing orders

The new capital units are delivered when the supplier has fulfilled the standing orders.
Capital and investment: user/supplier relations

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  - productivity embodied,
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Capital suppliers

1. Capital goods characteristics: vintage, productivity, technology type
2. Demand: current and past orders
3. Supply/Production: fulfil received orders with a FIFO rule
4. Allocate profits to process innovation:
   - Employ engineers
   - R&D as a random process à la N&W
Wages, dividends and prices I

- A minimum wage $w^m$ is negotiated at the macro level:
  - labour market (continuous)
  - inflation and productivity (discrete)

- Firms bargain a wage $w^1$ for the lower layer and pay a multiple to executives, which increase along the hierarchical structure (organisation)

$$
\begin{align*}
  w^1_t &= \omega w^m_{t-1} \\
  w^2_t &= bw^1_t \\
  \vdots \\
  w^\Lambda_t &= b^\Lambda w^1_t.
\end{align*}
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$\omega$: firm bargain; $b$: executive increase
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$\omega$: firm bargain; $b$: executive increase
Wages, dividends and prices II

- Executives benefit from a **bonus** compensations \( \psi^l \) as a share of cumulated profits

\[
\psi^l_t = \frac{\sum_{l=1}^{\Lambda} w^l_t}{\sum_{l=1}^{\Lambda} w^l_t} R^D_t
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\( R^D \): available resources devoted to premia

- Price is determined as a mark–up on unitary variable costs (wages bonuses and dividends)
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**Demand structure**

- **Income classes:** distribution of wages and dividends

  - Aggregate demand depends on the distribution of consumers classes

  - Demand from each class depends on:
    - Share of consumers population
    - Distribution of disposable income within the class boundaries
    - Distribution of consumers’ needs within the class, among existing products
    - Evaluation of products: consumers’ preferences, information on product characteristics and level of tolerance to substitutability
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Consumption and consumers’ behaviour

- Consumers perceive a level of quality per product characteristic reflecting the actual quality to different degrees (depending on their information set). Price is one of the qualities.

- Consumers’ preferences are given by the ranking of the characteristics; consumers select those firms that are able to provide characteristics ranked not below a tolerance level with respect to the maximum available in the market.

- They rule out from their choices all firms scoring below a price/quality threshold level on any of the characteristics. If none of the firms matches their requirements, no purchase occurs.
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Negligible micro difference have a non-negligible impact on macro evolution.

- The degree of ‘ignorance’ of individual consumers, *ceteris paribus*, generates significant differences in firms’ productivity \(\rightarrow\) market structure.

- The heterogeneity among consumer classes generate technological differences among firms.

- Product, process and organisational innovation strategies, in turn, modify aggregate consumption patterns via changes in distribution of dividends and profits.

\(\Rightarrow\) Demand feedbacks occur on firms investment, innovation, performance and growth.
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Where the model is going (or how to use the model)

Analysis

- The role of skill bias
- Short term adjustments: trade–off between price and innovation strategy

- Changes in the production and organisation structure
  - Organisational innovation (vertical scope outsourcing)
  - Input–output relations at the firm level
  - Skill composition of labour

- Degrees of radicality in product innovation and consumption patterns
  - Changes in capital goods (e.g. ICT)
  - Changes in skills and earnings/income as affecting...
  - ... Changes of needs and imitation across classes
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How do workers generate product innovation (other than capital)?

- Which skill for which technology: process but also product

- Relation between income and consumer classes
  - Wage, type of work, peers....

- Evolution of consumption patterns
Evidence from [Abowd et al., 2007]

- Relevance of heterogeneity
  - Technology
  - Organisation

- The relevant relation between change in vintage and skills
- Strong evidence that we cannot model skilled vs unskilled
- Separate LBD from HK
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Questions rising from [Abowd et al., 2007]

- Which skill for which vintage? A linear relation? Is there a ceiling?
  - So much change in only 5 years...
- Skills of whom, at which layer? Workers or top managers?
- How does the wage structure relates with skills?
  - Evidence of high intra–skills and low inter–skill wage differences
- Are top managers more skilled than specialised first layer workers?
  - With which skill indicator?
- Evidence on other innovation than process?
- Are not computers easy to use?
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Questions rising from [Abowd et al., 2007]

- Which skill for which vintage? A linear relation? Is there a ceiling?
  - So much change in only 5 years...
- Skills of whom, at which layer? Workers or top managers?
- How does the wage structure relates with skills?
  - Evidence of high intra–skills and low inter–skill wage differences
- Are top managers more skilled than specialised first layer workers?
  - With which skill indicator?
- Evidence on other innovation than process?
- Are not computers easy to use?
Data required (for robust assumptions)

- **Supply**
  - Engineers and R&D and/or skills and product innovation
  - Causal relation in firms vertical organisation (why do firms specialise or integrate?)
  - Layers and wage multipliers

- **Demand**
  - Innovation and consumption
  - Diffusion of consumption patterns
  - Wage classes and consumption
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- **Supply**
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- **Demand**
  - Innovation and consumption
  - Diffusion of consumption patterns
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What about

- Open economies: how do we compare the skills of a Chinese worker manufacturing computers, cars, etc, with a US specialised worker? Which is the difference in wage?
  \[ \Rightarrow \] Are wages related to skills in this sense?
- Demand pull vs. supply push: skills to buy and skills to produce
  - Capital vintage
  - Final product
References I


References II


References III


References IV


References IX

