Production Networks and the Wealth Distribution

Niccolò Battistini[1] Stefano Grancini[2] Martin Spitzer[1]

[1]European Central Bank
[2]Nova School of Business and Economics

EEA Bordeaux
25 August 2025

Outline

Motivation

- Rising interest in role of **heterogeneity** on the firm side (sectoral disaggregation) and household side (income and wealth distribution)
- These dimensions are often explored in **isolation**, with some **exceptions**:
  - **Empirical**: Globalisation (global supply chains/trade) influences wage inequality within countries and occupations and wealth inequality (Goldberg and Pavcnik, 2007; Costinot, Vogel and Wang, 2012; Helpman et al., 2017)
  - **Theoretical**: Input-output networks matter for impact of labor market policies on inequality (Bernon, Konings and Magerman, 2022) and transmission of monetary and fiscal policies across households (Schaab and Tan, 2023)

  In a nutshell, production structure $\Longleftrightarrow$ factor prices $\Longleftrightarrow$ income/wealth distribution
- In this paper, we focus on the **relationship** between:
  - **Production network intensity**, i.e. reliance on cross-sectoral input-output linkages, measured by the expenditures on intermediate inputs from different sectors as a share of total expenditures on intermediate inputs
  - **Liquid assets inequality**, measured by the Gini or Top 10% share of liquid assets (deposits)

Our questions, methods, and answers

Our questions

- Do production networks shape the wealth distribution and inequality?
- If so, what are the channels?

Our methods

- Empirical evidence via panel regressions with fixed effects on EU countries
- Rationalization via a heterogeneous agents model with production networks

Our answers

- Higher production network intensity leads to lower wealth inequality
  - Higher production network intensity tends to lead to higher prices relative to wages
    - ⋆ Feedback loop between wages and prices amplifies markups and reduces real wage
  - Lower real wage leads to lower wealth, higher interest rates, and lower inequality
    - ⋆ Role of heterogeneous propensity to save: $\downarrow$ Real wages $\Rightarrow \downarrow$ Savings $\Rightarrow \downarrow$ Wealth inequality

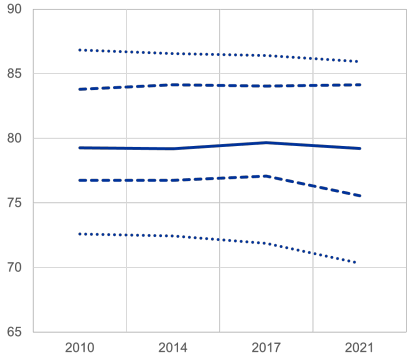
Outline

Stylized facts - Visual inspection

- Limited aggregate time variation, but large cross-country heterogeneity in both measures

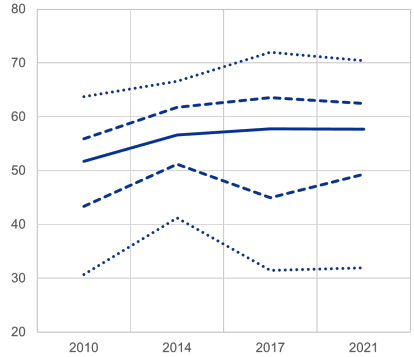
Production network intensity

(Off-diagonal share of intermediate inputs, %)



Top 10% liquid assets

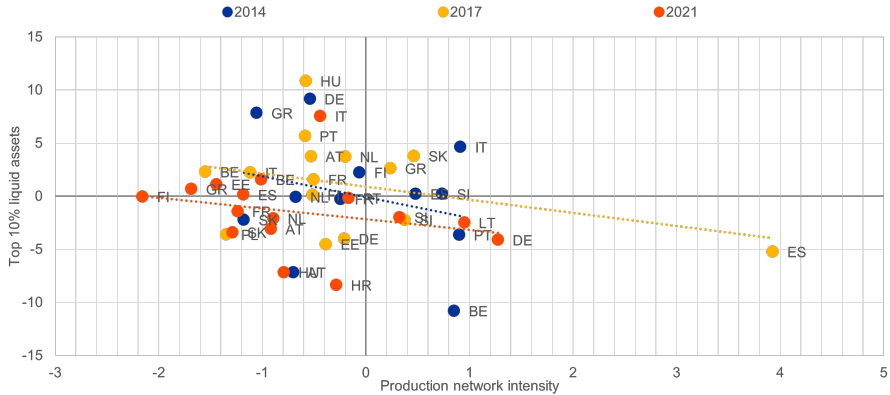
(share of total liquid assets, %)



