Policy, Capabilities and Output in EU Net-Zero Industry Sectors: A Combined Production–Accumulation Approach

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Working Group on “System Dynamics for System Innovation”
JRC Seville
1st December 2025

Review of the literature:
Capabilities, Structural Change & Late Industrialisation

- Industrialisation is a cumulative capability-building process: production know-how, engineering, organisational routines, standards.
- Effective industrial policy must coordinate investment, learning and standards rather than just "fix markets" (Amsden, 1989; Lall, 1992; Bell & Pavitt, 1993; Chang, 2002; Andreoni, 2019).
- Late-industrialising countries require active public coordination to reach capability thresholds and escape low-productivity traps.
- This perspective underpins NZIA-type approaches: focus on sectoral systems and capabilities, not only relative prices.

Review of the literature:
Endogenous Growth, Innovation & Intangibles

- Endogenous growth models show how knowledge accumulation and creative destruction drive long-run growth (Romer, 1990; Aghion & Howitt, 1992).
- Empirical work highlights R&D and intangibles (software, data, design, organisational capital) as key drivers of productivity with high social returns (Corrado et al., 2005; Haskel & Westlake, 2017).
- Innovation infrastructures and institutions (clusters, universities, IP regimes, standards) shape the ideas production function and interact with policy (Porter & Stern, 2000, 2001; Bloom et al., 2019).
- This supports NZIA's focus on capability-deepening and intangibles, not only physical capital.

Review of the literature:
Finance, Investment Cycles & Direction of Change

- Financial cycles influence the pace and direction of structural change and the deployment of new techno-economic paradigms (Perez, 2002).
- Credit constraints make firms' R&D and investment highly cyclical and sensitive to policy backstops (Aghion et al., 2012).
- For the green transition, policies interact with non-price risks (permitting, grid access, demand visibility), shaping capital deepening, sourcing choices (domestic vs imported) and complementary intangibles.
- This motivates the focus on guarantees, de-risking and regulatory certainty in NZIA-style policy mixes.

Review of the literature:
Production, Misallocation & Strategic Autonomy

- Econometric work on production functions tackles endogeneity and unobserved productivity: panel GMM (Arellano & Bond, 1991; Blundell & Bond, 1998), proxy methods (Olley & Pakes, 1996; Levinsohn & Petrin, 2003), and identification issues (Griliches & Mairesse, 1995).
- Misallocation is a major source of cross-country TFP gaps (Hsieh & Klenow, 2009), while management and organisation matter for productivity (Bloom & Van Reenen, 2007).
- Trade and GVC literature stresses capabilities and sourcing choices as central to upgrading and strategic autonomy (Rodrik, 2004; Sutton, 2005; Hausmann & Hidalgo, 2011).
- This motivates our combined production–accumulation framework and the split between domestic (Kd) and imported (Km) capital for NZIA vs AONS sectors.

Data sources

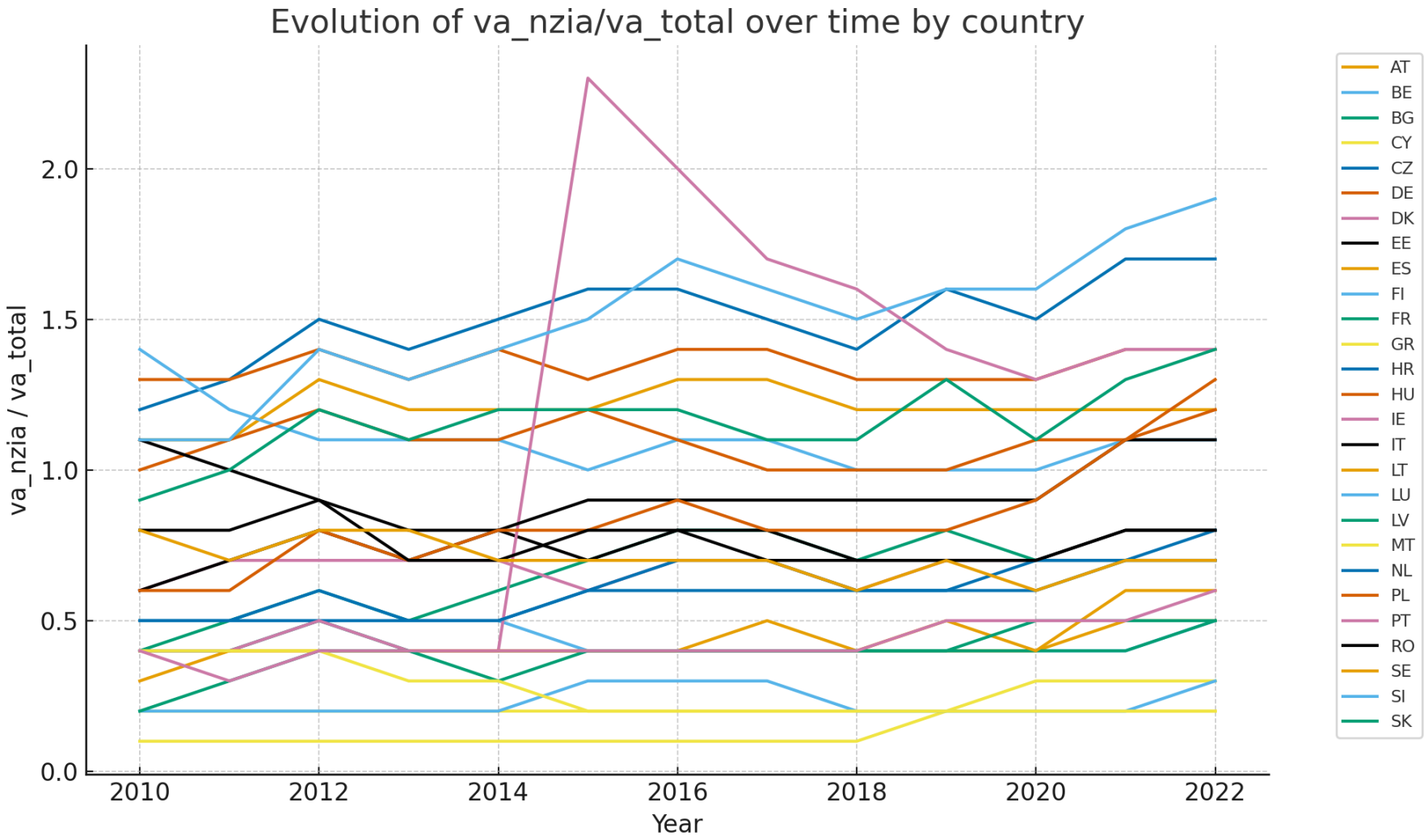
- EU_MS_NZIA_AONS

VA	**Value Added (VA) from the supply side** in this analysis are extracted from the FIGARO Use tables (matrix_eu-ic-use_24ed_YYYY.csv) by sector group (NZIA or AONS) for 2010-2022. In the Use tables, value added is recorded explicitly through its standard components: Compensation of employees (D1), Net taxes on production (D29X39), Gross operating surplus (B2A3G). The sheet contains 5 columns: year, country, va_nzia, va_aons, va_total
Capital	**Gross Fixed Capital Formation (P51G)** data from the FIGARO Industry-by-Industry Input-Output Tables to estimate capital input by sector group (NZIA or AONS) and country over the period 2010–2022. P51G is used as a proxy for capital investment at the industry level. The capital is disaggrated by Domestic and Imported. The sheet contains 8 columns: year, country, capital_total_aons, capital_dom_aons, capital_imp_aons, capital_total_nzia, capital_dom_nzia, capital_imp_nzia
Labour	**Labour Compensation (D1)** data from the FIGARO Industry-by-Industry Input-Output Tables to estimate labour input by sector group (AONS and NZIA) and country for the years 2010–2022. D1 includes both wages and employers' social contributions and is used here as a proxy for labour input at the industry level. The sheet contains 5 columns: year, country, labour_aons, labour_nzia, labour_total
Intangibles	**Intangibles** from EU KLEMS https://euklems-intanprod-llee.luiss.it/download/) here we report the broader defintion of intangibles (incl. organisational capital, training, etc.) for 2010-2021 (not 2022). If needed we have extracted the Intangibles from the National Accounts as well. The intangibles are divided by sector group (AONS and NZIA). There are 5 columns in sheet: country, year, intan_total, intan_nzia,intan_aons