Source: Eurostat's FIGARO Input-Output tables and ECB's Household Finance and Consumption Survey. Notes: The chart is based on statistics for a varying panel of countries over time, including, in its largest composition, Germany, France, Italy, Spain, the Netherlands, Austria, Belgium, Finland, Ireland, Portugal, Greece, Slovenia, Croatia, Lithuania, Latvia, Estonia, Sweden, Denmark, Bulgaria, Romania, Poland, Czechia, Hungary. The solid line depicts the cross-country median, while the dashed (dotted) lines indicate the 25th and the 75th (10th and 90th) percentiles of the cross-country distribution.

Stylized facts - Visual inspection

- Negative relationship b/w intensity and inequality across countries and over time



Source: Eurostat's FIGARO Input-Output tables and ECB's Household Finance and Consumption Survey. Notes: The chart shows the first differences (from one wave to the other) in production network intensity (x axis) and top 10% share of liquid assets (y axis) for each wave, namely 2014 (vs 2010), 2017 (vs 2014) and 2021 (vs 2017).

Stylized facts - Econometric analysis

Methodology

- Estimate the following relationship:

$$y_{i,t} = \alpha_i + \beta x_{i,t} + \gamma z_{i,t} + \epsilon_{i,t} \tag{1}$$

  where $y_{i,t}$ denotes an inequality measure (Top 10% share, Gini coefficient) or the real wage, $x_{i,t}$ refers to production network intensity (off-diagonal share of intermediate inputs) and $z_{i,t}$ denotes control variables

- Panel regressions with country fixed effects and robust standard errors

Data

- Eurostat's FIGARO Input-Output tables industry-by-industry (2010-2022)
- Eurosytem's Household Finance and Consumption Survey (2010, 2014, 2017, 2021)
- EU countries (different subsets)

Stylized facts - Econometric analysis

Results

	Liquid assets		Real wages
	Top 10%	Gini	
Production network intensity	-1.524***	-1.037**	-0.852*
	(0.480)	(0.384)	(0.431)
Obs.	59	59	324
F-stat p-value	0.01	0.03	0.00

Notes: Controls include other characteristics of the production structure (labor share of total output, sectoral concentration). All regressions include country fixed effects. Numbers in parentheses refer to robust standard errors.

- $\uparrow$ Production network intensity (1pp) $\iff$ $\downarrow$ Wealth inequality (-1.5pp Top 10% share)
- Rationalizing these results in two steps:
  - $\uparrow$ Production network intensity (estim: 1pp) $\iff$ $\downarrow$ Real wages (estim: -0.9%)
  - $\downarrow$ Real wages $\iff$ $\downarrow$ Wealth inequality

Outline

Model

Households: $\max_{c_{it}, n_{it}, a_{it}} U(c_{it}, n_{it}) \quad \text{s.t.} \quad c_{it} + a_{it} = (1 + r_t) a_{it-1} + y_{it} - \tau_t$ Households

Firms: $Y_{jt} = A_{jt} N_{jt}^{1-\sum_k \omega_{jk}} \prod_k X_{jkt}^{\omega_{jk}}$ Firms

Government: $\tau_t = (1 + r_t) B_{t-1} + \frac{P_t^G}{P_t^C} G_t - B_t$ Government

Market clearing:

- Goods: $Y_{jt} = C_{jt} + G_{jt} + \sum_{k=1}^{S} X_{jkt}$
- Assets: $\int a_{it} \, d\mu_t(a, e) = B_t$
- Labor: $\int e_{it} n_{it} \, d\mu_t(a, e) = \sum_{j=1}^{J} N_{jt}$

Definitions

Equilibrium: Solve in steady state to clear asset and labor markets

Baseline and counterfactual calibration

- Calibrate **baseline** on the euro area economy (FIGARO, HFCS, Eurostat)
  - β and ϕ set to clear asset market and labor market

Table: Matching key distributional moments in the baseline model.