- DG COMP's State aid Scoreboard

The metadata can be consulted here: https://competition-policy.ec.europa.eu/document/download/94d0dd07-ef97-4580-b9e2-9c05bb4b82a8_en?filename=scoreboard_reference-metadata-on-methodology-and-quality.pdf

Descriptive statistics: EU_MS_NZIA_AONS



Descriptive statistics: EU_MS_NZIA_AONS

capital_imp_aons	capital_imp_nzia
22.7	57.3
22.9	52.5
24.4	54.1
23.5	52.0
24.8	55.2
25.5	55.9
25.7	55.9
26.5	57.0
26.9	56.6
27.6	57.7

Descriptive statistics: DG COMP's State aid Scoreboard

Policies	Total aid in constant prices (EUR Mil.)	%
Additional costs (Art.15(4))	3413.2	
Additional costs in outermost regions (Art. 15(2)(b))	10968.7	
Aid for 4G and 5G mobile networks (Art. 52a)	5.8	
Aid for broadband infrastructures (Art. 52)	3650.0	
Aid for compensating the additional costs of employing disabled workers (Art. 42)	1322.3	
Aid for compensating the additional costs of employing workers with disabilities (Art. 34)	1955.9	
Aid for compensating the costs of assistance provided to disadvantaged workers (Art.35)	719.9	
Aid for consultancy in favour of SMEs (Art. 18)	997.8	
Aid for consultancy in favour of SMEs (Art. 26)	2202.1	
Aid for cooperation costs incurred by SMEs participating in European Territorial Cooperation projects (Art. 20)	208.5	
Aid for costs incurred by undertakings participating in European Territorial Cooperation projects (Art. 20)	67.7	
Aid for culture and heritage conservation (Art. 53)	33428.8	
Aid for early adaptation to future Community standards for SMEs (Art.20)	43.4	
Aid for environmental studies (Art. 49)	375.6	
Aid for environmental studies (Art.24)	98.9	
Aid for fixed broadband networks (Art. 52)	1179.2	
Aid for industrial property rights costs for SMEs (Art. 33)	412.7	
Aid for innovation advisory services and for innovation support services (Art. 36)	433.8	
Aid for innovation clusters (Art. 27)	1776.8	
Aid for Marie Skłodowska-Curie actions and European Research Council Proof of Concept actions (Art. 25b)	0.3	
Aid for newly created small enterprises (Art.14)	522.9	
Aid for process and organisational innovation (Art. 29)	620.9	
Aid for projects awarded a Seal of Excellence quality label (Art. 25a)	57.6	
Aid for research and development in the agricultural and fisheries sectors (Art. 34)	1146.8	
Aid for research and development in the fishery and aquaculture sector (Art. 30)	288.1	
Aid for small enterprises newly created by female enterpreneurs (Art. 16)	0.1	
Aid for SME participation in fairs (Art. 27)	270.9	
Aid for sport and multifunctional recreational infrastructures (Art. 55)	2602.7	
Aid for start-ups (Art. 22)	3530.0	
Aid for studies and consultancy services on environmental protection and energy matters (Art. 49)	3.6	
Aid for technical feasibility studies (Art. 32)	2007.8	
Aid for the acquisition of new transport vehicles which go beyond Community standards or which increase the level of environmenta	314.4	
Aid for the employment of disabled workers in the form of wage subsidies (Art. 41)	7430.6	
Aid for the employment of workers with disabilities in the form of wage subsidies (Article 33)	17217.9	
Aid for the establishment of research infrastructures (Art. 26)	2220.2	
Aid for the loan of highly qualified personnel (Art. 37)	13.5	
Aid for the recruitment of disadvantaged workers in the form of wage subsidies (Art. 40)	3313.1	
Aid for the recruitment of disadvantaged workers in the form of wage subsidies (Article 32)	2346.2	
Aid in the form of financing supported by the InvestEU Fund provided to SMEs or small mid-caps (Art 56e(10))	14.8	

Methodological framework

- We estimate a **dynamic production function** in which **value added** is explained by four main inputs: **domestic capital, imported capital, labour and intangible assets**
- These are estimated separately for the NZIA and AONS sectors.
- We first model each input as an autoregressive process with **policy variables and fixed effects**, and use the **residuals** from these input equations as control-function terms that **proxy unobserved productivity shocks**.
- These residuals are then included in the value-added equation, allowing us to correct for **simultaneity between input choices and productivity** and to obtain more reliable estimates of the elasticities of output with respect to domestic and imported capital.
- In a second step, we estimate the **full system of equations using 3SLS**, which exploits the cross-equation structure and improves efficiency while treating **all inputs as endogenous**.
- This combination of dynamic fixed effects, control-function correction and system estimation provides a coherent framework to identify both the relative contribution of domestic versus imported capital and the **way in which different policy instruments shape input accumulation and, ultimately, sectoral productivity**.

Methodological framework

5.1 Production block (TFP channel)

For sector $s \in \{NZIA, AONS\}$, country i and year t, the production equation is specified as follows:

$$y_{ist} = \alpha_i + \tau_t + \beta_{Kd} \cdot \ln(K^{d}_{ist}) + \beta_{Km} \cdot \ln(K^{m}_{ist}) + \beta_L \cdot \ln(L_{ist}) + \beta_I \cdot \ln(I_{ist}) + \theta^{T} \cdot P_{it} + \pi^{T} \cdot (P_{it} \circ Z_{ist}) + \varepsilon^{y}_{ist},$$

with $y_{ist} \equiv \ln(VA_{ist})$.

Here K^{d}_{ist} and K^{m}_{ist} are domestic and imported capital, respectively, L_{ist} is labour, and I_{ist} is intangible capital. P_{it} is a vector of policy variables (all sub-policies), and $P_{it} \circ Z_{ist}$ denotes element-wise interactions (e.g. policy $\times$ ln I) capturing potential complementarities with sector- or input-specific characteristics Z_{ist}.

Expanding the policy term explicitly over all K sub-policies $P_{k,it}$, the equation can be written as:

$$y_{ist} = \alpha_i + \tau_t + \beta_{Kd} \ln K^{d}_{ist} + \beta_{Km} \ln K^{m}_{ist} + \beta_L \ln L_{ist} + \beta_I \ln I_{ist} + \sum_{k=1}^{K} \theta_k P_{k,it} + \sum_{k=1}^{K} \pi_k [P_{k,it} \cdot Z_{ist}] + \varepsilon^{y}_{ist}.$$

Main empirical findings

1. Production technology and inputs

Value added is explained by domestic capital, imported capital, labour and intangibles, using a dynamic panel and 3SLS system.

All inputs show strong persistence (high AR(1) coefficients), indicating substantial inertia in firms' production structures.

2. Domestic vs imported capital

Imported capital (Km) has a large, positive and highly significant elasticity in both sectors, especially in **NZIA**.

Domestic capital (Kd) is never statistically significant in the value-added equation in either NZIA or AONS.

Tests strongly reject the hypothesis that the elasticities of Kd and Km are equal, confirming a structural asymmetry.

Main empirical findings

3. NZIA sector

NZIA is **strongly dependent on imported capital**, which drives a large share of value added.