	Wealth Gini	Top 5 %	Next 5 %	Bottom 50 %	Avg. quarterly MPC
EA 2021 (data)	0.730	0.430	0.160	0.043	0.25
Baseline (model)	0.722	0.311	0.182	0.024	0.24

Calibration details

- Calibrate **counterfactual scenario** with zero production network intensity to zero
  - Set $\tilde{\omega}_{jk} = 0$ for $j \neq k$ and $\tilde{\omega}_{jk} = \sum_k \omega_{jk}$ for $j = k$
  - Keep labor intensity and sectoral concentration unchanged
  - W and r set to clear asset market and labor market

Outline

Production network intensity $\rightarrow$ Real wages (1/2)

Analytical derivation

Set-up

- Note that optimal conditions for labor and intermediate input demand imply:

$$\ln \mathbf{w}(\Omega) = -\mathbf{L}(\Omega) \ln \mu$$

where $\mathbf{L}(\Omega) = (I - \Omega)^{-1}$ denotes the Leontief inverse of $\Omega = \{\omega_{jk}\}$, $\mathbf{w}(\Omega) = \{w_j\}$ $= \{W/P_j\}$ the associated vector of real wages, and μ the vector of sectoral markups:

$$\ln \mathbf{w}(\Omega) = -c\, \mathbf{v}(\Omega)$$

with $\mathbf{v}(\Omega) = \{v_j\}$ a vector of sectoral multipliers and $c = \ln \mu > 0$ a scalar

- Let $\Upsilon(\Omega) = \sum_{j \neq k} \omega_{jk} / \sum_{\forall j,k} \omega_{jk}$ denote production network intensity

Production network intensity → Real wages (2/2)

Analytical derivation

Proposition

- Consider two irreducible, nonnegative matrices Ω_0 and Ω_1, such that $\Omega_1 = \Omega_0 + \Delta$, with $\sum_k \Delta_{jk} = 0, \Delta_{jk} \geq 0$ $(j \neq k)$, and $\Delta_{jj} \leq 0$ and thus $\Upsilon(\Omega_0) < \Upsilon(\Omega_1)$
- Wage level reduction: if weight on high-multiplier sectors increases (alignment condition), i.e. $\sum_k \Delta_{jk}(v_k - v_j) \geq 0 \ \forall j$ along the path from Ω_0 to Ω_1, then:

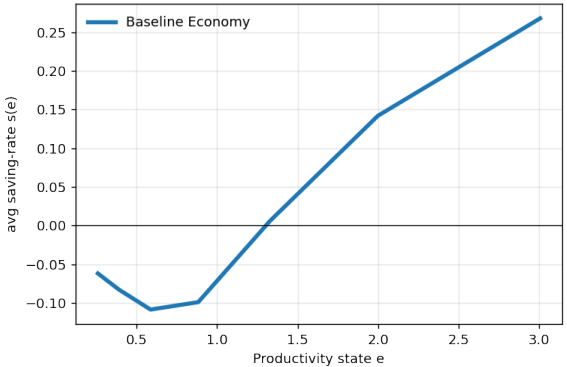
$$\mathbf{v}(\Omega_0) \leq \mathbf{v}(\Omega_1) \quad \Rightarrow \quad \ln \mathbf{w}(\Omega_0) \geq \ln \mathbf{w}(\Omega_1)$$

- **Economic interpretation**
  - Output prices are markups over wages and input prices ⇒ Feedback loop wages ↔ prices
  - ↑ Feedback loop, i.e. ↑ price-wage wedges or multipliers $\mathbf{v}(\Omega)$ ⇒ ↓ Real wages $\ln \mathbf{w}(\Omega)$
- **Empirical evidence**
  - Higher production network intensity typically associated with lower real wages
  - Focus on wage level reduction