Guarantees have a strong, positive and significant effect on domestic capital accumulation and intangibles.

Loans/repayable advances and some **tax advantages** show negative effects, suggesting that debt-based and poorly targeted fiscal tools can discourage investment. Traditional instruments (direct grants, broad tax incentives) generally have weak or no effects once dynamics and fixed effects are controlled for.

Main empirical findings

4. AONS sector

AONS is **less responsive to policy**, with smaller coefficients and lower significance levels.

Labour plays a much larger role in explaining value added than in NZIA: the sector is clearly more labour-intensive.

Guarantees still have a positive effect, but the magnitude is much smaller than in NZIA. Direct grants occasionally show small positive effects; most other instruments have limited impact.

The sector is heavily driven by its own inertia (high persistence in Kd and L), rather than by policy.

Main empirical findings

5. Conclusion

There is **strong sectoral heterogeneity**:

NZIA: capital-intensive, globally integrated, highly sensitive to guarantees and imported capital.
AONS: mature, labour-intensive, weakly affected by financial support instruments.

Many policy variables are collinear and often implemented in bundles, which limits the ability to identify large marginal effects for individual instruments.

Policy implications

The results suggest that EU industrial policy should be clearly differentiated across sectors.

In NZIA-type activities, public guarantees appear to be the only instrument with a strong and robust impact on capital formation, while debt-based tools and broad tax advantages risk crowding out investment or having no meaningful effect. Given the dominant role of imported capital, policies that secure resilient access to foreign high-tech equipment are likely to be more effective than those focused solely on domestic capital.

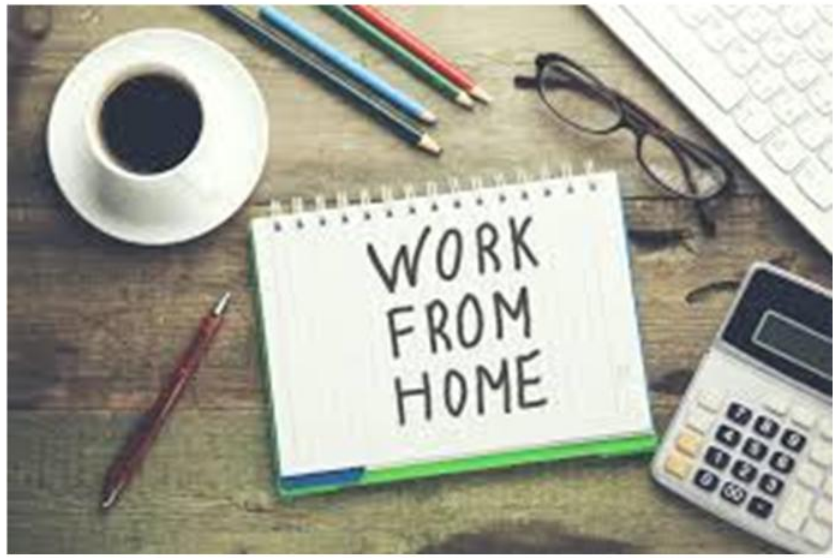
In contrast, AONS sectors are more labour-intensive and largely driven by structural inertia, with only modest responses to financial support measures. Here, horizontal interventions targeting skills, productivity and gradual upgrading may be more appropriate than trying to shift investment through grants and tax incentives alone.

What's next?

- Policy construction:
  Add other 'general' policies, i.e. employment
  Lag policy variables (t−1, t−2) to reduce simultaneity
  PCA to mitigate multicollinearity
  Scale by GDP/population where appropriate

- Specification:
  Add country-specific trends
  drop 2020 to check pandemic sensitivity
  Interact policy_index × imported-capital share to test whether policy effects are indeed stronger where imported capital matters more
  As an alternative to reg3, run a dynamic system GMM (Arellano–Bover/Blundell–Bond) as a check on the dynamic FE + CF approach.

Thank you!



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