Real wages → Wealth inequality

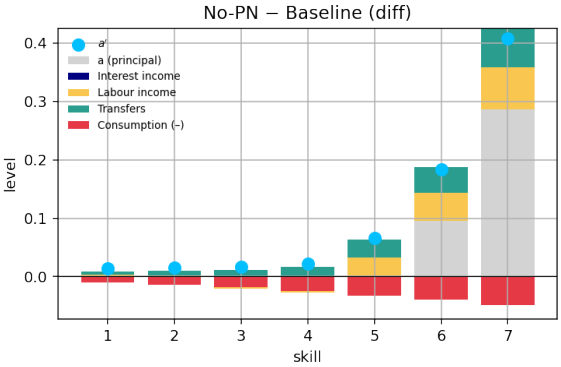
Numerical simulations

Saving rate $s(e_t)$ (steady-state flows, by skill)



- Non-homothetic saving rate: $s(e_t) = \int [(a_{it} - a_{it-1})/y_{it}]\ di(a)$
- Symmetric wage rise ⇒ Asymmetric asset accumulation (high-skill save more)

No-PN - Baseline (steady-state stocks, by skill)



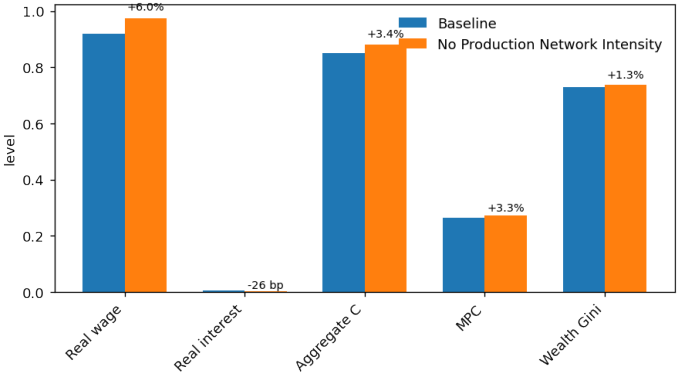
- High-skill accumulate disproportionately more wealth, mainly from asset income, but also labor income (through labor supply) and transfers, only partly offset by consumption

Production network intensity → Wealth inequality

Numerical simulations

- In line with empirical evidence, quantitative model simulations show that ↓ production network intensity ⇒ ↑ real wage ⇒ ↑ wealth inequality

Figure: Key steady–state variables: Baseline (blue) vs 'No-Production Network Intensity' (orange)



Outline

Conclusions

- **Main contribution**: Formal and simple link between production networks and wealth inequality, based on empirical evidence and a quantitative model
- **Main result**: Economies with higher production network intensity, i.e. higher reliance on cross-sectoral input-output linkages, exhibit lower wealth inequality
- **Main Channel**:
  - *Production network intensity affects wage-price feedback loop and, thus, real wage*
  - *Real wage interacts with heterogeneous propensity to save and affects wealth distribution*
- **Future work:**
  - General CES production function for intermediate inputs
  - Introducing aggregate uncertainty to simulate monetary policy shock

Thank You!

Questions?

Appendix

Households

Household i's problem:

$$V_t(e_{it}, a_{it-1}) = \max_{c_{ijt}, n_{it}, a_{it}} \left\{ \frac{c_{ijt}^{1-\sigma}}{1-\sigma} - \phi \frac{n_{it}^{1+v}}{1+v} + \beta \mathbb{E}_t V_{t+1}(e_{it+1}, a_{it}) \right\}$$
$$\text{s.to} \quad c_{it} + a_{it} = (1 + r_t) a_{it-1} + y_{it} - \tau_t \tag{2}$$
$$a_{it} \geq \underline{a},$$

where $y_{it} = \frac{W_t}{P_t^C} e_{it} n_{it}$

Back

Production

Production function:

$$Y_{jt} = A_{jt} N_{jt}^{1-\sum_{k=1}^{S} \omega_{jk}} \prod_{k=1}^{S} X_{jkt}^{\omega_{jk}}. \tag{3}$$

where Y_{jt} denotes the output produced by sector j, N_{jt} the amount of labor used by sector j, X_{jkt} the amount of inputs used by sector j produced by sector k, ω_{jk} the associated weight, and A_{jt} the productivity mapping for sector j

First-order conditions:

- Labor demand: $W_t N_{jt} = \left(1 - \sum_{k=1}^{S} \omega_{jkt}\right) P_{jt} Y_{jt}$
- Intermediate inputs demand: $P_{kt} X_{jkt} = \omega_{jkt} P_{jt} Y_{jt}$

Productivity mapping

Following Ghassibe (2024), for every sector $j = 1, 2, \ldots, J$, the productivity mapping A_{jt} takes the following form:

$$A_{jt} = Z_t \left(1 - \sum_{k=1}^{S} \omega_{jk}\right)^{-(1-\sum_{k=1}^{S} \omega_{jk})} \prod_{k=1}^{S} \omega_{jk}^{-\omega_{jk}}, \tag{4}$$

and Z_t is aggregate productivity following an AR(1) process:

$$\log Z_t = \rho_z \log Z_{t-1} + \zeta_t.$$

Firms minimize costs, leading to input demand and pricing decisions:

$$X_{jkt} = \frac{\omega_{jk} P_{jt} Y_{jt}}{P_{kt}} \tag{5}$$

Back

Fiscal and monetary policy

- **Government:** issues bonds, B, spends on goods and services, G_t, balance budget constraint period by period:

$$\tau_t = B_t + \frac{P_t^G}{P_t^C} G_t - (1 + r_t) B_{t-1} \tag{6}$$

- **Monetary authority:** standard Taylor rule to set the nominal interest rate:

$$i_t = r_t^* + \phi_\pi \pi_t + \epsilon_t \tag{7}$$

where r_t^* is the optimal real interest rate, and ϕ_π is the inflation Taylor rule coefficient

Back

Definitions

- Consumption indices are CES aggregates of consumption of sectoral goods:

$$C_t = \prod_{k=1}^{S} C_{jt}^{\omega_j^C}, \qquad G_t = \prod_{k=1}^{S} G_{jt}^{\omega_j^G} \tag{8}$$

- The sum of sectoral consumption is equal to aggregate consumption:

$$\sum_{k=1}^{S} P_{jt} C_{jt} = P_t^C C_t, \qquad \sum_{k=1}^{S} P_{jt} Y_{jt} = \tilde{Y}_t \tag{9}$$

Back

Calibration

Parameter	Description	Value
Households & preferences		
β	Discount factor	0.9801
EIS	Elasticity of intertemporal substitution	0.50
Frisch	Frisch elasticity of labour supply	0.50
φ	Disutility of labour (level)	1.0905
W	Gross wage (normalisation)	0.90
ρ_e	AR(1) of idiosyncr. earnings	0.966
σ_e	Std. earnings shock	0.50
n_e	# earnings states	7
$\underline{a}$	Borrowing limit	0
Government & policy		
π	Steady-state inflation	0.0
G	Government consumption (% GDP)	27
B	Government debt (% GDP)	85 %
ϕ_π	Taylor-rule coefficient	1.5
ϕ_T	Fiscal feedback (spending)	0.1
r	Real interest rate	0.005
ϕ_τ	Tax feedback parameter	0.2
T^{ss}	Net lump-sum transfers (baseline)	0

Back

References I

Bernon, Bastien, Joep Konings, and Glenn Magerman. 2022. "Income inequality in general equilibrium." National Bank of Belgium Working Paper Research 417.

Costinot, Arnaud, Jonathan Vogel, and Su Wang. 2012. "Global Supply Chains and Wage Inequality." *American Economic Review*, 102(3): 396–401.

Ghassibe, Mishel. 2024. "Endogenous production networks and non-linear monetary transmission." Working paper.

Goldberg, Pinelopi Koujianou, and Nina Pavcnik. 2007. "Distributional effects of globalization in developing countries." *Journal of Economic Literature*, 45(1): 39–82.

Helpman, Elhanan, Oleg Itskhoki, Marc-Andreas Muendler, and Stephen J Redding. 2017. "Trade and Inequality: From Theory to Estimation." *Review of Economic Studies*, 84(1): 357–405.

Schaab, Andreas, and Stacy Yingqi Tan. 2023. "Monetary and Fiscal Policy According to HANK-IO." Working paper.